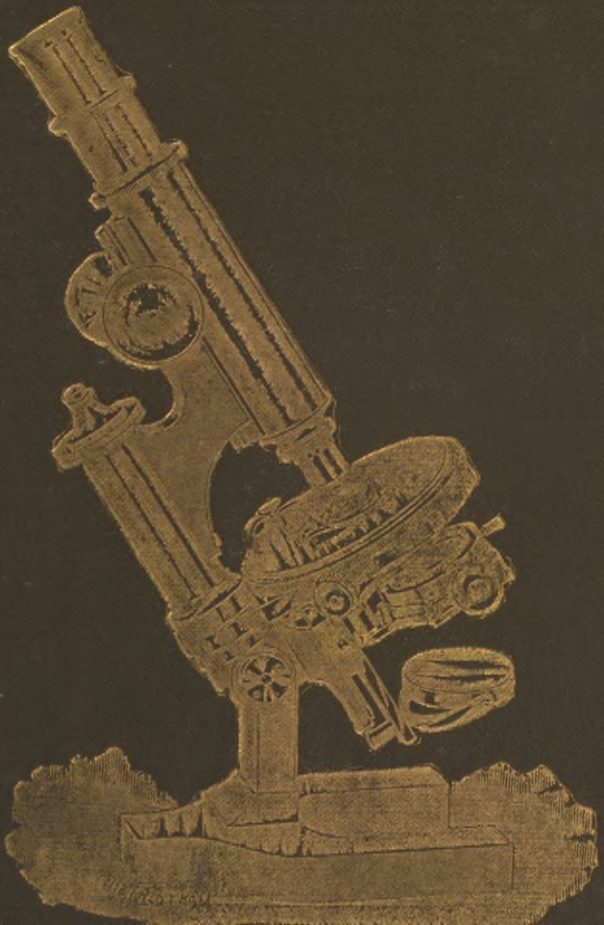
edical Microscopy

Reeves



HAND-BOOK

OF

MEDICAL MICROSCOPY.

REEVES.

A HAND-BOOK

OF

MEDICAL MICROSCOPY

FOR

STUDENTS AND GENERAL PRACTITIONERS,

INCLUDING CHAPTERS ON

BACTERIOLOGY, NEOPLASMS, AND URINARY EXAMINATIONS.

BY

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WITH A GLOSSARY

AND NUMEROUS ILLUSTRATIONS (PARTLY IN COLORS).

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TO

MRS. FRANCES M. REEVES,

MY BELOVED WIFE

AND

ONLY COMPANION IN MICROSCOPY,

WHOSE GREAT MIND AND LOVING HEART HAVE ENCOURAGED
MY PROFESSIONAL ENERGIES AT EVERY STEP, AND TO
WHOM I AM INDEBTED FOR THE GREATEST
HAPPINESS OF MY LIFE,

THIS VOLUME

Is Gratefully and Most Affectionately Dedicated

BY

THE AUTHOR.

PREFACE.

This little volume has been written from the standpoint of a general practitioner of more than forty years' active experience who thinks he is well acquainted with the needs of his professional brethren.

It cannot fail to strike all those who have paid any attention to modern medical education that the microscope has contributed in very large measure to bring about the high scientific tone which characterizes the profession of to-day. Indeed, as an aid to correct diagnosis, it is the most important instrument in the hands of the physician; yet those who have neglected to make themselves familiar with its advantages in the daily routine of ordinary practice are in overwhelming majority,—the excuses offered for such delinquency being "lack of time," "the expense of a microscope," and "no private teacher," or "guide-book worthy of the name."

It is the object of this volume to deny all such excuses by showing how small the necessary expense of a microscopic outfit—how easy and delightful the way to successful work, or for the physician to become his own microscopist.

The book itself proves what may be accomplished by singleness of purpose without a teacher, also the truth of the old adage, "Where there is a will there is a way." In other words, I have tried in a plain and simple manner to put myself "in his place," and given just such a guide as I felt the need of when I began the study of microscopy, and would most cheerfully have paid for the instruction a hundred times the price of this volume.

For kindly and valuable assistance in carrying the work through the press, I owe many grateful thanks to Professor Charles S. Dolley, Professor James Tyson, and Dr. John H. Packard. Also, I am indebted to the publishers for their painstaking to produce one of the handsomest volumes ever issued by them.

I have no apologies to offer in presenting the work; for it is intended to be useful, and must stand or fall by its own measure.

JAMES E. REEVES.

CHATTANOOGA, *July, 1894.*

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HAND-BOOK

OF

MEDICAL MICROSCOPY.

I. INTRODUCTION.

IMPORTANCE OF THE MICROSCOPE IN MEDICINE.

For the purposes of this volume, it would be a waste of words and space to repeat the oft-written history of the Microscope, and tell how from the beginning with a simple convex lens, or magnifying glass, the instrument has reached marvelous perfection, optical and mechanical, and become a necessity in the households of Science and Art.

Neither is it necessary to attempt a recital of the many ways in which the microscope has advanced the science and art of medicine. Open any book we may, and behold the revelations of the microscope. Indeed, but for the priceless aid afforded by this instrument in the discovery of exact knowledge of the minute structure of the human body in healthy and diseased condi-

tions, the complete text-books of to-day on anatomy, physiology, pathology, bacteriology, and the theory and practice of medicine would have been an impossibility.

Especially may we boast of the truly wonderful advances made in bacteriology—the newest branch in the cycle of the medical sciences,—and claim for its all-absorbing importance the crowning glory of microscopic triumph. By its searching power and incomparable penetration into the boundless world of life which lies beyond the ken of normal vision, the microscope has wrought a complete transformation of once dominant ideas concerning the nature and treatment of epidemic and contagious diseases; thus dethroning and demolishing long-cherished idols, whose dicta had not only swayed the multitude of medical opinion, but really made it hazardous to disregard their precepts in the diagnosis and treatment of many diseases.

In those days, however, the laborers in the medical vineyard saw "through a glass darkly, but now face to face;" and in the near future it is confidently hoped the Ark of the Covenant with biologic science, quickened by the possibilities of microscopic technique, will move forward another day's journey to possess richer fields and broader highways in the realms of "Biologos." Then, looking down from some Pisgah height, peering deeper and deeper into the little lump of protoplasmic jelly, the basis of life, from which the cell-wall is elaborated and all living structure springs—"things that visive organs reach not,"—we may, per-

chance, find the secret of life and save the children of men from "the pestilence that walketh in darkness and the destruction that wasteth at noonday."

The time has now come when all progressive physicians and surgeons, general practitioners and specialists alike, must either themselves possess sufficient skill in microscopic technique for the faithful and proper discharge of the high obligation which rests upon them in the diagnosis and treatment of diseases, or else be able to command the ready service of some accomplished microscopist and pathologist to do such necessary work for them. In no other way can they conscientiously perform their duty to those whose lives are placed in their hands, and fully meet all the reasonable requirements of advancing medical science.

To be a learned, capable physician in the full sense requires that he shall be an all-round doctor,—physicist, chemist, anatomist, physiologist, pathologist, bacteriologist, and microscopist: have all these varied qualifications correlated and blended with his professional name and life-work, never forgetting for a moment that it is the welfare of the patient he should always have first at heart.

Pathologic microscopy is the key to open up the way to rational and successful treatment. It is the foundation to all therapeutic deduction; and without its proper study and acquaintance, the Practice of Medicine and Surgery would be but little better than guesswork and a dangerous play with human life.

How should the astronomer hope to be able to com-

prehend his subject without having a thorough knowledge of mathematics and skill in the manipulation of the telescope? or the pilot on an ocean steamer find his way to the port for which he set sail without a compass to guide his course across the trackless waters? Such, precisely, is the relation which pathologic microscopy occupies to the practice of medicine in all its branches; it touches every department of the profession with immense practicality, and nothing can supplement its power in the search for abstract truth concerning diseased conditions and their proper treatment.

To comprehend disease at the bedside or wherever else it is confronted, the physician must have in his mind's eye a clear and exact picture of the changes going on in the minute structure of the part involved; he must know the nature of the disease—"hear the cry of the suffering organ," and distinguish it—before he can reasonably hope to repair the wrong. It is not enough merely to look into a microscope. A person who cannot tell a microscope from a telescope may do as much, and go away from the instrument without having derived the least profit by his curiosity.

There is a vast difference between seeing and observing. To be able to observe correctly requires not only eyes to see, but fingers to feel and a heart to sympathize. Every avenue of the mind and soul should be engaged and cultivated to the most delicate impressions—indeed, all these being necessary qualities of preparation, which neither books alone nor the possession of the

most complete microscopic outfit, or both combined, can supply.

In pathology, as elsewhere in the domain of science, there is no short road to knowledge and technical skill. The eye, the hand, and the mind must all alike be trained by long use before a technique most complex and difficult can be mastered and scientific research undertaken with hope of credit.

When I began the use of the microscope, nearly twenty years ago, there were but few pathologic laboratories in the United States, and even the chairs of Histology and Pathology were "more honored in the breach than the observance" in at least nine-tenths of the first-class medical colleges. But now, what a happy advance. In every large city well equipped pathologic laboratories have sprung up to meet the professional demand; every first-class medical college can now boast of its laboratory equipments and "show its faith by its works;" and thus in all directions we may discover the march of scientific medicine.

At the beginning of my experience with the microscope, I fully realized the fact that the instrument was more ornamental than useful in my hands, but I never became discouraged by my failures to meet my own expectations; and so, on and on, I have kept going to this day, when I find myself more than ever before in love with my silent but most instructive companion,—the wonderful instrument which has aided me in a thousand ways of doing good to my patients by a correct understanding of their diseases.

The whole world of science was at once quickened into activity by the discoveries of Pasteur, Koch, and others in bacteriology; and nothing of all the revelations of the microscope is or can be more interesting to the medical scientist, or of greater importance to mankind, than the knowledge thus derived concerning living microörganisms,—their almost incredible minuteness; some of them rods, others spirals, others chain-like, others ovals, others spheres, each class arranging itself in its own peculiar order; their wonderful life-histories and marvelous rapidity of growth, either by division or spores, some well-known forms doubling their number every hour, so that a single bacterium may produce eight million, three hundred and eighty-eight thousand, four hundred and eight of its kind in the space of twenty-four hours, each variety elaborating its own specific poison in the genesis of disease, and of incomparable activity in the processes of fermentation and putrefaction; some of them having power of motion by means of flagella at one or both ends; either aërobic or anaërobic, and producing pigments of various colors; liquefying gelatin or not; cultivated in various media outside the animal body, and having a thermal death-point ranging from 122° to 212° F., according to the particular variety, culture-medium, and time of exposure: a temperature of 212° F., maintained for five minutes, being sufficient to kill all pathogenic organisms and their spores.

But notwithstanding the value of the microscope as an aid in advancing pathology and bacteriology, it is not to

be supposed that sharp cultivation of the senses by clinical experience is less necessary now than before the instrument became of such high importance in all the branches of the practice of medicine and surgery. To feel the pulse, look at the tongue, hear the heart's beat and other physical sounds in the chest, and go over the patient from head to foot to find out the diseased organ or failure of function is just as necessary to-day as before instruments for diagnostic precision were used. The symptoms of pulmonary involvement by disease are not less important because we have the pleximeter and stethoscope to discover physical signs, and the microscope with which to examine the sputum. And should the surgeon be excused for less skill with the knife because he cannot tell certainly a sarcoma from a carcinoma, or a benign tumor from a malignant growth without the aid of the microscope?

While the science and art of medicine have been greatly improved in modern times by the proper use of ingenious instruments, clinical skill is none the less important for the correct interpretation of symptoms and the causes of diseases. Indeed, by reason of the now indispensable instrumental aids in the hands of the physician, clinical knowledge and skill are more necessary than ever before. In tracing disease to its origin the necessary methods are far more complex and intricate than those hitherto employed. The high aim now is at the precision of the exact sciences, and in that way pathology and therapeutics are both aided and advanced.

The following examples, selected from a large number that could be furnished, are given in proof of the every-day value and necessity of the microscope in the practice of medicine and surgery:—

CASE I.—A pale-faced young woman, unmarried, came to me on account of her uneasy sensations, from which she had suffered, more or less, for the previous six months. She had a dragging gait, and complained of loss of appetite, pain in the back and weakness in the lower limbs, palpitation of the heart, sleeplessness, nervousness, "a ball in the throat," and a constant feeling of general weariness. She was dark under the eyes, had lost flesh, suffered from leucorrhea, and was plainly hysterical.

After hearing the history, I told her to bring me for three successive days a morning and evening specimen of her urine. The next day she came with the first bottle. The urine was pale and cloudy, of low specific gravity, and slightly alkaline. Microscopic examination of the deposit revealed numerous spermatozoids; and thus the cause of all her ailments was most surprisingly discovered.

CASE II.—A married man, having a creamy-looking discharge from the urethra and painful urination, came to me with a sad story—sad because he charged his wife with infidelity and blamed her for his condition, firmly believing he had gonorrhea and that he contracted the disease from her. To make very sure, however, that there should be no mistake about the case before beginning divorce proceedings and making public his shame, he determined to have me make a microscopic examination of the running matter from his privy member.

The absence of Neisser's gonococcus in the pus-discharge was my warrant for telling the unhappy man that he had charged his wife wrongfully. She had an acrid leucorrhea, and he, as a consequence of his wife's innocent affliction, had a non-specific urethritis—"merely this and nothing more." He went away from my office wiser and happier than when he came, and was soon well of his "bad disorder."

CASE III.—A female child, three years old, suffered from frequent and painful micturition. The vulva was inflamed and much swollen, accompanied with copious leucorrheal discharge. This condition of the symptoms had lasted eight or ten days when a specimen of the child's urine was brought to me for examination with the report that the mother had tried various domestic remedies, including castile soap washes, but without effect. A drop of the deposit in the urinary specimen placed under the microscope showed large crystals of ammoniaco-magnesium phosphate and a female oxyuris, or seat-worm. Of course, after the discovery of the worm, the cause of the little patient's distress was made plain and the curative treatment at once instituted.

CASE IV.—A physician in Western New York sent me what he supposed to be "an undescribed intestinal parasite," and with it the following history of the case:—

The patient, a female, aged thirty-six, and unmarried. She was a chronic sufferer from "nervous dyspepsia," and every few days passed strange-looking masses from the bowels, like the specimen I had received. With each like discharge the patient became more and more alarmed about her condition, and the case was a puzzle to the attending physician.

After examining the specimen I wrote the physician and asked him if his patient was not fond of oranges? The hint was enough, and he replied, "Yes, sometimes she devours a dozen a day." The supposed intestinal parasite was nothing more than a portion of the undigested pulp of an orange.

CASE V.—The patient had suffered from sore and painful ears for several weeks. The external meatus was the seat of trouble, and besides great tenderness and pain, there was a slight creamy discharge. A cover-glass preparation of the matter showed the *Aspergillus nigricans*, or fungous character of the affection. Thorough douching with a solution of the hyposulphite of soda, and powdered alum blown into the ears, cured the disease promptly.

CASE VI.—An unmarried female, aged twenty-seven, a seamstress, enjoying the benefits of a comfortable home, consulted me on

account of her suffering for eighteen months from nausea and vomiting, coming on within an hour after each meal, regardless both of quality and quantity of food taken into the stomach. She had lost flesh, and was pale and feeble in appearance; but her will-power never failed, and kept her from giving up her trade-work.

For relief from her distressing condition she had been under treatment by several physicians, and, from first to last, had taken every dose—pharmaceutic and domestic—she could hear of as ever having been of service in dyspepsia. Besides medicinal doses and the observance of dietetic rules, she had had her stomach washed out several times, but all of no lasting benefit.

I placed a fragment of the yeast-like vomited matter on a slip of glass and added to it a drop of liquor potassa colored with methylin blue. When placed under the microscope, the well-known fungus, **Sarcina ventriculi**, was easily discovered as the probable cause of the stomach trouble.

A dose composed of one drop of carbolic acid and ten grains of hyposulphite of soda, administered before each meal, did more good than all else that had been given; but I soon lost sight of the case and do not know whether the patient was permanently benefited by the treatment or not.

CASE VII.—Miss ——, aged twenty-six, of healthy parentage, average weight 130 pounds, dark hair and eyes, bright and cheerful disposition, with active home-life and good hygienic surroundings.

Nearly four years previous to the recent illness below described she had an attack of dysentery which lasted two weeks before convalescence was fully established. After recovery from that sickness she grew fat and hearty, and remained the very picture of perfect health until July, 1892, when she began to droop; lost her appetite, had a hacking cough, was feverish in the afternoon and chilly in the morning, with constipated bowels and sleeplessness. Such was her condition for ten or twelve days, during which she lost flesh and strength in a marked degree. Then suddenly followed exacerbation of all the features of the case, and the attending physician was hurriedly summoned. There had been a severe chill, and the

pain in the right chest, extending from the axilla to the liver, was now so acute that she could not take a full breath without a moan. The cough was most harassing and unappeasable, expectoration copious and of pneumonic appearance, respiration hurried and jerking, temperature 103½°, and rapid pulse.

Day after day this condition continued with but little change, except that the expectoration became more and more copious. The persistent cough, heavy expectoration, night-sweats, wasting of flesh, and progressive debility led the family and friends to fear the case was one of "hasty consumption," and to clear up the diagnosis a specimen sputum was sent to me for microscopic examination, by the attending physician.

The absence of tubercle bacilli and presence of pus cells, fragments of hepatic tissue, and liver-cells, was unmistakable proof that the case was one of hepatic abscess communicating with a bronchus certainly, and, probably, also the colon.

After two months' confinement from this serious illness, during which she several times passed by stool pus-like matter, the recovery was sufficiently complete to enable her to go out-of-doors and visit among her friends. She kept up for several months and then was taken down again to endure the same suffering as at first. During this second illness, the expectoration sometimes showed, mixed with the pus-discharge, little gelatinous masses streaked with blood, which I examined for **Amœba coli** with negative result. The patient is now, to all appearances, perfectly well.

CASE VIII.—A babe six weeks old that had an easy birth, and thrived well at its mother's breast for the first fifteen or twenty days, was attacked with diarrhea and soon transformed from a fine, plump, healthy infant into a starved nursling with sunken jaws and wrinkled skin, notwithstanding an undiminished supply of mother's milk. A specimen of the secretion was brought to me for microscopical examination and found to contain colostrum corpuscles and comparatively few milk globules. The presence of colostrum corpuscles, normally present during the first eight or ten days after childbirth, was proof of the poor quality of the milk. The infant was taken

away from the breast, fed artificially, and at once commenced to improve.

CASE IX.—A young man discovered a small tumor, not larger than a filbert, under the skin a little below and to the left of the navel, and tender on pressure. It soon began to increase in size, and he went to a surgeon, who advised its immediate removal and performed the operation. The specimen was brought to me for microscopic examination, and turned out to be a small round-celled sarcoma. My diagnosis was received with evident distrust by the surgeon, he thinking the growth nothing more than "a simple fibrous tumor." I replied, "I hope so."

Within the next eighteen months quite a number of like tumors made their appearance under the skin in different parts,—principally in the groins and about the root of the neck,—and at the expiration of two years from the date of removal of the first tumor the patient was dead,—the death-certificate giving correctly the cause of death, "Multiple Sarcoma."

CASE X.—A clerk in the office of the W. & A. Railway, at Atlanta, came home to Chattanooga on account of his sickness, which had lasted for several days and presented symptoms pointing to an attack of "the fever" which then prevailed in that city. He had started out with a decided chill, head-ache, pain in the back, and soreness of the muscles from head to foot, loss of appetite, thirst, nausea, with occasional vomiting, and inability to sleep.

When the patient came under my observation his condition for the first three days so closely resembled genuine enteric or typhoid fever, with which I had been so long familiar, that I thought the opportunity was at hand of showing my professional neighbors the wide difference in the mode of access, march, and complications between this case and the usual clinical history of the malarial fever-cases met with at all seasons in this community and the country round about.

There was, however, something about the case when the symptoms were all critically studied, after a few days' attendance, that excited my uncertainty of the diagnosis, and I appealed to the mi-

croscope for a decision. A drop of blood taken from the finger showed the presence of both crescents and pigment granules, thus proving the malarial character of the case.

The temperature range was more fitful than in typhoid fever, perhaps, for one day running at 100½° in the morning and 102° in the evening; the next day, 103° in the morning and 101° in the evening. On the tenth day the afternoon temperature reached 104½°, the following day it did not go above 100½°. At no time was diarrhea present. Within two weeks the patient was discharged.*

CASE XI.—Mrs. ——, aged forty-three, the mother of five

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* It was not until after my removal to Chattanooga, in 1888, that I had frequent opportunity of seeing this hydra-headed form of continued fever,—variously called "typhoid fever," "typho-malarial fever," "simple malarial fever," "continued malarial fever," etc.,—such as the case above reported. I can remember several occasions when I was in doubt, during the first week of the case, because of the fitful and irregular march of the symptoms.

The poison of malaria and the contagium of enteric or typhoid fever are not antagonistic forces, and may conjointly display their effects, thus producing a commingling of symptoms truly confusing to the clinician; but such a blending of types cannot give origin to a distinct, permanent type of fever. Such products are hybrids in the full sense of the word, and wholly incapable of multiplication. When the enteric or typhoid element is conjoined, then *that* is the only quantity which is capable of propagation, or spreading from person to person.

Enteric or typhoid fever is communicable from person to person, and cannot spring up *de novo*. In its prevalence, it may assume different degrees of severity,—appear either in isolated cases with but feeble contagious power, or seize whole households, attack whole neighborhoods, or spread over large districts, according to the prevailing "epidemic constitution."

Such is not the history of the outbreak and spread of continued

children, short in stature, accustomed weight one hundred and fifty pounds, ruddy complexion, rheumatic or gouty tendency, and enjoying a full share of home comforts, including the protection afforded by good hygienic surroundings, while warm and perspiring, exposed herself to a cool draught in an open porch, where she sat for a few minutes "to cool off." She soon became chilly, and from that moment her illness began. For the next week she complained of stiffness and soreness of the limbs; had headache, backache, and was more or less feverish and thirsty. At the end of that time her attending physician pronounced the case enteric or "typhoid fever," and treated it accordingly, he being very careful to avoid laxative medicine.

On account of rapid deepening of all the symptoms, I saw

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malarial fever. The clinical features are also markedly different. The temperature-curve is more variable and uncertain as to the time of rise and fall; the remissions are more regular and decided; the gastro-hepatic involvement is more pronounced; and the absence of diarrhea, epistaxis, tympanites, rose-colored eruption, dull and listless expression of countenance, and great prostration of muscular strength, that mark enteric or typhoid fever. Besides, the duration of malarial fever is shorter.

In enteric or typhoid fever one attack affords immunity, usually, for the remainder of life. This is as constant as the safety from a second attack of measles, smallpox, scarlet fever, or yellow fever. In malarial fever the patient is more liable to a second attack than if he had not had the disease, and so on his liability increases with each successive attack.

After convalescence from enteric or typhoid fever, there is in most cases rapid accumulation of flesh which is out of all proportion to the muscular strength; the hair falls out, and in due time the person is either greatly improved in general health or quickly succumbs to tubercular consumption, if he have such tendency. After convalescence from malarial fever, the subject is for months in poor health and strength, his countenance is sallow, and digestion feeble.

the patient in consultation on the tenth day after the date of exposure on the "porch" where she was said to have taken cold. She had fever, cough, with frothy expectoration streaked with blood, hurried and jerking respiration, dusky countenance, and slightly contracted pupils; puffiness of the eyelids, feet, and ankles; twitching of the muscles, itching of the skin, bowels not moved for twelve hours, urine scanty and dark-colored, and, withal, great drowsiness of manner.

An immediate examination was made of the urine. It was of acid reaction with sp. gr. 1012, and highly albuminous. Under the microscope the deposit revealed all sorts of casts—blood casts, epithelial casts, both pale and dark granular casts, a few hyaline casts, and a still fewer number containing oil drops. Besides casts there were red blood and white blood corpuscles, crystals of uric acid, and granular matter.

After these discoveries in the urine, the plan of treatment was changed so as to include as quickly as possible the revulsive and hydragogue effect of a full dose of compound jalap powder, under which influence the patient waked up from her uremic intoxication. During the next couple of weeks the jalap powder was several times repeated.

To make a long history short, it may be stated that within the next three months the patient was able to go out-of-doors, and after twelve months she seemed to have so far recovered as to be able to resume control of her household affairs; but all the while she was extremely sensitive to changes of weather, and suffered from slightly swollen feet and ankles. Now, ten years afterward, notwithstanding the reminder of a little swelling of the feet and ankles, she is still in the enjoyment of a fair state of health by avoiding, in her manner of living, excesses and exposures of every kind.

In the diagnosis and treatment of urinary and renal diseases, I am so very dependent upon the microscope for guidance that I should be compelled to decline the medical management of all such cases if from any cause I were deprived the use of the instrument, for without it my treatment would be but guesswork.

The mere discovery of albumin in the urine is not alone sufficient to establish the diagnosis of Bright's disease. Indeed, there may be a form of this malady with but slight, if any, trace of albumin, especially in the interstitial variety of the disease so common in whisky drinkers or habitual "tipplers" and hard-pressed business men, in which cases there may be no complaint of serious trouble in the kidneys until the subject is struck down with a convulsion.

Any life insurance agent or other person totally ignorant of the pathology and treatment of Bright's disease may learn in a half-hour's time how to make the test for albumin; but the burden of most important knowledge concerning the condition of the kidneys—important alike to the company and the applicant—can only be obtained in the field of the microscope by a competent manipulator and appreciative observer.

CASE XII.—Mrs. ——, aged thirty-one, of tuberculous family, but enjoying accustomed good health, took cold from wet feet, and sickened with symptoms so closely conforming to the usual clinical history of enteric or typhoid fever that no doubt existed in the mind of her experienced physician concerning the correctness of his diagnosis—namely, "typhoid fever;" and the case was treated accordingly for more than three weeks. After the beginning of the third week there was but little change in the symptoms, nothing to mark particular attention except the increased amount of heavy expectoration and an occasional night-sweat. Cough and bronchial râles were prominent features among the prodromata, and the nose bled once or twice. From the beginning of the illness there was a tendency to looseness of the bowels. The rose-colored spots were not searched for because of the assumed certainty of diagnosis. The anticipated and anxiously looked for critical days came and passed without sign of improvement, and in that way the fifth week was reached without abatement of any of the symptoms. All the while, the appetite was poor and capricious, sometimes amounting to entire disgust of food.

On account of the lingering character of the case—the unappeasable cough and copious expectoration, wasting of flesh and strength, easily relaxed bowels, hectic and night sweats—it was deemed ad-

visable to have a microscopic examination made of the sputum, when lo! swarms of tubercle bacilli were discovered. The patient died within four months from the beginning of her illness, the death-return being "Acute Tubercular Phthisis"—to which might have been added, of the typhoid type.

And thus I might go on narrating case after case in my experience to prove the value of the microscope in the practice of medicine and in the pursuit of scientific truth.

The microscope is the watchful sentinel to warn us against the enemies of our flesh. It scans with searching eye the food we eat, the water we drink, the clothing we wear, and the very air we breathe. And this is not all of its usefulness. Besides helping us to understand the nature of our diseases and the way of their proper treatment, it is the unerring detective of the cheat and adulterator of either food or medicine, and dreaded alike by the forger and the murderer. As such, the instrument is a blessing to all mankind.

Already the literature of the microscope is voluminous, and thousands of active workers are in the field gathering the ripe wheat of the harvest, yet there is room for a more general knowledge of the best and simplest methods of technique. To aid in filling such need, and encourage the use of the instrument in the hands of medical students and physicians, by simplifying its use, is the end whereunto, and with many sincere wishes for its success, this little volume is sent to the medical profession.

II. NECESSARY MICROSCOPIC OUTFIT.

The difficulties which I myself encountered when I took up the study of microscopy without a teacher—especially my innocent ignorance of just what was really necessary in a microscopic outfit for a practising physician—may now be turned to the profit of those of my readers whose limited means forbid unnecessary expense in the purchase of a microscope.

The splendid catalogues that are now sent out by microscope makers and dealers, while marking the wonderful advancement that has been made in microscopic science, are not only misleading, but truly bewildering to the beginner at the tube by their attractive show of illustrations and explanatory descriptions. In proof, see the variety of microscope stands, different grades of objectives, and all sorts of accessories, including microtomes of ingenious design, also photographic apparatus, and a hundred other useful things worth having by those who can afford them ; in other words, the offer of "complete" outfits varying in price from $40.00 to $1200.00.

It was in such uncertainty of my actual needs that I spent many hard-earned dollars unnecessarily, and today can produce enough old keepsakes from such purchases to buy—if I had the money they cost—a sufficient microscopic outfit for a beginner.

In the selection of a stand there are really but four important points necessary to be considered, namely,

solidity, steadiness, fine adjustment by micrometer screw, and plenty of room with all needful fittings for sub-stage condenser and other accessories.

It must not be supposed that the larger and more ornamental the stand the more powerful the microscope. A twenty-five-cent chromo may be set in a hundred-dollar frame without in the least improving the quality of the picture, but a hundred-dollar picture may be put in a twenty-five-cent frame without detracting from the value of the piece. If the picture is good, we are wholly indifferent as to the quality of the framework which holds the canvas. And so with the choice of a stand. It is the eye-piece at one end of the tube and the objective at the other which make the microscope, and the cost of the objective may be much or little, according to the wish of the purchaser to accommodate his needs.

Fortunately, in these days of Columbia's lead in the arts and sciences, we no longer have to go abroad for our microscopes and other scientific instruments, nor for instruction how to use them. Our own microscope makers are now not only fully able to supply the home demand, but have gone into foreign markets with their superior instruments and challenged comparison with the very best patterns in England, France, and Germany. In fact, everything that can be needed or desired by the working microscopist may be obtained in this country, and at reasonable price.

Owing to the great variety of microscopes in the market,—foreign as well as home products,—the in-

experienced person in the technique of the instrument should, if possible, get some trustworthy expert to assist him in making the choice, for unless such precaution be taken to prevent mistake, nine chances to one the purchaser will sooner or later regret his outlay as so much money unwisely spent, if not, as well, thrown away.

A very good microscope fitted with all needful accessories for medical and ordinary bacteriologic work may be had for the very low price of $50.00 or $60.00, and a very complete outfit—such as will answer the physician for a lifetime—can be purchased for $100.00, or less, from either of our first-class makers and dealers.

It is not too much to say that Bausch & Lomb, Rochester, N. Y., and Joseph Zentmayer, Philadelphia, are probably the largest manufacturers of microscopes in this country; and an instrument purchased from either house may be confidently relied upon to be just what is claimed for it in the catalogue description.

Besides these two well-known makers, there are others who turn out perhaps equally good work, but have not, as manufacturers, engaged such long general public attention concerning the superiority of their wares. Chicago is well represented by W. H. Bulloch and the McIntosh Co.; Rochester, N. Y., besides Bausch & Lomb, the Gundlach Optical Co.; and Philadelphia can boast also of the house of J. W. Queen & Co., together with the agency of R. & J. Beck. It should also be stated that in supplying the market with micro-

scopes there are several justly distinguished specialists who confine their skill to the manufacture of objectives. A notable example is the H. R. Spencer Co., whose high-power lenses are truly marvelous in performance.

Then, again, there are dealers who carry, besides some particular microscope with their own trade-name, various stands and objectives, both new and second-hand, and at such an establishment sometimes a great bargin can be secured. The society-screw and standard length of tube make it possible to use all sorts of objectives with any make of stand, and thus this branch of the microscope business is more and more encouraged by persons in search of cheap microscopes. But it should not be forgotten by beginners in microscopy that much risk is run in purchasing a second-hand outfit, no matter how reputable the maker, without the approval of some expert to determine its true value. A very prevalent impression with the uninitiated is that the larger and more ornamental the stand, the greater the magnifying power of the glass, or that it must be a very fine instrument because it "magnifies seven hundred times," as a physician once said in praise of his microscope, and to prove his skill in detecting tube-casts in a case of Bright's disease.

My own equipment consists of a Bausch & Lomb professional stand with Abbe condenser, and the following battery of objectives: 1½ in., $\frac{4}{10}$, $\frac{1}{6}$, $\frac{1}{10}$, and $\frac{1}{12}$, the last two being oil-immersion objectives, and all of them "first-class." The $\frac{1}{10}$ is a Spencer, and for excellence in performance is unsurpassed by any glass of like power.

This outfit leaves nothing better, in my judgment, to be desired. The Bausch & Lomb $\frac{4}{10}$* and $\frac{1}{6}$ are dry, and so useful in every-day work that I should not know how to get along without them. Because of its wide angle and freedom from the inconvenience of immersion fluids in the examination of fresh mounts, the $\frac{1}{6}$ is well adapted to ordinary bacteriologic work, and is indeed a jewel of incomparable value to any working microscopist.

Besides these old friends of mine, there are other well-known lenses, whose fortunate owners praise them in the highest for superior performance under the most severe tests. In this class I am pleased to speak of the Gundlach objectives, also of the specialty of Queen & Co., their 1–15 oil-immersion objective, which has won testimonials from various experts whose good opinion in such matters is worth having.

My advice to the beginner is to start with first-class lenses, no matter how cheap the stand; but the stand must be fitted with a sub-stage condenser, to get the full performance of the objective and do satisfactory work in bacteriology.

The accompanying illustrations show the most inexpensive as well as the most useful patterns of stands. For all ordinary use, the cheapest stand will answer as well as the costliest; and to that end the Continental, shown on the opposite page, is good enough for

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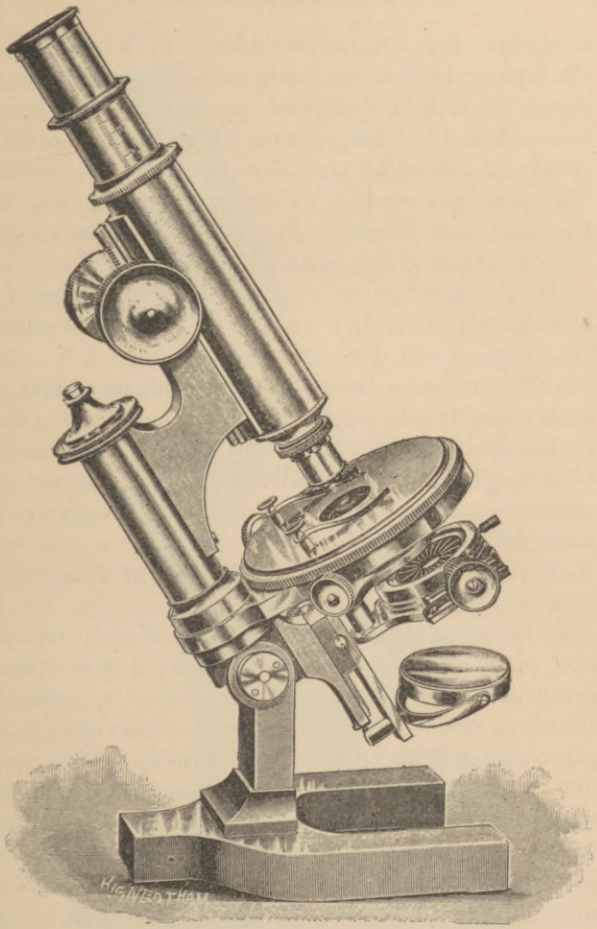
* This superb glass, the $\frac{4}{10}$th, Messrs. Bausch & Lomb do not keep in stock, and can only furnish it on special order.

FIG. 1.



(Cut one-half of actual size.)

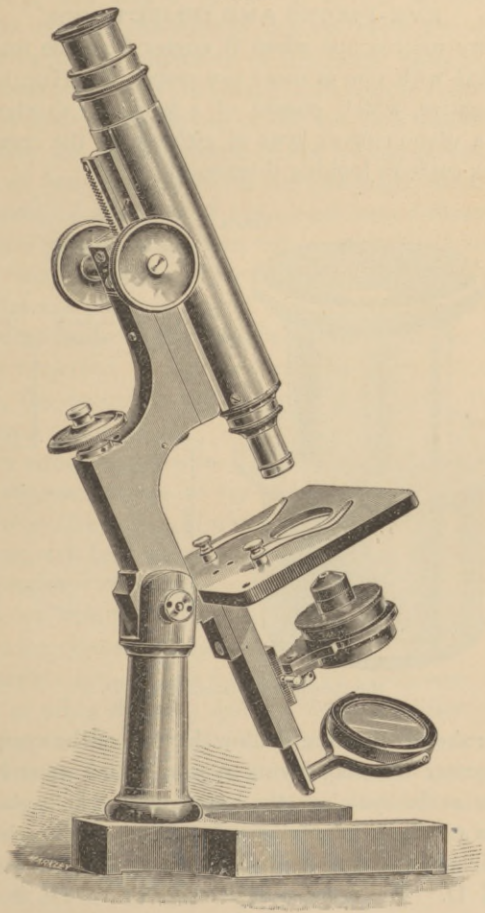
Bausch & Lomb Continental Microscope.

anybody. It is a happy combination of the useful with the ornamental, but not really better than other stands shown in various illustrated catalogues. The selection—when all of the patterns are so good—is more a matter of individual taste than exercise of judgment. The particular machine we are most familiar with we like best, and recommend it for that reason to our friends—"merely this and nothing more."

But the selection of a microscope and all needful accessories is one thing; the successful use of the instrument another and quite a different performance. Before the instrument can be properly manipulated and its fields correctly interpreted, the student must by long and patient effort bring his senses up to the full requirement of cultivation; he must understand what is meant by accurate microscopic vision, and become master of a most difficult technique before expecting to reap the plenteous harvest which lies within reach of industrious effort and singleness of purpose.

By failing to appreciate the necessity of such preparation, many a physician after purchasing a microscopic outfit has learned to his sorrow that it was of no immediate use to him. As well might the purchaser of a grand piano expect on going to the key-board for the first time to be able to strike harmonious chords and bring forth sweet sounds without previous and patient training of his senses to the most delicate impressions, as for the physician to expect to use a microscope successfully without first learning **how to see** and **observe.** For this reason, the show of a microscope in a physician's office is often more ornamental than useful.

FIG. 2.

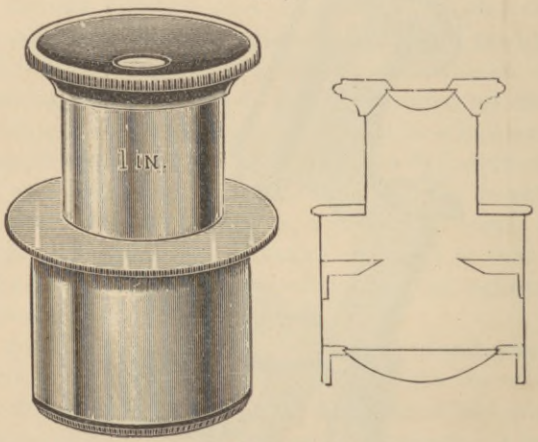


Zentmayer American-Continental Stand.

EYE-PIECES AND OBJECTIVES.

Every microscope when it comes from the maker is supplied with one or more eye-pieces, the Huyghenian or negative, which consist of a longer or shorter tube with a plano-convex lens at either end, the curved or convex surfaces looking downward.

FIG. 3.



Huyghenian Eye-pieces,—C and D.

The shorter or more shallow the tube of the eye-piece, the greater the magnifying power. The upper lens is known as the eye-glass, the lower one the field-glass.

The accompanying full-sized sections of Huyghenian eye-pieces show the depth and construction of oculars C and D. The A has a depth of 2 in., B 1½ in., C 1

in., D ¾ in., and E ½ in. It should be observed that the shorter the tube of the eye-piece the deeper the curvature or convexity of the lower surfaces, and that, correspondingly, the diaphragm is more contracted and the aperture in the cap of the eye-glass smaller.

Unlike the fixed measure of the society-screw, with which all first-class objectives are now made, there is no uniformity of diameter of eye-pieces from different microscope makers, and hence the necessity of buying all extras from the maker of the stand.

If the eye-piece is a good one, it correctly amplifies the image made by the objective; and so, if the objective is imperfect in any respect and gives a distorted image, the eye-piece will magnify it in proportion to the depth of the tube.

Very strong eye-pieces—C, D, and E—are really of but little use, except to try the excellence or poverty of an objective which, if well made as to its optical proportions, will bear stronger eye-pieces than one of faulty construction. The good rule constantly gaining favor is to work with a low eye-piece and rely upon the objective for necessary amplification.

A perfect eye-piece is free from all cloudiness, striæ, spots, or other defects; and the field of vision should be sharp and intensely black. Specks of dust or other dirty accumulations may be easily seen by rotating the eye-piece. All such foreign matter should be carefully removed by blowing the breath on the glass and wiping with an old silk handkerchief or piece of well-washed chamois.

Beginners at the monocular microscope find it difficult, with both eyes open, to look into the tube with one eye and see nothing whatever with the other eye. To accommodate those who cannot accustom themselves to work with both eyes open, various devices to blind one eye have been employed; but a simple piece of dark blue blotting paper or card-board, with a hole through the center to admit the cap of the eye-glass, will answer as well as anything else that has been offered.

Objectives.—Each maker of objectives makes claim of some private formula for working his combinations of different qualities of glass—crown and flint—to suit varying density and refractive indices, also in grinding the curves of his lenses and spacing the different systems in the mounting. Upon such assumed correct knowledge of optical principles and claim of faultless technique he bases the superiority of his instruments; but, unfortunately, there is no established or acknowledged standard by which to decide such claims and fix their relative merits. Every observer, like the maker of his objective, is a law unto himself and an unknown, because unstable, quantity. There are, indeed, so many accidental circumstances, both of person and environment, which may influence one's judgment of the performance of any particular objective that very often a distinction is made without a difference. The present condition of health of the operator, whether his nervous system has been impressed or disturbed by excessive indulgence of any kind, his stomach full or empty, digestion good or bad, also the state of the weather and

the quality of light—all these,—are active factors in determining the appreciable performance of an objective. In other words, every expert microscopist is aware of the fact that in many cases—especially when using high powers and in the study of bacteria—the objective is blamed when the fault lies in the observer himself.

There are, however, certain easily discovered qualities by which the value of an objective may be determined. These are: defining power, flatness of field, penetrating power, and resolving power.

Defining power depends upon the correction for spherical and chromatic aberration. Until within the last few years complete achromatism was believed to be impossible on account of the disproportionate dispersion at different parts of the spectrum. But by the genius of Prof. Abbe and his distinguished co-workers in optical science—Dr. Schott and Carl Zeiss—suppression of the secondary spectrum was triumphantly accomplished, and since then chromatic and spherical aberration have been practically eliminated.

If an objective is not properly corrected for spherical aberration the lines of objects appear cloudy and indistinct, truly lacking in defining power. For discovery of such defect, a stage micrometer will afford a convenient test—to see if the lines are clear and sharp, like the lines in a copper or steel plate. If not corrected also for chromatic aberration, colored fringes are in the field—blue, if the lens be **under**-corrected; red, if **over**-corrected.

Flatness of field gives as clear and perfect definition

at the periphery as at the center of the field. Without this important quality, the objective is not worth having; but the examiner should make sure, if any inequality of clearness of field exist, that the fault is in the objective. Unless the slide is perfectly flat, a really good lens may be rejected as lacking in flatness of field. Here again the stage-micrometer may be used in the test; but it should be remembered that the ruled lines may not all be equally sharp, hence it will be necessary to run them in various directions. If the lines are exactly parallel to each other, sharp alike at all distances from the center as at the center of the field, then the perfection of the objective in this particular respect is assured. A better test, perhaps, is by comparison of the field under a well-known faultless lens of the same power and angle.

Penetrating power is the depth or measure to which an objective can reach into an object or tissue and expose the character of its make-up. In histologic work good penetrating power is an essential quality of an objective. The surface of the field is not only to be explored, but the component structures beneath must be looked into. The lower the angle of aperture the better the penetrating power, is the rule, which is equivalent to saying the higher or wider the angle of aperture the less its power of penetration. A good test-object is a section of human liver, double-stained.

Defining and resolving power both increase with and depend upon the absolute angle of aperture of the objective, provided the aberrations are well corrected. A glass may have all needful defining power, yet if it

have not sufficient aperture its field is accordingly contracted. In other words, the wider the aperture the greater the resolving power, if corrections for aberrations are accurate. The larger the window the greater the flood of light that enters, and wider the landscape view; hence the value of wide angles of aperture in bacteriologic work.

The working distance of all wide-angle objectives is small,—especially with dry objectives,—requiring the thinnest of cover-glasses, or No. 1.

In spite of the excellent quality of the objective, the thickness of the cover-glass exerts much influence over the field, particularly when using high powers. An object which under a No. 1 cover gives a sharp image becomes blurred and dimmed when viewed under a No. 2 cover. To overcome the influence of varying thickness of cover-glasses, lenses are made with correction collar, by means of which the relative positions of the individual systems of lenses may be changed to suit the thickness of the cover-glass; but it requires a practised eye at the tube to find the exact turn of the screw which stops at the best effect. Collar-correction seems to be more necessary in dry than immersion lenses.

The usual tests for resolving power of high-angle objectives are the frustrules of certain diatoms, the *Amphipleura pellucida* being the most difficult to resolve. But this test is too high for a dry lens, unless it be one having the widest possible angle of aperture.

Immersion Objectives have certain great advantages over the dry system. They afford larger working-distance than is possible with a dry lens of the same

angle; and the denser the immersion fluid the greater the working-distance. The drop of liquid—water, glycerin, cedar oil, bisulphid of carbon, or other medium—which connects the front lens and the upper surface of the cover-glass serves the important purpose of partially extinguishing the two glass surfaces, and thus prevents loss of light, which always takes place from air surfaces. By the immersion system, more rays of light pass into the microscope, the medium approximating the same effect as an enlargement of the angle of aperture.

Immersion objectives do not require the same precision of adjustment of collar-correction for thickness of cover-glass that is so necessary in the use of dry lenses. The discovery of this important effect led to the construction of non-adjusting immersion lenses, which are easily used, very satisfactory in performance, and have become great favorites with all classes of microscopists. To the busy physician they are a great help, for besides more rapid work they require less skill to use them. The latest triumph of Mr. Edward Bausch, of the firm of Bausch & Lomb, Rochester, N. Y., in the production of his non-adjustable 1–12 inch oil-immersion objective, is something of which all American microscopists may justly feel proud; for the performance of this remarkable low-priced lens leaves nothing to be desired by the working histologist and bacteriologist.

The instructions given on a preceding page for the care of eye-pieces will, as far as they go, equally apply to the proper care of objectives. The beginner should be content to use low and medium powers in order thereby to prepare himself for more difficult work. At

least, he should not resort to the use of a high-power objective until he has learned how to handle such a glass safely and properly. The lack of such knowledge and caution has been the ruin of countless valuable objectives, not to mention the smashing of cover-glasses also, by unskilful persons.

Even in the most expert hands the front glass becomes now and then soiled with balsam, but no damage is thereby done unless too much benzol or other cleansing agent is used. Two or three folds of old cotton or silk should be placed over the end of the finger, slightly moistened with benzol, and then whipped back and forth two or three times over the face of the glass. After that, the breath should be blown upon it and then gently wiped again.

LINEAR MAGNIFYING POWERS OF OBJECTIVES AND EYE-PIECES.

CALCULATED FOR A TUBE LENGTH OF 8.5 IN. = 216 MM.

OBJECTIVES.	3 IN.	2 IN.	1½ IN.	1 IN.	⅔ IN.	½ IN.	⅓ IN.	⅕ IN.	⅛ IN.
EYE-PIECES: 2 in. (A)	16	25	33	40	50	70	176	210	265
1½ in. (B)	21	35	42	55	70	102	247	295	385
1 in. (C)	30	50	66	80	100	140	353	420	530
¾ in. (D)	42	70	84	110	140	205	495	590	770
½ in. (E)	60	100	132	160	200	280	705	840	1060

TUBE LENGTH 8.5 IN. = 216 MM.					TUBE LENGTH OF 160 MM.				
OBJECTIVES.	1/16 IN.	1/25 IN.	1/32 IN.	1/50 IN.	⅛ IN.	1/12 IN.	⅙ IN.	1/16 IN.	1/25 IN.
EYE-PIECES: 2 in. (A)	360	450	570	690	18	37	196	267	422
1½ in. (B)	540	660	845	1025	26	52	285	400	626
1 in. (C)	720	900	1140	1380	37	74	392	534	844
¾ in. (D)	1080	1320	1690	2050	52	104	570	800	1252
½ in. (E)	1440	1800	2280	2760	74	148	784	1068	1688

INSTRUCTIONS FOR USING THE EYE-PIECE MICROMETER.

As the eye-piece micrometer is not compared directly with the object itself, but only with the image of it formed in the focus of the eye-piece, it is only when the exact proportion between the size of the object and that of its image is known that measurements of the object can be readily determined by the eye-piece micrometer.

This proportion depends upon : 1st, the focus of the objective ; 2d, the distance of the image from the object ; 3d, the focus and the place of the field-lens when the latter is situated between the objective and the image.

As these relative conditions are not of equal value in all microscopes, and consequently the relative size of the images, as formed by different objectives of the same rating, are not always the same, these sizes have to be ascertained for each microscope and objective separately.

To reach this result, a reliable stage micrometer should be used as an object, and its image accurately measured with the eye-piece micrometer.

The figures designate the proportion of the linear measure of the object, the latter being taken as 1.

The actual size of any object is, therefore, obtained when the size of its image, which is obtained by direct measurement by means of the eye-piece micrometer, is divided by the figures so obtained.

For adjustable objectives, the figures are intended for close adjustment.

In instruments having draw-tube, make measurements when tube is at standard length.

25.4 mm. = 1 inch.

ILLUMINATION AND ACCESSORIES.

The proper use of the mirror is one of the most important parts of microscopic technique; yet it is often least studied and therefore undervalued by the operator.

All first-class stands are provided with a double mirror,—one side plane, the other concave. The mirror serves to reflect the light on the object to be examined. In ordinary use, the quality is known as transmitted or central light. The concave surface reflects the incident rays in a convergent direction to the well-hole in the stage, and should be used with high-power objectives.

The plane mirror gives less intense illumination, and is suitable for use with low powers.

The best light is day-light when the sky is clear and bright. But direct rays from the sun should be avoided as a rule. In sky-light the rays are all practically parallel, while those from a lamp or other artificial source converge strongly from the luminous center.

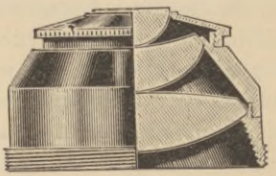
In contradistinction with transmitted or central light, the more intense and searching power of oblique light becomes sometimes a necessity. For this use, the mirror should have all needful swinging motion in order that it may be placed in the required lateral position. This quality of light—either from the direct rays of the sun or from an artifical source—is necessary in resolv-

ing various test-objects; but great skill in manipulation is required to reach the best effect of the mirror.

When choice of position can be had, the microscope should face a north window to receive the very best quality of day-light. Working in strong light, either natural or artificial, endangers the eyesight, and should be avoided. In all my twenty years' experience with the microscope I have not spent, I am sure, altogether a week's time by lamp-light; and for that reason can now boast of unimpaired eyesight.

The Achromatic Condenser is a very necessary

FIG. 4.



Achromatic Condenser.

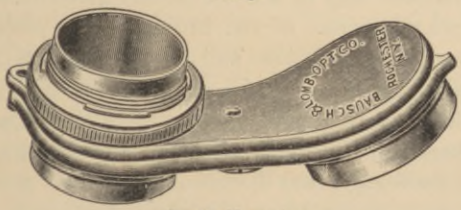
aid of high-power objectives, in order to concentrate the light to a greater extent than can possibly be done with the mirror alone. In bacteriologic investigations, especially, the condenser cannot be dispensed with; but in its use care must be taken to insure the coincidence of the optic axis with that of the objective.

Corresponding with oil-immersion objectives we have now also oil-immersion condensers, some of them able to utilize the rays of 130° balsam angle. All of the best patterns are provided with various diaphragms and

a blue-glass plate or disc. The "Abbe Condenser" is the type of the best, but there are others and less expensive ones that will answer every purpose. The condenser manufactured by Messrs. Bausch & Lomb is one of these. Its numerical aperture is sufficient—about 1.42—to accommodate and aid the performance of objectives of the widest angle. It may be worked both dry and immersion.

A microscope without a sub-stage condenser of some sort is of but little use to the physician.

FIG. 5.



Double Nose-piece.

While the **Double Nose-piece** is a great time-saving convenience in changing quickly from one objective to another, it is a dangerous instrument; for unless very great care is exercised in its use the front glass of the objective may be struck in making the sweep, and ruined.

A nose-piece out of "center" is worse than a nuisance; hence the necessity of its thorough testing before fitting it permanently to the microscope. If correctly fitted, this accessory is worth ten times its cost.

III. HOW TO WORK.

And now, having purchased a good microscope, with all needful accessories, the student is ready to begin work. The first thing necessary is a strong work-table of the ordinary height, and placed, if possible, in front of a north window. The feet of the table should be shod with thick rubber to prevent jarring from passing vehicles on the paved street. The top should be a slab of plate-glass overlying several thicknesses of common, white, unglazed paper, such as newspaper printers use. The glass-plate may be secured at any glazier's shop at cheap price, because of the broken pieces always on hand from broken windows and doors of business houses.

To aid him in successful work, the student should supply his library as soon as possible with all needful books covering the departments of Microscopy, Histology, Pathology, and Bacteriology. The complete list of such publications is already large—too large for reproduction in these pages.

There will be no difficulty in making a selection from the following-named authors, whose distinguished labors have greatly advanced microscopy in particular and medicine in general:—

IN MICROSCOPY.

Bausch, Edward. Manipulation of the Microscope. New edition. Bound in cloth.

Carpenter, W. B. The Microscope and its Revelations. Seventh edition; revised, enlarged, and partly rewritten by Rev. W. H.

Dallinger, F. R. S. Octavo, cloth, 1050 pages, 800 illustrations, including a number of lithographs.

Davis, Geo. E. Practical Microscopy. Cloth, 436 pages, with 310 illustrations and colored frontispiece. An English work, having extensive reference to American instruments, etc. New and revised edition.

Gage, S. H. The Microscope and Microscopical Methods. Fourth edition; revised and enlarged. Octavo, 96 pages, illustrated with six plates and eight figures in the text; bound in flexible cloth.

Gould's New Illustrated Medical Dictionary.

James, Frank L. Elementary Microscopical Technology; a Manual of the Art of Mounting. 107 pages, illustrated; flexible cloth.

Frey, Heinrich. The Microscope and Microscopical Technology. Translated and edited by Geo. R. Cutter, M. D.

Phin, John. Practical Hints on the Selection and Use of the Microscope. This is an excellent hand-book that we can highly recommend. It also treats briefly, yet practically, on the mounting of objects. Cloth, extra, 231 pages. New edition, illustrated.

Wormley, Theodore G. Micro-chemistry of Poisons, including their Physiological, Pathological, and Legal Relations; with an Appendix on the Detection and Microscopic Discrimination of Blood.

IN HISTOLOGY AND PATHOLOGY.

Delafield and Prudden. Hand-book Pathological Anatomy and Histology. Fourth edition, 715 pages, 300 illustrations.

Friedlander, Carl. Microscopical Technology. For Use in the Investigations of Medicine and Pathological Anatomy. Translated from the second enlarged and corrected edition by Stephen Yates Howell, M. A., M. D.

Gibbes, Heneage. Practical Pathology and Morbid Histology.

Heitzmann, C. Microscopical Morphology of the Animal Body in Health and Disease.

Klein, E. The Elements of Histology.

Piersol, Geo. A. Normal Histology.

Prudden, T. M. A Manual of Practical Normal Histology.

Schaefer, E. A. The Essentials of Histology.

Stowell. Microscopical Diagnosis. Octavo, 250 pages, profusely illustrated with wood-cuts and lithographed plates. By Chas. H. Stowell, M. D., and Louisa R. Stowell, M. S., of the University of Michigan.

Wethered, Frank. Medical Microscopy.

Woodhead, G. Sims. Practical Pathology.

Ziegler, E. A Text-Book of Pathological Anatomy and Pathogenesis. Translated by D. MacAlister. Three parts complete in one volume.

IN BACTERIOLOGY.

Abbott, A. C. The Principles of Bacteriology.

Crookshank, Edw. M. A Manual of Bacteriology.

Dolley, Chas. S. The Technology of Bacteria Investigation. Explicit Directions for the Study of Bacteria, their Culture, Staining, Inoculation, Mounting, etc. 12mo., cloth, 263 pages.

Fraenkel, C. Text-Book of Bacteriology. Translated by J. H. Linsley.

Hueppe, Ferdinand. The Methods of Bacteriological Investigation. Translated by H. M. Biggs. 8vo, cloth.

Jaksch, Dr. Rudolph v. Clinical Diagnosis. The Bacteriological, Chemical, and Microscopical Evidence of Disease.

Klein, E. Microörganisms and Disease. An Introduction into the Study of Specific Microörganisms.

Kuhne, A. Practical Guide to the Demonstration of Bacteria in Animal Tissues. Translated and edited by Dr. V. D. Harris.

Prudden, T. Mitchell. The Story of the Bacteria and their Relations to Health and Disease. 16mo, 143 pages, cloth, 1889.

Salomonsen, C. J. Bacteriological Technology for Physicians.

Schenk, Dr. S. L. Manual of Bacteriology.

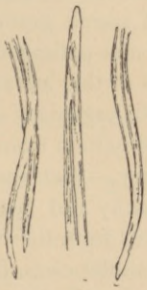
Sternberg, Geo. M. A Manual of Bacteriology.

Vaughan and Novy. Ptomains and Leucomains and Bacterial Proteids; or, The Chemical Factors in the Causation of Disease.

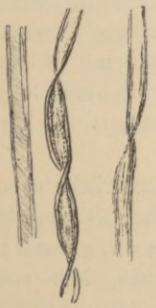
Besides guide-books, the beginner should supply himself with a goodly number of typical mounts—histologic,

FIG. 6.

Linen Fibers × 150 Diam.



Silk Fibers × 200 Diam.



Cotton Fibers × 200 Diam.

Woolen Fibers × 200 Diam.

pathologic, and bacteriologic—for study and comparison with his own efforts at mounting tissues and making

cover-glass preparations. He should also as soon as possible become familiar with all sorts of extraneous matters commonly found in the microscopic field,—hairs, fibers of wood, cotton, flax, and silk; cat-hairs, mouse-hairs, particles of feathers, etc. The various kinds of starch granules will afford interesting study; also the non-pathogenic fungi.

A still further advanced step will be the examination of various organized deposits,—the squamous epithelial cell; epithelium from the bladder, ureter, and pelvis of the kidney,—each variety with its differential shape, and both healthy and fatty; red and white corpuscles, pus-cells, casts from the renal tubes—blood-casts, epithelial casts, granular casts, fatty casts, and hyaline casts; cylinders composed of urates, or false casts; spermatozoids and casts from the seminal tubes; fragments of morbid growths, mucus and fibrinous threads, expectorated matters, etc. All these may be definitely known within a short time after commencing the use of the microscope, and every step in advance becomes lighter and lighter because of the intensely interesting character of the subject.

The necessary stock of materials need not be large or expensive, as shown by the following list:—

One-half gross white glass slides, 3 x 1, ground edges.
One-half ounce square cover-glasses, No. 1, assorted sizes.
One curved-pointed forceps.
One dozen test-tubes, assorted.
One " pipettes.

One spirit lamp.
Litmus papers.
One quart commercial alcohol.
One pint Squibb's absolute alcohol.
One " Bullock & Crenshaw's benzol.
Four ounces xylol.
One pint spirits turpentine.
Two pounds hard paraffin.
Either a Bausch & Lomb or Ryder microtome.
One Reeves' water-bath and oven.
One ounce Canada balsam and xylol, in drop-bottle.
Two ounces Delafield's hematoxylin.
One ounce pulverized borax.
One-half ounce "No. 40" carmin.
One half " gentian violet (in powder), Grübler's.
Four ounces anilin oil.
One-half ounce methyl violet (in powder), Grübler's.
One-half " methyl-blue " "
One-half " safranin " "
One-half " Bismarck brown " "
One-half " rosanilin hydrochlorid (fuchsin),* Grübler's.

* In ordering "fuchsin" from a dealer, it should be remembered that there are several salts of rosanilin—the sulphate, hydrochlorate, and acetate. The acetate will not hold its (magenta) color, and is entirely worthless for staining tubercle bacilli. The only reliable salt is the hydrochlorate, and it should always be so written in making an order for "fuchsin." The German preparation (Grübler's) is the best in the market (like all other of his anilin stains); but I have sometimes been led to think that this distin-

One-half ounce rosanilin acetate, Grübler's.
One-quarter ounce sulphindigotate soda.
One eight- " graduate measure.
One one- " " " (c. c. scale).
One six- " glass funnel (ribbed).
One three- " " "
One one- " " "
One-half dozen six- or eight-ounce wide-mouth glass-stopper bottles.
One-half dozen two-ounce glass-stopper, narrow-mouth.
One brass table.
One one-ounce capped dropping-bottle.
Half-dozen wood boxes, each to hold 25 slides.

All of the glassware named in the above list may be had at any drug store. I have constantly supplied myself in that way with all needful bottles, finding the wide-mouth ¼- and ½- lb. German chloral bottles admirably suited to my wants.

Clean Slides and Covers.—Slides and cover-glasses when first received are more or less greasy and dirty, and must therefore be well cleaned before use. New glasses may be cleaned by immersing them in

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guished Chemist's name is not always a sufficient guaranty of the purity and genuineness of the article it covers. Not long ago I purchased in New York city some "fuchsin" that was nothing more, probably, than magenta of English manufacture. Certainly, it could not have come from Grübler's laboratory. Staining solutions of all kinds ready made and of the most reliable quality can be obtained from Voigt Bros., Chemists and Pharmacists, Chattanooga, Tenn.

liquor potassa for a moment, then washed thoroughly in water, and next wiped perfectly dry before placing them in alcohol to be ready for use.

Old mounts may be quickly taken down by pouring over the slides boiling water and letting them stand in it five minutes or more. By this means the cover-glasses may be slipped off easily, after which slides and covers may both be cleaned with benzol, followed with alcohol. In cover-glass preparations, after washing in benzol, the thin glasses must be dipped in warm water to loosen the baked coating, after which the final cleansing may be accomplished by slipping the glass between the folds of a soft cloth held between the thumb and forefinger.

IV. PREPARATION OF ANIMAL TISSUES.

Very little progress, if any, has been made within the last eight or ten years in the preparation of tissues for microscopic use—fixing and hardening, cutting sections, staining, clearing, and mounting,—notwithstanding the appearance of numerous hand-books, guides, and other special treatises on the subject. Indeed, it is really surprising that successive authors should have deemed it necessary to repeat so many worn-out and useless methods: Muller's Fluid and other chromic compounds —which, possibly, may be excused in special cases, such as dealing with specimens from the central nervous system, but is most damaging to tissues requiring

bacteriologic study,—the same method of imbedding, and the same old diagram for folding a "card-board tray" in which to make a paraffin cast; the same instructions for cutting sections and floating them in a beaker containing spirits of turpentine; staining them in a watch glass; next, their decoloration with acid alcohol in another shallow glass; next, their dehydration with strong alcohol; then clearing them in oil of cloves; and finally, after much unnecessary handling and whipping of the cell-elements in transferring the sections from one re-agent to another, they are "lifted" to the slide, where they are variously sealed, ringed, and finished.

It is the aim of this little volume to cut loose entirely from all effete methods and lead the beginner to a technique so simple, easy and inviting, that it will put him heartily in love with his microscope for all the great things it will be worth to him in the practice of medicine and surgery.

The waste of valuable pathologic material because of the generally uncultivated state of the science of pathologic histology, not only among the masses of the medical profession, but even with those who occupy professorial positions, is greatly to be deplored. But the light is now fast breaking in all directions of the medical horizon, and soon—may we not hope—it will be high-twelve!

What rare opportunities are missed in every community for the collection of tissue-material of the most instructive and valuable character, from lack of ability

on the part of the medical observer to see beyond the **macroscopic** appearances? Within the last two weeks two such examples have come to my knowledge. In one case, a laparotomy was made to remove a supposed ovarian tumor, but an immense kidney was found to be the offending tumor. Luckily, before the mass became completely spoiled from want of proper care, a little specimen was secured, and on microscopic examination revealed carcinoma with easily differentiated inclusions of so-called "psorosperms."

In another case, of still greater interest, an intra-uterine tumor was found post-mortem, and carelessly thrown aside as a "degenerating fibroid." A small portion of this tumor was, by the merest accident, placed in my hands, and turned out to be probably an unprecedented curiosity in uterine pathology. Besides papillomatous and myxomatous appearances in some parts, there were fields of cartilage cells, showing, possibly, the **teratomatous** character of the specimen. When I asked for more of the material, the answer was, it had been "thrown away."

In handling fresh material the importance of a sharp knife—as sharp as a barber's razor—cannot be overestimated. Hacking and tearing with a dull knife may utterly ruin a valuable tissue for microscopic study. In collecting portions of brain the necessity of a thin, keen blade needs no argument. And at every subsequent division the sharper the knife the better the result.

For killing and hardening of tissues, nothing is better, I think, than a one per cent. alcoholic solution of cor-

rosive sublimate, twenty volumes of the solution to one of tissue.

After soaking in this solution for twenty-four hours, the specimen is hard enough to be cut up into very thin slices—say, the one-fourth of an inch thick—and should then be transferred to commercial alcohol to remain other twenty-four hours; next, it should be placed into absolute alcohol, there to remain not less than twenty-four hours, provided there is no hurry for the result of the microscopic examination.

Many specimens of connective tissue become too hard after going through alcohols to be cast and cut successfully. In all such cases, particularly in dealing with pieces of dense tumors, the material should first be softened in a ten per cent. solution of common salt for a few hours, then washed and soaked in commercial alcohol, then go into benzol, and next into paraffin-benzol.

Tissues containing lime-salts may be successfully decalcified by soaking them for twelve hours or longer, if necessary, in a twenty-five per cent. solution of nitric acid in seventy per cent. alcohol. When the process of decalcification is complete, the specimen should then be washed in tap-water, and further disposed of in the ordinary way.

It is possible to make a permanent tissue-mount within the short space of five hours from the time the specimen is taken either from a living or dead body. A very small, thin piece is placed at once into absolute alcohol, to remain one hour; then into benzol for one hour and

a half; then into melted paraffin a half hour or more; then cast, cut, and mounted,—all this within four or five hours.

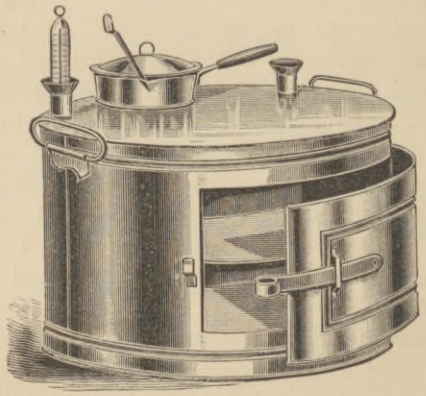
In ordinary work, and when time is no object, from absolute alcohol the specimen is laid between blotting papers for a moment that any floating drops of alcohol may be absorbed, and then it is ready for more perfect dehydration and clearing up in benzol. Here it must remain a longer or shorter period, according to the density and size of the particular piece. So long as air bubbles are imprisoned in the tissue, it is not prepared for the next step, or for soaking in a solution of paraffin in benzol, liquefying at 90° Fahr. In this mixture—kept at the liquefying point—the specimen may soak from one hour to twenty-four hours, according to the convenience of the manipulator. Unless I happen to be in a hurry to make a finished mount, I give the specimen an over-night bath, or at least several hours, in the paraffin solution.

The next step is to transfer the specimen to melted paraffin, hard or soft, according to the season, winter or summer, and kept just at the melting point, from one to eight hours, according to size and density of the tissue, or until air bubbles cease to rise to the surface of the paraffin—like so many glistening little beads around the border.

The accompanying illustration shows a water-bath and oven devised by myself and advertised in Bausch & Lomb's catalogue. It is so simple in its construction that any tinner can make it. The paraffin cup has a

capacity of about six ounces, contains a lifter and a cap, also a thermometer. The water-bath may be placed over a small gas-jet, or kerosene lamp flame, supported, of course, by a frame or rest of some sort. The thermometer is the ordinary dairy scale, with registry to 160° F., and costs but a few cents. The water-bath complete, need not cost more than a few dollars.

FIG. 7.



Water Bath and Oven, Dr. Reeves', with thermometer. Heavy polished copper, with paraffin cup and lifter. Size 8½ inches high by 10 inches wide, outside diameter.

Embedding.—And now, all things being ready to make the paraffin cast, the procedure of embedding is as follows: Take an ordinary prescription blank, lay it on any smooth surface—preferably, a small slab of plate-glass or marble—and pour upon it enough paraffin to cover the size of a half dollar; then as quickly as pos-

sible catch up and lift the specimen from the bottom of the cup and place it on the film of paraffin, with best surface downward; next, place over the specimen thus laid a mold sufficiently large to cover it without pinching, and then pour the cylinder nearly full of paraffin. The cast should be cooled with ice, if in summer time, or set out-of-doors if made in winter. When the paraffin is sufficiently cold and set, the cast is then pushed out of the mold with the thumb. If it is inclined to stick to the mold, a few taps against the table will make it easy to slip. After removal from the mold, the cast is cut down from the end at which it was poured until the specimen is nearly touched. The disc thus made is then held for a moment over the flame of a spirit lamp to melt its surface and stick it to a wooden block fitted in size to be received in the jaws of the microtome. If the cast is perfect, it will not shrink or become depressed at the surface of the specimen embedded.

Celloidin is employed in preference to paraffin and all other media by many reputable authorities and practical workers; but after fair trial of both, and long use of paraffin for all purposes for which an embedding material is used, I like it the better of the two. Perhaps, for embedding the globe of an eye celloidin may have some advantage; but even this exception may be more a matter of habit and favoritism than anything else.

The paraffin method, along with many superior claims, I think, over all other media, is free from the

objection of holding a part of the staining material, particularly when the anilin dyes are used.

The molds referred to may be had at any plumber's shop. They are simply sections, an inch long and from an inch to an inch and a quarter in diameter, of gas-casing, made either of iron or brass, and used to cover ordinary gas-pipe connecting chandeliers. The wooden blocks, on the ends of which to stick the casts, may be obtained at any carpenter's shop. This method of holding the cast in the microtome is the very best that can be employed.

V. RECAPITULATION.

Fixing and Hardening of Tissues:—

1. A 1 per cent. alcoholic solution of corrosive sublimate—time, 24 hours: 20 volumes of solution to 1 of tissue.
2. Remove the specimen and cut into thin slices, not more than $\frac{1}{8}$th inch thick; then transfer to commercial alcohol—time, 24 hours: not less than 20 volumes of alcohol to 1 of tissue.
3. Absolute alcohol—time, 24 hours: 20 volumes to 1 of the specimen.
4. The specimen placed between blotting-papers for a moment.
5. Benzol until all imprisoned air bubbles are expelled and the tissue thoroughly saturated and cleared: 1 hour to 8 hours.

6. Solution of paraffin in benzol, liquefying at 90° Fah.—time, from 1 hour to 24 hours.

Embedding:—

7. From No. 6, the specimen is transferred to pure paraffin in the cup for that purpose belonging to the water-bath and oven, the temperature of the melted paraffin never to exceed 140° Fah.—time, from 1 hour to 8 hours, or until air bubbles cease to rise to the surface.

Making the Cast:—

8. Place a piece of writing paper, or prescription blank, on any smooth hard surface and pour upon it a thin coating of paraffin.
9. Lift the tissue-specimen from the melted paraffin in the cup and place it on the coated paper.
10. Set over the specimen the mold and pour it nearly full of the hot paraffin.
11. Cool quickly as possible, and free the cast from the mold by tapping the cylinder several times on the table and pushing with the thumb.
12. Cut down the cast from the poured end, and fix the disc containing the specimen on a little block of wood for the jaws of the microtome, as directed.

All chips of paraffin may be put back into the pot for remelting as often as they are cut.

VI. CUTTING SECTIONS.

Practical microscopy has long since passed the necessity of free-hand cutting, which is now only valuable in history as marking the skill of some long-ago accomplished workmen, the highest among them, in this as well as in photo-micrography, being our own lamented Woodward, whose free-hand sections were the wonder of the whole world of microscopy.

But little progress in pathologic histology and bacteriology could be made without a microtome of some sort, and no one wishing to engage in the examination of tissues can expect to do so successfully without the aid of this very important instrument.

Along with the progress of more perfect microscope stands and objectives have come also various patterns of microtomes, and where all have particular claims and are so good, it is a difficult matter to make choice of the best. Indeed, it is the person who operates the machine that makes the good or bad performance. In other words, the most perfect instrument may prove a failure in unskilled hands, while the very poorest machine may make a good showing in experienced hands. Besides this, every worker is best acquainted with the instrument he uses, and, of course, can manipulate it more successfully than a less experienced person.

The best-known microtomes of American manufacture are probably "The Laboratory" and "Student" designs, manufactured by Bausch & Lomb, Rochester, N. Y., and the "Ryder Automatic," manufactured by

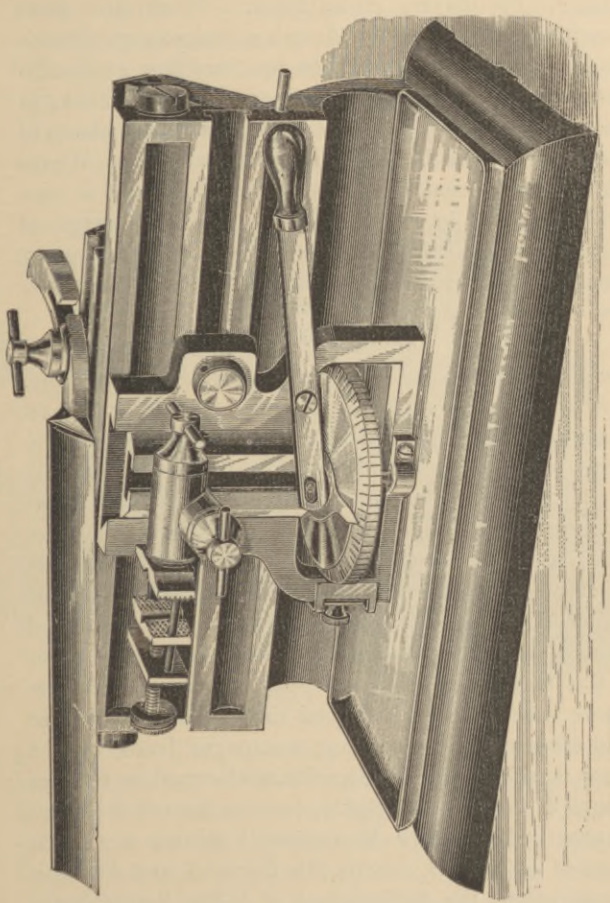


FIG. 8.

(Cut one-third of actual size.)

Bausch & Lomb Laboratory Microtome.

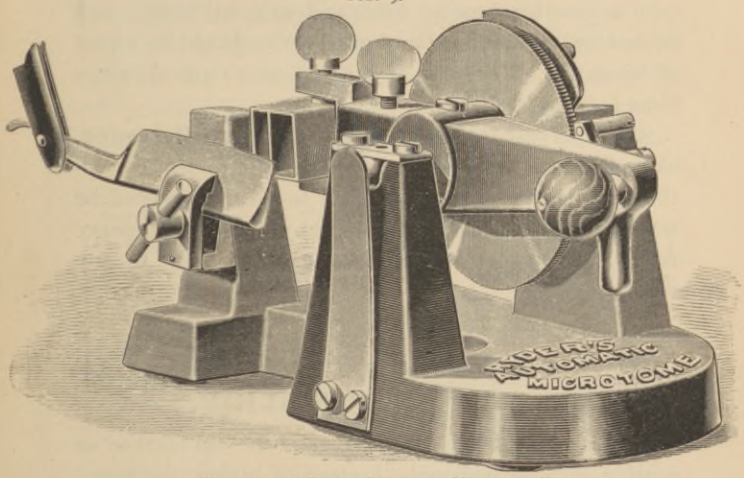
Joseph Zentmayer, Philadelphia. These are good machines and, like our American microscope stands and objectives, fully equal to the very best of foreign patterns. I can manipulate either of them, I think, to its best capacity; but they fill very different places of usefulness. The Bausch & Lomb "Laboratory Microtome" has recently been much improved and is now truly first-class in every respect. The wide range of work for which it is fitted—cutting wet or dry, large or small sections—makes it almost a necessity in laboratory and class-room work.

"The Ryder Automatic" is far less bulky and weighty, and is really a most perfect little machine. By using a larger and stronger knife than the common razor-blade attachment, its usefulness far exceeds the limit set by its distinguished inventor, Prof. John A. Ryder, of the School of Biology, University of Pennsylvania, who designed it for cutting very small sections, as a rule, for embryologic work. With this little machine—not occupying a space on the work-table larger than 4½ x 8½ inches, and may be lifted and carried with one hand—a section larger than a silver dollar may be cut to any desired thickness. But, as above stated, to reach its best capacity both as to size and evenness of the section, a stronger blade than a razor must be used. The knife manufactured by Charles Lentz & Sons, Philadelphia, for the Bausch & Lomb smaller "Laboratory Microtome," having a cutting edge of 4½ inches, exactly fills the need, and with this improvement the performance of "The Ryder Auto-

matic" cannot be excelled or praised too highly, and is worth more than it costs. But if the cast is not a perfect one, it will be impossible to make a faultless section, no matter what machine is employed.

The statement on a preceding page concerning the short time—but four or five hours—within which a

FIG. 9.



Zentmayer "Ryder Automatic Microtome."

permanent section-mount may be made, shows how unnecessary the use of the **Freezing Microtome** even in laboratory work. It is a refinement truly "more ornamental than useful;" and the physician who invests in such a machine will soon find out to his sorrow that it were better he had spent his money for something more

needful. I speak from experience, in having to regret such a purchase.

Sharpening the knife is an important part of technique; for without an edge sharp enough to "cut a hair" the section will be imperfect. The slightest gap makes its mark in the section, hence the necessity of a faultless edge. Every operator should learn as soon as possible how to hone and strop his knife; and to that end a slate hone and good strop should be a part of his outfit. The hone is the ordinary slate or water hone used by barbers.

An important little device is the **Section-flattener**, to be fixed to the knife. By its use all imperfect sections may be seen in the cutting, so that there need be no waste either of time or material. A wire with paper flange, devised by the author, can be fitted to any blade.

VII. FIXING THE SECTION IMMEDIATELY ON THE SLIDE.

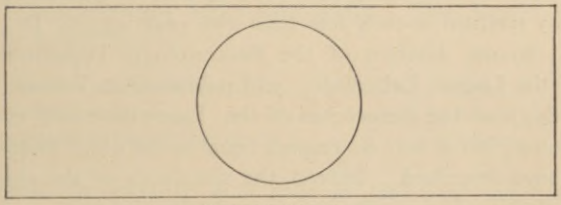
This is a great improvement over the old method of dealing with the section. Instead of lifting and transferring the section from one watch-glass and reagent to another, the section is at once fixed on the slide by means of a carbolized solution of egg albumin, made as follows: Beat up the white of one fresh egg in eight ounces of a two per cent. aqueous solution of carbolic acid; then filter until a clear, pearly-white solution results.

A small ordinary capped bottle should be filled for convenient use at the work-table, and the remainder bottled, well-stoppered, and put away for future need. A camel's hair pencil with quill long enough to be easily caught hold of may be kept in the capped bottle and used as a dropper.

I have been using this particular fixing-medium to the exclusion of all others for the last six years.

Before commencing to cut, the operator should have placed within convenient reach as many clean slides as will be needed at that sitting; a piece of blotting paper containing the following diagram upon which to lay

FIG. 10.



Centering Diagram.

the slide. Then, with the camel's hair pencil, place a drop of the fixing solution at the center. The section is then cut, its edge caught with the fine pointed forceps, and placed on the drop of fluid at the center of the glass slip. A piece of clean, heavy, white filtering paper is laid over the section, and upon this a slip of smooth, oiled cardboard is pressed to squeeze out the excess of fluid and smoothly fix the section to the glass.

Better than oiled cardboard for such use is a slip of thin sheet celluloid.

After removal of the papers, the slide is wiped and exposed to the air of the room to dry, say for five or ten minutes, after which it is placed in spirits of turpentine to get rid of the paraffin in the section.

This method of dealing with sections—fixing them immediately on the slide—I have constantly employed for the last nine or ten years, and owe Dr. Wm. M. Gray, of the Army Medical Museum Microscopic Laboratory, for the suggestion. In no other way can a section be safely dealt with.

"A method of fixing sections on the cover-glass," instead of the slide, was made known to a New York City medical society less than two years ago by Dr. J. M. Byron, director of the Bacteriologic Department of the Loomis Laboratory, and published in Volume II (1892) of the Researches of the Laboratory and elsewhere; but it is in no respect equal to the older method I have described. Indeed, the simplicity of the old is in striking and suggestive contrast with the new.

As demonstrator of pathologic histology at the recent Pan-American Medical Congress, I had the honor of showing all the steps of the better method of fixing the section immediately on the slide.

While by frequent whipping of the slide in turpentine the paraffin may be sufficiently dissolved within an hour to go on with the staining and finishing of the section, it is my habit to cut and fix the sections in the evening, and let the slides remain in the turpentine over night.

After removal from the turpentine the slides are thoroughly washed in benzol, and wiped close to the edge of the section. They are then put into commercial alcohol "No. 1," and within the next five or ten minutes transferred to alcohol "No. 2." After thus treating a few slides, a "No. 3" bottle of alcohol will be necessary to maintain a clear unmixed standard, in which the slides, with their sections duly fixed, may remain until it is convenient to finish them.

VIII. STAINING AND FINISHING.

The best and most beautiful nuclear pictures are made with borax-carmin and hematoxylin. The former is made as follows:—

Best "No. 40" carmin,	1 dram.
Pulverized borax,	2 drams
Carbolized water (2 per cent.),	4 ounces.

Heat the solution in a glass or porcelain vessel to boiling, and when cool filter into a bottle with mouth wide enough to receive the width of a slide.

A decolorizing mixture is necessary to bring out the finest effect of the stain, and may be made thus:—

Hydrochloric acid, chem. pure,	3 drams.
70 per cent. alcohol,	3½ ounces.

This mixture should also be put into a wide-mouth bottle, for the same reason above given, namely—the easy handling of the slide.

How to Use the Stain.—With the forceps in the right hand, a slide is taken from the alcohol and immersed for twenty or thirty seconds—whipping it up and down—in the bottle of carmin. Still holding the slide with the forceps, it is drained for a moment on the mouth of the bottle and then transferred to acid alcohol for decolorization and proper differentiation of the section,—but just how long it should there remain words cannot tell more definitely than to say from one minute to a half hour, the time depending entirely upon the particular character of the tissue and its duration in the stain. Experience is the only unerring guide in the matter, and repeated failures, at first, should not be discouraging. It is generally the case that beginners oftener **over**-stain than **under**-stain their sections.

The next step after use of the acid alcohol is thorough washing in clear water to get rid of all trace of the acid ; next, the slide is put back into commercial alcohol ; next, into absolute alcohol. Then, freeing it from the forceps and seizing the upper left-hand corner between the left thumb and index finger—being careful to hold the slide as level as possible,—the section is then washed and cleared up by pouring upon it from a bottle held in the right hand either benzol or xylol. After the clearing up, the slide is cautiously wiped with a cloth all around the section. Then a drop of balsam and xylol let fall upon the center of the section, and placing upon it a cover-glass—either a square or circle—finishes the mount.

Should it be desired to double-stain the section, the

very finest differential effect may be accomplished with borax-carmin, as a base, and sulphindigotate of soda, commonly called indigo carmin.

After the return of the slide to commercial alcohol from the acid alcohol and plain water wash, a weak aqueous solution of sulphindigotate of soda is poured upon the section and allowed to remain for a half minute or longer; the slide is then quickly whipped three or four times in clean water and placed immediately into commercial alcohol. The subsequent steps are precisely those above stated in dealing with and finishing a single stained section.

Solutions of sulphindigotate of soda do not keep well even when made with carbolized water, on which account but a small quantity should be made at a time. It should also be remembered that the color deepens when the section is placed in alcohol.

Those of my readers who may wish to know something about the refinement of **treble staining** are referred to other books for the knowledge.

Staining with Hematoxylin.—The best formula, probably, is the one bearing Delafield's name. It is made as follows:—

"To 100 c.c. of a saturated solution of ammonia alum, a solution of one gram of hematoxylin, dissolved in six c.c. of absolute alcohol, is added, drop by drop. The solution is exposed to the air and light, in an unstoppered bottle, for three or four days; it is then filtered, and twenty-five c.c. of glycerin, and twenty-five c.c. of alcohol are added. The mixture is allowed

to stand until its color becomes dark, and is then again filtered and preserved in a bottle with a closely fitting stopper. It keeps well, but should not be used for two months after it has been prepared."

Recently, I have added to Delafield's preparation, at the time of use—and with fine effect, I think—just enough sulphindigotate of soda to produce double staining. The method is this: Take a dram or two of five per cent. carbolized water and add to it enough of the sulphindigotate of soda to give a deep bluish-green color; then, to one part of this solution add seven parts of Delafield's Hematoxylin. The double-stain thus made should be poured on the section and let stand from a half hour to an hour and a half, or longer if necessary, to give sufficient color. After staining, the slide holding the section is immersed in a beaker of weak acidulated water—made by adding a few drops of nitric acid—and washed until sufficient decoloration has taken place. It should remain in the acidulated water until the section shows a clear, deep, sky-blue color; then it should be thoroughly washed in clear water, and afterward transferred to commercial alcohol, to remain at least twenty minutes to deepen the color. From the alcohol it is to be treated and finished in the same manner as for a simple carmin mount.

This hematoxylin double-stain differentiates the cell-inclusions — "chromatin," "protozoon parasites," "coccidia," "psorosperms," "*Rhopalocephalus carcinomatosus*," or whatever else called—in cancer-cells in a surprising manner, giving better result, I think,

than the Ehrlich-Biondi method, or any other with which I am acquainted.

With these two stains—borax-carmin and Delafield's hematoxylin with sulphindigotate of soda—may be demonstrated, in ordinary tissue-work, the very finest histologic details, and sufficient for all practical purposes, both in the hands of experts and beginners. Besides them, I could easily give enough formulæ to fill a score of pages, yet accomplish nothing more than to utterly confuse the beginner, who, to be profited in the highest degree, should be led by the simplest methods to the fullness of technique.

IX. FORMULARY.

The Anilin Dyes.—Ehrlich first drew attention to the fact that these colors are divisible into two main groups: One, in which the staining principle is an *acid;* the other, *basic*—such as methylene-blue, fuchsin, gentian violet, methyl-violet, vesuvin, etc. These important stains, and many other wonderful products, are coal-tar derivatives, serving the science of bacteriology and every day aiding its progress.

With either an alcoholic or aqueous solution of these dyes all varieties of bacteria may be more or less deeply stained. The basic anilin stains differentiate very sharply both the cell nuclei and the bacteria, while most of the acid anilin stains are simply "nuclei stains," and worthless in differentiating bacteria.

Gentian Violet is a very intense stain, and in its

use there is more danger of *over* staining than *under* staining.

Fuchsin is also an intense stain, pleasant to the eye, and not so apt to overstain as gentian violet.

Methyl-violet colors less intensely than either of the above named stains, also is less durable.

Methyl-blue is the feeblest of the four colors above listed, and therefore requires longer time to produce thorough staining; but it has a wide range of usefulness and is very durable.

Bismarck Brown, or **Vesuvin**, has a narrow field of usefulness, being mostly used as a contrast stain with gentian violet.

These five basic anilin colors fill the most important place in bacteriologic demonstrations, and are sufficient for all practical purposes. The technique for the employment of one, with but few exceptions, will stand for all, both in cover-glass preparations and section mounts.

Many valuable combinations and methods have been given and indorsed by distinguished experts in microscopy and bacteriology; but as it is not within the scope of this volume to reproduce them all, I shall limit the description to those only which I am in the habit of using, referring the reader to the various text-books for all the knowledge on the subject.

No. 1.—**Carbolized Solution Methyl-blue.**—

Ten c.c. of absolute alcohol are poured over 1.5 grm. of methylene-blue in a mortar and 100 c.c. of a five per cent. aqueous solution of carbolic acid then added, and the whole rubbed together until the blue is entirely dissolved.

No. 2.—**Aqueous Solution Methyl-blue.**—

Methylene-blue,	2 grm.
Alcohol,	15 c.c.
Water,	85 c.c.

No. 3.—**Koch's Solution Methyl-blue.**—

Concentrated alcoholic solution methyl-blue,	1 grm.
Ten per cent. potash solution,*	2 c.c.
Distilled water,	200 c.c.

No. 4.—**Löffler's Solution Methyl-blue.**—

Concentrated alcoholic solution,	30 c.c.
Potash solution, 1–10,000	100 c.c.

No. 5.—**Chenzynski's Solution.**—

Concentrated aqueous solution methyl-blue,	40 grm.
1–2 per cent. solution of eosin in 70 per cent. alcohol,	20 grm.
Water,	40 "

12 drops of a 20 per cent. solution potash, aqueous.

No. 6.—**Plehn's Solution.**—

Concentrated aqueous solution methyl-blue,	60 parts.
1–2 per cent. solution eosin in 75 per cent. alcohol,	20 "
Distilled water,	40 "

12 drops of a 20 per cent. solution caustic potash.

No. 7.—**Unna's Borax Methyl-blue.**—

Borax,	1 part.
Methylene-blue,	1 "
Water,	100 parts.

For tubercle and lepra bacilli, stain sections for five minutes; then

---

* Potash solution, 1–10,000.

into five per cent. aqueous solution pot. iod. with a crystal of iodin added; then rinse in alcohol until blue cloud forms; then differentiate in creosote.

No. 8.—**Unna's Stain for Microörganisms in the Skin.**—

Sections to be first stained in carmin, then for two minutes in borax methyl-blue, rinsed in water, for a few seconds in aqueous solution arsenic acid, next in alcohol, next in xylol, then balsam.

No. 9.—**Noniewicz-Löffler-Unna Method for Glanders Bacilli.**—

Sections are transferred from alcohol to concentrated aqueous solution methyl-blue for two to five minutes, then rinsed in water, then decolorized in a mixture of 75 parts of 1–2 per cent. acetic acid and 25 parts of 1–2 per cent. aqueous solution of tropæolin, washed in water, dehydrated, cleared with xylol.

No. 10.—**Anilin Oil Methyl-blue.**—

Methylene-blue,	1 grm.
Anilin oil,	10 c.c.

Gentian Violet.—

No. 11.—**Ehrlich's Solution.**—

Concentrated alcoholic solution gentian violet,	5 c.c.
Anilin water,	100 c.c.

No. 12.—**Aqueous Solution.**—

Gentian violet,	2.25 grm.
Distilled water,	100 "

Fuchsin (*rosanilin hydrochlorate*).

No. 13.—**Carbolized Fuchsin** (*Neelsen's*).

Fuchsin,	1 grm.
Alcohol,	10 c.c.
5 per cent. carbolized water,	100 c.c.

No. 14.—**Aqueous Solution.**—

Fuchsin (rosanilin hydrochlorate),	2 grm.
Alcohol,	15 c.c.
Water,	85 c.c.

No. 15.—**Gibbes' Double Stain.**—

Rosanilin hydrochlorate,	2 grm.
Methylene-blue,	1 grm.
Triturate in a glass mortar; then dissolve anilin oil,	3 c.c.
In absolute alcohol,	15 c.c.
Add this to the stains, then slowly add distilled water,	15 c.c.

No. 16.—**Carbolized Double Stain.**—(*Reeves.*)

Rosanilin hydrochlorate,	2.5 grm.
Methylene-blue,	1.5 grm.
Absolute alcohol,	20 c.c.
Anilin oil,	3 c.c.
Shake well and add slowly 5 per cent. carbolized water,	30 c.c.

Methyl-violet.

No. 17.—**Koch's Solution.**—

Concentrated alcoholic solution,	11 c.c.
Absolute alcohol,	10 c.c.
Anilin water,	100 c c.

No. 18.—**Methyl-violet,** 2.25 grm.
Carbolized water, 100 c.c.

Bismarck Brown.

No. 19.—**Concentrated Solution.**—Equal parts of glycerin and carbolized water.

No. 20.—**Aqueous Solution.**—

Bismarck brown, ...	2 grm.
Alcohol, ...	15 c.c.
Carbolized water, ...	85 c.c.

No. 21.—**Borax Carmin.** (See page 77.)

No. 22.—**Hematoxylin Double Stain.** (See page 80).

No. 23.—**Weigert's Fibrin Stain.**

The section, hardened in alcohol, is stained for an hour in saturated anilin gentian violet (No. 11), rinsed in 0.7 per cent. solution of table salt. After washing in water and partially drying the section by means of filter paper, iodin water (No. 25) is dropped upon it and thus flooded for a minute or two, after which filter paper is again applied to absorb the superfluous fluid, and anilin oil poured on for the purpose of decolorizing and anhydrating it. The anilin oil must be replaced two or three times, or as long as it becomes dark, by fresh oil, and then entirely replaced with xylol, after which comes balsam and the cover-glass.

No. 24.—**The Author's Method.**—

Concentrated alcoholic solution of safranin, .	} equal parts.
Concentrated aqueous solution of safranin, .	

The section should be flooded on the slide with this solution for a half hour, after which it is washed for a few minutes in commercial alcohol. A weak solution of sulphindigotate of soda in 5 per cent. carbolized water is then poured on and allowed to remain a minute or two, or until the fibrin threads are sufficiently colored. After the use of the sulphindigotate of soda, the section is whipped several times in clean water, and then transferred to alcohol, and cleared with benzol or xylol. By this method a pretty orange-red color is given the nuclei, while the fibrin threads are stained more or less deeply a bluish-green.

In preparing the safranin stain, great care should be exercised to have a reliable dye—Grübler's, if possible.

As a nuclear stain safranin, in the above proportions, may be employed in studying the cell-structure of morbid growths, the process of karyokinesis, and also epithelial structures, but it cannot take the place of hematoxylin (No. 22) for the same uses.

No. 25.—**Gram's Solution.**—

Iodin,	1 part.
Iod-pot,	2 parts.
Distilled water,	300 parts.

No. 26.—**Gram's Method Modified.**—

First of all, stain the section safranin (No. 24) for a few minutes; next, rinse in water; next, stain with methyl-violet (No. 17 or 18) for five minutes; next, wash in water; next, Gram's solution for a minute and a half; next, pour off the solution and dry the surface of the section with filter paper; next, anilin oil in sufficient changes to decolorize and anhydrate the section; next, thorough washing in xylol to get rid of all trace of the oil; and then balsam and the cover-glass.

No. 27.—**Anilin Oil Solutions.**—

Anilin Oil Solutions of methyl-blue, safranin, auramin, acid violet, etc.

These solutions may be employed either for restoring too much waste in decolorizing, or as second stains.

No. 28.—**Anilin Water.**—

Anilin oil,	12 drops.
Distilled water,	6 c.c.

Shake well together and pass through a moist filter.

No. 29.—**Flemming's Solution.**—

To four parts of a two per cent. aqueous solution of osmic acid, add 15 parts of one per cent. solution of chromic acid, and one part of glacial acetic acid.

After remaining in this mixture for two or three days, the tissue-specimen should be washed in water for three to six hours, and finally hardened by successive immersions for 24 hours each in 30, 60, and 96 per cent. alcohol.

No. 30.—**The Ehrlich-Biondi Triple Stain.**—

Dr. Sims Woodhead prepares the stain as follows:—

Saturated solution of methyl-green, ...	5 c.c.
" " " methyl-orange, . . .	10 c.c.
" " " acid fuchsin, ...	2 c.c.

To each of the above substances add about 40 volumes of water, to avoid the formation of a precipitate; then mix all together.

Stain the section for about 15 minutes to 12 hours, rinse in 1 per 1.000 acetic acid, wash in dilute and then for one minute in absolute alcohol, and finally immerse in xylol or benzol, and mount in xylol-balsam.

No. 31.—**Malachowski's Method.**—

1–2 grm. each of borax and methyl-blue in 100 c.c. of water.

No. 32.—**Toison's Staining Fluid.**—

Distilled water, ...	160 c.c.
Glycerin, ...	30 c.c.
Sulphate soda, ...	8 grm.
Chlorid sodium, ...	1 grm.
Methyl-violet, ...	0.025 grm.

X. BACTERIOLOGY.

The germ theory of disease, now so progressive and popular, is not a modern creation. It is nearly two and a half centuries old; indeed, almost coëval with the discovery of the microscope, whose astonishing revelations of bacterial life swarming in stagnant waters, stale infusions of vegetable and animal substances, also in the secretions from the mouth and accumulations about the teeth and gums, gave origin and currency long, long ago, to the belief that definite microörganisms were active factors of many contagious diseases.

The proof that a given organism is the cause of a particular disease can only be shown as follows:—

First. "An organism of a definite form and with definite characteristics of life-history must always be found in the blood or in the affected parts of the animal body.

Second. "The blood or the affected parts containing these organisms, when inoculated into another animal of the same species, must produce the same disease.

Third. "Treatment of the blood or affected parts in such a manner as to destroy the microörganisms present in them must also destroy their power of causing disease in another animal.

Fourth. "When the diseased parts are inoculated on suitable soil outside the animal the microörganisms grow, and can be indefinitely propagated on similar soil.

Fifth. "When in this manner the organisms have been separated from the remains of the animal substances in which they were embedded, their inoculation on a suitable animal must again produce the disease, the same organisms being also found in the diseased parts."—*Cheyne.*

In numerous well-known diseases this sort of severe experimental proof has been furnished, anthrax being the highest type of absolute proof.

In another class whose infectious character and clinical history are well understood, the invading specific microörganism has not yet been isolated,—yellow fever, for example.

Again, the cultivation of some pathogenic organisms has not yet been successful—relapsing fever, syphilis, and *Plasmodium malariæ.*

It would far exceed both the purpose and limits of this book to attempt even a hurried run over the nomenclature and purely theoretical study of the various classifications that have been proposed in recent years. Medical men generally are only interested in the subject of bacteriology from a purely etiologic standpoint, leaving all else to those who have inclination and time to spend in its search.

Bacteria—*Schizomycetes,* or fission-fungi are the lowest members of the vegetable kingdom, closely related to the lower *Algæ.* They are colorless cells of a transparent or glassy appearance, with enveloping membrane having protoplasmic contents but no nucleus. The presence or absence of the cell-capsule or pellicle

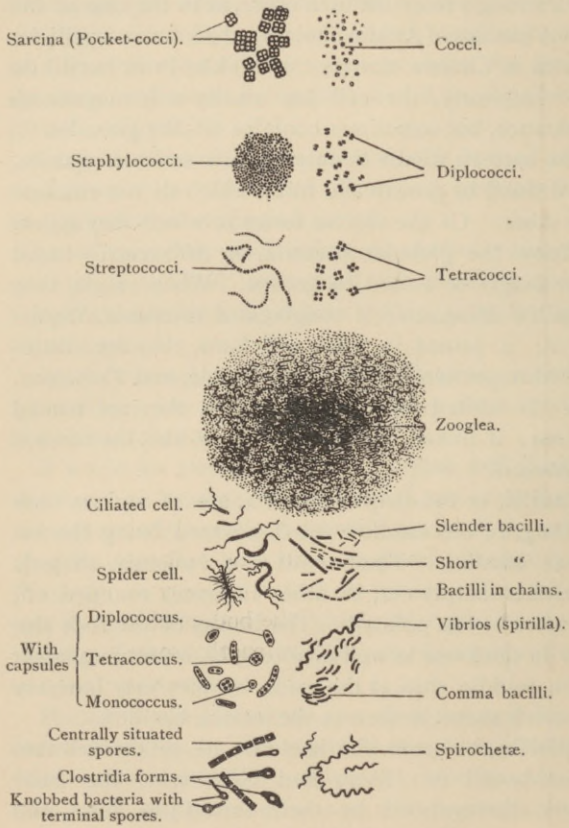
sometimes serves to distinguish between microörganisms which strongly resemble each other, as in the case of the comma bacillus of Asiatic cholera, which forms a pellicle, whereas in Cholera nostras the Finkler-Prior bacilli do not. Interiorly, the cell has usually a homogeneous appearance, but sometimes contains oil-like granules.

The bacteria divide themselves in a series of species, well defined by growth and form, which do not run into each other. Of the various forms in which they appear we know the globular bacteria, or *Micrococci*—found either singly or united in groups. When single, they are called *Monococci;* if congregated in masses, *Staphylococci;* if joined in pairs and fours, they are distinguished respectively, *Diplococci*, double, and *Tetracocci*, four. If united in blocks of eight, they are named *Sarcina;* if linked together and chain-like, the name is *Streptococci.*

Bacilli, or rod-shaped bacteria, are of various sizes and lengths, the smallest yet discovered being the influenza bacillus. Their ends are variously shaped, sometimes sharply cut, in other instances rounded off, and more or less pointed. The bodies of the rods also differ in thickness as well as in lengths, sometimes larger at the middle than at the ends, or they may have the drumstick shape, as seen in the tetanus bacillus.

Spirilla, or screw-like bacteria, are subdivided into comma-bacilli or *Vibrios* and *Spirochetæ*, the latter mainly distinguished by their thread-like form and flexibility; the former, by its strings of cells resembling spirilla. (Schenk.)

FIG. 11.



Forms of Bacteria.

(*From Schenk*, magnified about 700 times.)

Many of the bacteria possess the power of movement and are more or less active. This, however, must not be confounded with oscillatory movement nor molecular (Brownian) movement. True movement is accomplished by means of flagella with which the microörganism is provided. These may spring from either end or both ends of the rodlet.

The name *Schizomycetes*, or fission-fungi, is expressive of the mode of multiplication of bacteria. When the individual microörganism has reached maturity, a sharp line makes its appearance at the center and forms the division; after that the two parts free themselves from each other and become independent organisms. In that way the multiplication goes on from beginning to end. Upon the play of the daughter-cells depends the character of the grouping. If they do not become disjointed, the cells remain connected either in strings, clusters, or chains.

Another mode of propagation is by the development of spores, which have remarkable power of resisting the influence of either extremes of temperature or the action of chemicals. So permanent and important is this mode, that it has been proposed as a basis for a scientific arrangement of the bacteria. Take, for example, the anthrax bacillus. While the rodlet is comparatively a tender organization which quickly perishes at a temperature above 60° C., the spore is able to resist all the forces nature can marshal against it, either chemical or physical, save the one exception of sunlight and the actual flame.

Spores, in most cases, occupy the center of the rodlets, but in a few varieties they occupy the end. This is well seen in the tetanus bacillus. When occupying the center, the bulging caused by its presence may give the organism a spindle-shape, or the clostridium form.

Again, bacteria may be classed and distinguished according to their respective capability of living and multiplying upon dead substances or upon living matter —saprophytes and parasites. The parasites have been subdivided into obligate and facultative. The former are true parasites, thriving and multiplying only in the living body, and quickly perish when apart from living material. Facultative parasites can adapt themselves to either condition—live and multiply either within or without the living body. In other words, they are ambigenous.

Besides the above-named distinctions of class and varieties, there are aërobes and anaërobes. The former cannot grow except in the presence of oxygen, while those microörganisms whose multiplication occurs only in the absence of oxygen are denominated obligate anaërobes. When growth may occur either in the presence or absence of oxygen, the microörganism is said to be a facultative anaërobe.

The products of metabolism are also properties of bacteria. A large number of bacteria generate coloring matter while they are themselves colorless and transparent; the pigment being merely the formed product of their metabolism under the influence of light. Again,

many species throw off odorous products, and some of the anaërobic class generate and exhale very offensive putrefactive gases, ammonia, sulphureted hydrogen, etc.

Again, besides peptonizing albuminoid substances, some microörganisms possess the faculty of resolving organic bodies into their simplest elements, some breaking up the chemical combination of albuminoid bodies, causing putrefaction; others, inducing fermentation; while a few others, in consequence of molecular activity of their protoplasm, are phosphorescent, or have the property of becoming luminous in the dark.

Up to the present time, 489 different microörganisms have been isolated and variously classified. The general knowledge on the subject, derived from Sternberg's "Manual of Bacteriology," may be epitomized as follows:—

Pathogenic micrococci,	44
Non-pathogenic micrococci,	78
Pathogenic bacilli,	108
Non-pathogenic bacilli,	174
Pathogenic spirilla,	6
Non-pathogenic spirilla,	21
Leptotrichea and cladotrichea,	8
Not classified,	50

Asiatic Cholera.—Standing at the head of the class of pathogenic bacteria is that most dreadful of all disease-producing parasites, the comma bacillus of Asiatic cholera (Koch). A definite and morphologically distinctive microörganism found in the alvine dis-

charges and intestinal walls, rarely in the vomit, never in the breath, urine, tears, or other secretions, nor in the blood; body from 0.8 to 2.0 μ* long, or about half as long as the tubercle bacillus, sometimes curved and so connected at the ends as to form S shapes and half circles, or running out into long or short spirals † resembling the spirilla of relapsing fever, motile and armed with a single flagellum, by which it whirls through the microscopic field "like a swarm of dancing gnats,"—aërobic and grows rapidly in gelatin and blood serum at a temperature of 30° or 40° C.—multiplies by division—not yet known whether it is spore-producing or not—acids unfavorable to its growth,—easily killed by drying: thermal death-point 52° C.

Methods of Artificial Culture.—Koch's method of plate-cultivation with nutrient gelatin has been generally accepted as the best. Thus cultivated, the colonies commence to form in 24 hours, or less. They make their appearance in small, white specks or dots, sinking below the surface, resembling so many air-bubbles, and may be seen with the naked eye. When magnified 100 diameters, the field appears as if strewn with bits of glass. As the culture grows older the gelatin becomes more and more thoroughly peptonized, and during the liquefying process a disagreeable odor is emitted.

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* μ the *micron* or micromillimeter = .001 mm., $\frac{1}{25\frac{1}{400}}$ of an inch, nearly.

† Strict systematicians look upon the "bacillus" as only a *fragment* of a real *Spirillum*.

The nutrient gelatin may be prepared as follows:—

Take one pound of beef, free as possible from fat, and chop it up finely; then transfer the mass to a glass or porcelain vessel and add a quart of distilled water. Shake well the mixture and place it in a refrigerator for 24 hours. After thus standing, it is again well shaken up and the liquid portion filtered by squeezing through a linen cloth. Then to the reddish-colored filtrate add enough distilled water to make a quart mixture, and immediately put into it

5 grms. of common salt,
10 grms. of dry peptone,
100 grms. of best white edible gelatin.

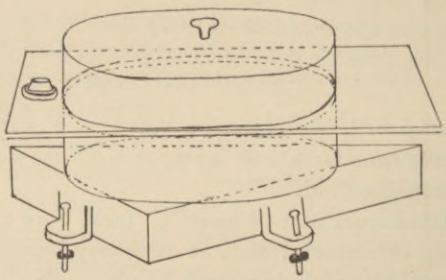
Shake up well, and place the vessel in a water-bath with gentle heat for a half hour, or until the gelatin is completely dissolved.

The test should now be made to make sure of exact neutrality of reaction, and, if necessary, sodium carbonate added to produce such result. The liquor is then heated for an hour in the water bath and tested again for its reaction. In about ten minutes before the boiling is completed, the white of an egg, with the shell, is added, and the mixture then filtered while hot, through paper and a funnel specially fitted for the purpose. Should the filtrate show the least turbidity, it must be put back into the heating vessel and boiled a second time for at least ten minutes, then refiltered. But it should be remembered that too long boiling prevents the gelatin from solidifying.

This formula may be modified at will by the addition of organic or inorganic substances, and will serve for the cultivation of all pathogenic bacteria which grow at the ordinary room temperature.

How to Make the Plate-culture.—A glass plate, or one of iron, having first been carefully sterilized, is cooled and then exactly leveled on a tripod constructed for that special purpose. Upon this plate is laid another sterilized plate, either of glass or iron, but

FIG. 12.



Koch's Plating Apparatus as arranged for "Setting" Agar or Gelatin Plates.

smaller than the bed-plate, and upon it the nutrient gelatin is poured, as evenly as possible, and at once covered with a sterilized bell-glass.

After the gelatin coating has sufficiently cooled and set to permit movement, the plate is transferred to a glass dish in which it is placed on sterilized blotting paper wet with corrosive sublimate solution, and covered with a sterilized bell-glass.

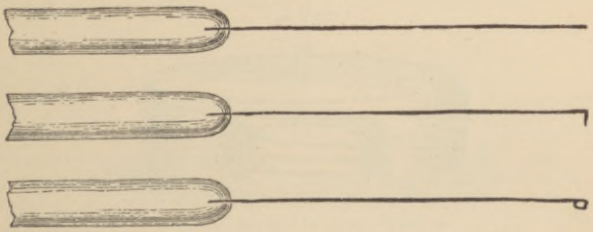
The inoculations are then made with a platinum

needle, also duly sterilized and charged with a particle of the infective material, with which the gelatin surface is pricked here and there.

Agar-agar.—In all cultures which do not require a lower temperature than blood-heat, this medium may be used. It is prepared in the same way as nutrient gelatin, only that 1.5–2 per cent. of finely divided agar-agar is used.

Nutrient Potato.—Sterilized potatoes make a convenient culture-garden, and are of great service in study-

FIG. 13.



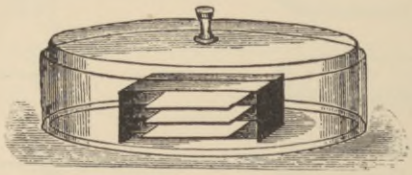
Oese or Platinum Needles, Straight, Hooked, Looped.

ing pathogenic bacteria. The bacterium of cholera, glanders, enteric or typhoid fever, diphtheria, etc., develops on potato, and in some cases in a highly characteristic manner, particularly enteric or typhoid fever. When this nutrient substance is employed, potatoes with smooth skins and but few eyes should be selected. They are at first scrubbed and freed from sand or dirt of any kind with a brush, and afterward placed for an hour in a

five per cent. corrosive sublimate solution, and then boiled for a half hour. They are next cooled on a sterilized plate, cut into halves with a knife that has also been properly sterilized, and otherwise made ready for inoculation. For further instructions in the technique of culture media the reader is referred to any standard text-book on bacteriology, particularly Dr. Sternberg's great work.

Cover-glass Demonstration.—The cholera microörganism is not always an easy matter to demonstrate in cover-glass preparation from the typical rice-

FIG. 14.

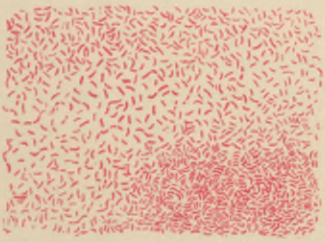


Damp Chamber for Plate Cultivations.

water stools, owing to the "garden full of weeds" which is usually present in the microscopic field; but an accidental good catch may now and then be made, and is therefore worth trial in all cases. Where this fails, the method of plate-cultivation above particularly described should be promptly resorted to, for upon the correct diagnosis of the "suspicious case" may depend the safety of a whole community.

A speck of the heaviest flaky matter is picked out, with a large needle or other instrument, from the stool and smeared on a clean cover-glass. Upon this is then laid another like clean cover and both pressed together in order to give an even coating to both glasses. The squeezed-out matter around the edges is then wiped off, and the two pieces carefully slipped apart. After drying in the air of the room for a few minutes, they are caught with the forceps and whipped several times—the smeared

FIG. 15.



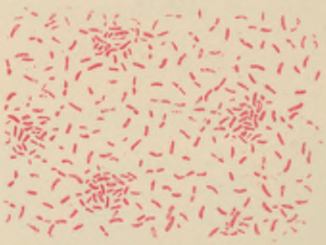
Comma Bacillus of Asiatic Cholera.

side up—through the flame of a spirit lamp to fix the serum-albumin and microörganisms in the film. After this preparation of the covers, they are laid on blotting paper, coated side up, and covered with a bell-glass to wait for the application of the stain, to be used as follows: Put into a small test-tube, having a lip—and fixed in a holder—a little alcoholic solution of fuchsin, methylene-blue, or violet, and double its bulk with five per cent. carbolized water. Shake the mixture, and hold the tube

over the flame of a spirit lamp until the fluid begins to steam, then lift the bell-glass, pour on each of the glasses just enough of the stain to fully cover their surfaces, and replace the bell-glass.

After standing thus flooded with the stain for one or two minutes, catch the edge of the cover-glass with the forceps and drain off the waste staining fluid by tilting the glass on a blotting paper; then, while still holding

FIG. 16.



Finkler-Prior Bacillus of Cholera Nostras.

the glass with the forceps, wash thoroughly in water, and stand it on its edge on blotting paper to drain and dry. Before mounting on the slide, the covers should be thoroughly dried by heat to make sure they are in condition to receive the drop of balsam and xylol to clear up the film and seal them to the slide.

After finishing the mount, if the specific microörganism is present, it may be discovered with a Bausch & Lomb 1–12 oil immersion, aided by an Abbe condenser.

Bacillus of Cholera Nostras.—The Finkler-Prior bacillus is larger and thicker than the *Comma bacillus* of Koch, and, because of its resemblance to the micro-organism of true Asiatic cholera, may be mistaken for it in a cover-glass preparation from the stools. In case of doubt, the culture-method should be resorted to, by which the question can soon be settled, namely, whether it is the *Vibrio proteus* of Cholera nostras, or the *Comma bacillus* of Asiatic cholera, which is present. The culture on a nutrient gelatin plate liquefies so rapidly and extensively after inoculation with the *Vibrio proteus* that a mistake should not be made in interpreting the correct result of the culture. Even on potato, the crucial test may be made. On this culture-medium, the *Vibrio proteus* grows at ordinary temperatures, while in genuine or Asiatic cholera the *Comma bacillus* only grows at incubator temperature. Thermal death-point 50° C., same as Asiatic cholera.

Enteric or Typhoid Fever.—At present the consensus of opinion among bacteriologists accepts without hesitation Eberth's bacillus, discovered in 1880, as the true pathogenic factor of enteric or typhoid fever. The etiologic relation of the microörganism has been abundantly confirmed by the researches of Klebs and Eppinger, Koch, Friedlander, Pfeiffer, Frankel and Simmonds, Meyer, Gaffky, Sternberg, and other distinguished authorities in bacteriologic science the world over. Sternberg says: "No other organism has been found, after the most careful search, in the deeper portions of the intestinal glands involved in this disease,

or in the internal organs; on the other hand, this bacillus has been demonstrated to be constantly present. It is undoubtedly present during the life-time of the patients, and is found in greater abundance in those cases which terminate fatally at an early date. It is not a putrefactive organism, and is not developed in the tissues post-mortem, although it has been shown by Frankel and Simmonds that it multiplies rapidly in the spleen after death, up to the time that putrefactive decomposition commences."

While the spleen is the organ in which the bacillus

FIG. 17.

Bacillus of Typhoid Fever.—Rods and Spider-Cells.

has been more frequently found, it also invades the liver, kidneys, and mesenteric glands. Rütimeyer and Newhauss have stated that it may also be found in the blood of such typhoid patients, taken from the rose-spots, and that they succeeded in cultivating the specific microörganism from it. Further confirmation on this point, however, seems necessary, as the more recent researches of Janowsky show that the bacillus is very rarely present in the blood during life, and its detection should therefore not have much weight in the resources of the differential diagnosis.

It is always extremely difficult to demonstrate its presence in the feces; hence the necessity of appeal to artificial cultivations. The morphologic description given by various authors is uniform in every essential particular,—namely: that the microörganism is "three times as long as broad, with rounded ends, may grow to long threads as well as be found in short rods, motile and probably possesses flagella, and resists the action of anilin colors to a greater degree than most similar organisms." The high degree of motility is well accounted for when Löffler's "spider-cells" are placed under a power of 1.200. With such amplification the rodlets present really the appearance of spiders.

Of all the diagnostic characters given, says Sternberg, "the peculiar growth upon potato, first pointed out by Gaffky, is the most important. This serves to distinguish the typhoid bacillus from similar organisms which in their morphology and growth upon gelatin or upon agar-agar closely resemble it. The rods, as first pointed out by Eberth, have rounded ends, but this is by no means peculiar to the typhoid bacillus. They vary greatly in length, and while the prevailing form is that of a short rod three or four times as long as broad, filaments of considerable length are developed in cultures made in gelatin or upon potato."

When a positive decision is required concerning the presence or absence of the microörganism, the potato culture-test may be employed, but it cannot be relied upon alone. In three or four days, at room temperature, and provided the slices of potato have an acid reaction,

—for which the culture should always be previously tested,—there appears on the surface a moist, pearly-looking gloss which is peculiar to the growth of the typhoid bacillus on potato. In case of doubt, a further means of recognition has been proposed by Chantemesse and Widal, namely, the carbolized nutrient gelatin-test. These authorities are responsible for the statement that it is a peculiarity of typhoid fever bacilli that they thrive on a nutrient gelatin which has been mixed with 2 per 1.000 of carbolic acid, whereas all other microörganisms perish on this mass. It thrives whether oxygen is excluded or not, but is more luxuriant in the presence of this gas.

According to Gaffky and Birch-Hirschfield, spores occupying the ends of the rodlets are formed in the course of three or four days at a temperature of 33°–40° C., and at a temperature lower than 20° C. sporulation ceases. This statement has been antagonized by Buchner, Janowsky, and Sternberg, who believe that the refracting granules described by Gaffky as spores are not reproductive bodies—and for this reason they are utterly destroyed by a temperature of 60° C., while spores are distinguished by their resistance to heat and other destructive agencies. In fact, according to Buchner, the bacilli containing these refractive granules are even less resistant than fresh cultures in which they are not present; and he looks upon them as representing a degeneration of the protoplasm of the cells. (Sternberg.)

The thermal death-point of this bacillus is 56° C.

Cover-glass preparations may be made as directed for the demonstration of the cholera bacillus, except that the time of staining should be lengthened from ten to fifteen minutes.

Staining Sections.—It has already been stated that the bacillus of enteric or typhoid fever is refractory to the anilin stains, as ordinarily used. By a very simple method I have been able to overcome completely such difficulty in staining, and by it produced the most satisfactory results—not only in demonstrating the typhoid bacillus, but as well other specific microörganisms in tissue. In fact, by the method now to be described (for the first time, I believe) there is not the least danger—I should have said possibility—of washing out too much of the stain in the process of dehydrating the section. It completely bridges over "the weak point," stated by Dr. Kühne, "in the processes hitherto used, viz., the dehydration of already differentiated sections in alcohol, by which under certain circumstances the decolorizing properties of the fluid must have had a very bad effect. "I tried," says Dr. Kühne, "to minimize this undesirable accessory effect of the alcohol by adding to it some of the stain in which the sections had been previously stained, and by these means a part at least of the staining matter removed by the alcohol was replaced. Afterward anilin oil was recommended by Weigert as a means of dehydration," and to meet the emergency.

The "simple method" with benzol, referred to above, is so successful that indeed both absolute alcohol and anilin oil may be dispensed with as dehydrating

agents in that class of fission fungi fatally faded by alcohol. By its use deep staining is unnecessary.

The material having been properly hardened in alcohol, cast in paraffin, the section cut and immediately fixed on the slide with a carbolized solution of egg-albumin, then freed of all trace of the embedding material by soaking in spirits of turpentine, next thoroughly washed in benzol followed with alcohol,—in other words, the section having been made ready for staining,—the procedure is as follows: Take a small quantity of "Löffler's Solution," or, instead, equal parts of a strong alcoholic solution of methyl-blue and five per cent. carbolized water, in a test-tube in the manner described on a preceding page, and steam it over the flame of a spirit lamp. Then, taking a slide holding the section from the beaker or bottle of alcohol, the under surface and ends are wiped quickly with a linen handkerchief, after which it is placed section side up on a piece of blotting paper. The hot staining fluid is then poured upon the section, and the slide covered with a bell-glass.

The section should remain covered with the stain for ten or fifteen minutes. Then, catching the slide with the forceps and draining off the surplus stain, it is washed in distilled water for a few seconds and next wiped with a cloth, especially the under side. A bit or square of fine, thick, white filter-paper is then pressed upon the section to absorb the water and stain on its surface.

The section is now flooded with benzol—the upper

left-hand corner of the slide being held between the thumb and index finger of the left hand—for a minute or so; next, the benzol is poured off and another piece of the filter paper applied; then flooded again with benzol for half a minute, after which it is replaced with xylol. This process of dehydration should be continued until the section is well cleared up, after which a drop of balsam and xylol is placed upon the section and the cover-glass laid on.

It may be here remarked that benzol not only has the capacity to replace spirits of turpentine, but possesses great affinity for water, on which account it is of priceless value in the demonstration of some particular forms of bacteria in tissue.

By this method, absolute alcohol is not needed in dehydrating sections, and thus treated microörganisms that do not stain well by the old methods, or are easily faded with alcohol, hold fast all the color necessary to make their demonstration complete.

Pulmonary Tuberculosis.—Happily, there no longer exists any excuse for uncertainty concerning the true condition in a case of pulmonary tuberculosis. Koch's discovery of the tubercle bacillus has made possible an unerring diagnosis, even in the incipient stage and before there is manifested a single physical sign to give warning of the presence of the disease. Recognition of this inestimable truth should quicken the physician's sense of his great responsibilities and impel him, who is not already qualified with such useful knowledge,

to become familiar as soon as possible with the various methods of demonstrating the tubercle bacillus.

The outlay of less than fifty dollars will fully equip him with the necessary microscopic outfit, and the devotion of a few hours' time under the direction of a competent instructor will do the rest.

The medical student who does not possess sufficient microscopic technique to demonstrate the tubercle bacillus ought not to be commissioned, either by a medical college or the State, to practise medicine. No part of his preparation for accurate diagnosis is of so much importance as the ability to detect, by means of the microscope, tuberculosis of the lungs in its incipiency. It were far better he should, when engaged in practice, be without horse and carriage, or the display of surgical instruments and attractive office furniture—particularly the Gynecological Chair, representing "The Great Medical Error of the Day"—than without a good microscope and the ability to use it successfully.

The immense waste of health and life, and treasure also, from lack of such knowledge and technique on the part of physicians generally is incalculable; for the statement cannot be gainsaid that tubercular consumption, if discovered and properly treated in its incipiency, is a manageable disease in numberless instances. I make this statement with as much confidence as I have in any truth in medicine. I could recount scores of cases, if it were necessary, in which the early recogni-

tion of the disease, by the discovery of the bacillus tuberculosis in the sputum, was the saving of the patient; for my experience has never failed me in a single instance that the presence of this bacillus in the sputum is the proof of the existence of either pulmonary or laryngeal tuberculosis. On the other hand, the *absence* of the microörganism in the sputum is the full warrant—no matter how well pronounced the resemblance of symptoms to favor the diagnosis of tuberculosis—that the case is *not* one of tubercular consumption.

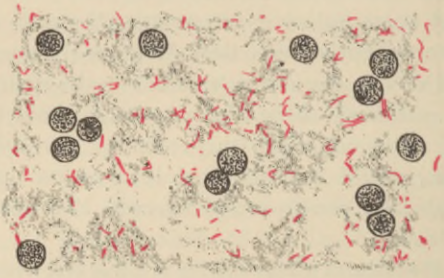
If all cases called "consumption" could be subjected to the microscopic test—to prove the presence or absence of the *Bacillus tuberculosis* in the sputum—the ghouls in human shape who now fatten from the sale of vile nostrums which they offer as *cures for consumption*, would find fewer victims to rob and feed upon by false promises and *mirabile dictu* newspaper stories.

The **Bacillus tuberculosis** is a fine rod with clearly rounded ends, varying in length from 2–8 μ, but having an average nearly equal to the diameter of a human blood-corpuscle; either straight, curved, or crooked at all angles, but mostly of fiddle-bow curve; lying singly and in pairs, sometimes overlapping each other, or lying in bundles or heaps, occupying both epithelioid and giant-cells, and strictly parasitic in its character. In giant-cells, the position of the bacilli is quite characteristic; and by their presence a series of most interesting changes take place in the center of the cell, finally end-

ing in the massing of necrotic or dead cells which cannot be stained differentially.

The bacilli are destitute of motion,—probably multiply by spores, though this mode is not necessary for perpetuation of the species, —aërobic, very selective of culture media, and restricted in development to narrow ranges of temperature with 37° C., or blood-heat, for the standard of most thrifty growth. In sputum espe-

FIG. 18.



Bacillus Tuberculosis in Sputum.

cially, because of the thick albuminous character of the material, the bacterium is capable of living in a dried condition for several months. This fact is terribly suggestive of the danger of infection, particularly in towns and cities, from inhaling particles of dried sputum swept by the winds through the streets. Very many times, on seeing a suspected sputum on the pavement, have I picked up such a specimen for micro-

scopic examination and found it loaded with tubercle bacilli.*

When one's "standard vitality" is lost from the effects of cold or other cause, producing a favorable culture-surface in the bronchial tubes, the inhalation and lodgment of the bacillus is not only possible, but, no doubt, in that way the disease is frequently contracted, as well as by breathing the air and dust of a hospital ward for tuberculous subjects, or the confined atmosphere of a private room occupied by such a patient.

I think my observation fully warrants the statement that the sputum becomes more and more loaded with tubercle bacilli as the disease advances to a fatal termi-

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*There can no longer be any doubt concerning the unity of scrofula, lupus, and tuberculosis, or that they are due to one and the same microörganism. In 1887 I had the opportunity of clearly demonstrating not only the presence of giant-cells in lupus tissue, but also swarms of tubercle bacilli. (*The Med. News*, Phila., 1887.)

In searching for diseases kindred to tubercle, chronic glanders, syphilis, leprosy, and antinomycosis cannot escape particular attention. They are all of bacillary origin, and produce tissue-growths that are strikingly similar in histo-pathologic characters. The closest resemblances are to be found between tubercle, syphilis, and leprosy.

Indeed, so closely does the *Bacillus leprœ* resemble the *Bacillus tuberculosis* that the most authoritative bacteriologists have been unable to mark much difference between them. Baumgarten has asserted that, both in their morphology and staining receptivity, they cannot be distinguished.

nation, and that their number diminishes with any improvement of the patient's condition.

The infectious activity of this parasite defies all temperatures reaching near the boiling point; neither is its vitality in the least diminished by decomposition of animal tissues and secretions, nor contact with the gastric juices.

Here, again, as with anthrax, the killing influence of direct sunlight on bacteria has another example. Koch found that the tubercle bacillus is killed on exposure varying from some minutes to several hours to direct sunlight, while diffuse daylight required from five to seven days to destroy it.

Observations have already been made by Marshall Ward and others on the effect of electric arc light as a disinfecting agent, and with sufficient favorable result to encourage further experimental inquiry.

The well ascertained thermal death-point of the tubercle bacillus is 70° C. for four or five minutes.

"The following is Kitasato's method of preparing pure cultures from sputum: The patient is requested to evacuate his morning sputum into a sterilized double capsule. A flake is isolated with sterilized instruments, and carefully washed in at least ten watch-glasses full of distilled water, one after the other, to remove the bacteria taken up in passing through the cavity of the mouth. The flake is now transferred to glycerin-agar or serum. After it has been kept for some fourteen days in the incubator the first colonies form, appearing as circular, pure, white, transparent specks,

which project above the surface of the medium." (*Schenk.*)

Another and perhaps more simple method (Pastor's) is as follows :—

"A patient is chosen whose sputum is very rich in bacilli and shows comparatively little contamination with other microörganisms, and he is made to rinse out his mouth and pharyngeal cavity repeatedly with distilled water, and then to expectorate into a sterilized test-glass. The sputum, or more properly the liquid contents of the pulmonary cavities, is shaken up with sterilized water and filtered through fine gauze to remove the coarser particles. A few drops of the filtrate are mixed with melted nutrient gelatin in such a manner as not to render it very turbid, and the mixture is poured out on plates which are left under bell-glasses at room temperature. In from three to four days the various colonies of bacteria contaminating the sputum form." (*Ibid.*)

As a matter of common observation, and an important point of difference between a tubercular sputum and one which is not tubercular, is that the former when kept at room temperature soon becomes liquid and putrid, of greenish color, and exhales a most offensive odor, while the latter—no matter from what other form of chronic pulmonary disease—soon thickens by drying, becomes pasty, and is not offensive to the smell.

Tubercle bacilli cannot be seen in an unstained sputum ; hence the necessity of certain staining methods.

For the demonstration of the tubercle bacillus, either

in cover-glass or tissue preparation, I have for the last several years employed, to the exclusion of all other formula with which I am acquainted, a compound stain constructed on the basis of the Gibbes' Double Stain (No. 16). With this "Carbolized Double Stain"—as I have been in the habit of calling it,—I have been able to get better results, a sharper differential field, and more durable picture, than from the use of any other formula. The following is the method of employment:—

A cover-glass having been prepared in the usual manner with the sputum—thinly-coated, dried, and several times whipped through the flame of a spirit lamp,—a small quantity of the stain is filtered into a test-tube, which should then be moved back and forth through the lamp flame until the fluid begins to steam. The cover-glass is then placed on a piece of blotting paper and the hot stain poured upon the coated or sputum surface,—just enough of the stain, drop by drop, to flood the cover almost to running over. It is now covered with a bell-glass and thus stained for five or ten minutes. When ready for the next step, it is picked up from the blotting paper with the forceps, washed, and sufficiently decolorized in alcohol. It is then taken between the thumb and forefinger of the left hand and wiped on the under surface, and otherwise handled as directed on a preceding page.

If it be a section-mount, the slide containing the adherent section—duly prepared as described on a preceding page—is placed on a blotting paper and the same hot stain poured upon the section, in sufficient quantity

to cover it completely. The slide is then covered with a bell-glass, and so kept for fifteen or twenty minutes, after which the right-hand end is seized with the forceps, the slide tipped to drain off the surplus staining fluid, and then washed and decolorized in alcohol,—from one beaker or bottle into another, until the alcohol flows off the slide without color.

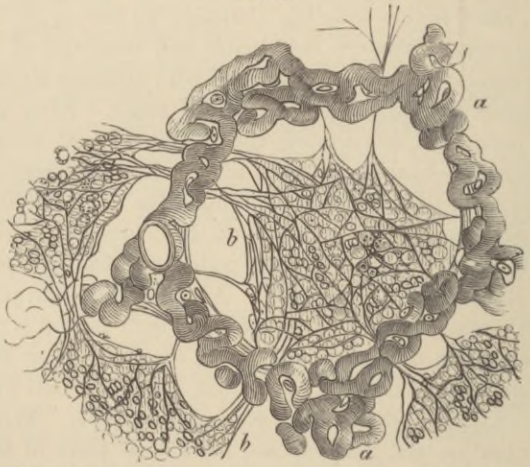
It is then quickly wiped with a linen cloth, free from lint, after which—holding the slide by the upper left hand corner, between the thumb and forefinger of the left hand—the section is flooded with absolute alcohol, which is poured off and on several times. After having been thus dehydrated, the section is next flooded with xylol—again and again, until it is well cleared up, —then the slide is wiped all around the section, a drop of balsam and xylol applied, and the cover-glass laid on.

If benzol is used instead of xylol as a clearing agent, the stained bacilli soon fade. Another important point worth remembering in connection with benzol is that it cannot be used successfully as a clearing agent in a humid atmosphere. At such times, when poured upon the section, it produces a milky appearance. Whenever that occurs, xylol should be used in place of benzol.

Croupous Pneumonia.—Two very different microorganisms, with some features in common, have been found in the lungs and sputum of patients suffering from this disease,—the *Micrococcus pasteuri*, discovered by Sternberg in 1880, and the *Pneumobacillus of Friedlaender*, both varieties, presumably, being of a specific

character. The relative frequency, however, of the detection of the two forms in a given number of cases differs widely. Weichselbaume found the "*Diplococcus*" in ninety-one cases out of a hundred, while, on the other hand, in one hundred cases the pneumobacillus was only present nine times.

FIG. 19.



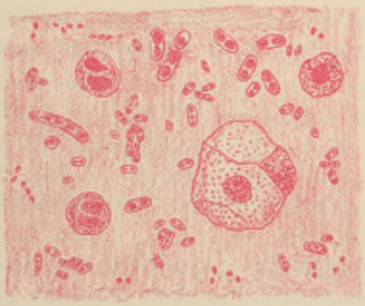
Recent Croupous Pneumonia. *a*. Alveolar Septa with Injected Capillary Vessels. *b*. The Exudation. 1–300.

Though never presenting as distinctly rod-shaped as Friedlaender's bacterium, Sternberg's *Micrococcus pasteuri* is sufficiently well marked to distinguish it from all other microörganisms. Both of them develop a

capsule in the animal body and never outside of it, and may be artificially cultivated, but the culture-medium must have at least a faint alkaline reaction, as an acid renders growth impossible.

Both varieties are alike immotile, semi-anaërobic, and may be found in the mouth and nasal passages of healthy persons, also in the lungs and expectorated matter of patients suffering from other pulmonary dis-

FIG. 20.



Pneumonococci. (*Jaksch.*)

eases. The thermal death-point for this microörganism is 56° C.

The strongest differential point is, probably, that while Sternberg's *Micrococcus pasteuri* may be beautifully stained and demonstrated by Gram's method, the pneumobacillus of Friedlaender is decolorized and undemonstrable. Sections showing fibrin-choked alveoli may be prepared either with Weigert's Fibrin

Stain, or the author's Safranine method. (See Nos. 23–24.)

The general knowledge on the subject concerning the causal relation of these microörganisms to croupous pneumonia accepts the *Micrococcus pasteuri* as being the true factor of the disease.

Diphtheria.—The microörganism of diphtheria is now well known as the *Klebs-Löffler bacillus.* The rods are about the same length as the tubercle bacillus, either straight or curved, crooked or club-shaped, and at least twice as thick as the tubercle bacillus. Some of the rodlets appear much longer than others, but the

FIG. 21.

Bacilli of Diphtheria. × 1000. (*Gould.*)

long ones are found on careful inspection to be made up of single pieces linked so closely together by their ends as to give the appearance of being a continuous body. They are motionless and have no spores. The false membrane is a network of fibrin enclosing in the meshes epithelial cells, blood and pus-corpuscles, and various microörganisms, besides the Klebs-Löffler bacillus which is found in all typical cases of the disease and retains its virulence, even when completely dried, for several months. The older and thicker parts of the false membrane are the sites of the most luxuriant growth of the bacillus, but it may be grown outside the animal

body, on gelatin and in blood serum. It is semi-anaërobic and thrives best at a temperature between 20° to 42° C.

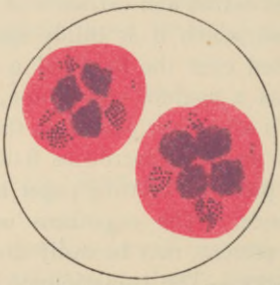
The method of staining may be made a means of differential diagnosis, Löffler's alkaline methyl-blue giving good demonstration with deeply colored ends of the bacillus, while Gram's method yields a negative result.

Dr. Sims Woodhead's method of staining the microorganism is as follows: It is only necessary to remove a small fragment of the false membrane by means of a bit of absorbent cotton and carried with the forceps to a cover-glass, on which it is thinly spread out, then dried and heated over the flame of a spirit lamp in the same way as a sputum preparation, after which a drop of Löffler's solution is placed on the slide and the cover-glass laid on it. Superfluous fluid should be removed with a piece of blotting-paper and the mount examined at once. The organisms occur in small groups, and, if present, may be easily discovered.

Scarlet Fever.—The bacteriologic study of scarlet fever has not yet resulted in the discovery of the specific germ to which the disease is due. Various investigators have discovered cocci in typical scarlatina, but the organisms in no way could be distinguished from the *Streptococcus pyogenes* derived from pus. Very recently Dr. Klein succeeded in separating a microörganism from the blood which he regards as the true virus or contagium of the disease, notwithstanding its close resemblance to the *Streptococcus pyogenes*, but the experiments upon which he based his

claim have not been accepted without serious question. Neither has the very able experimental work of Jamieson and Edington, reported in the *British Medical Journal*, 1887, fulfilled the hope it so brilliantly encouraged. So, at present, it may be here stated that up to this time no microörganism has yet been discovered and isolated which can confidently be accepted as having causal relation to scarlet fever.

FIG. 22.



Gonococci contained in Pus-cells. (*From Friedlaender.*)

Gonorrhea.—The doctrine of the causal relation of the microörganism called *Gonococcus*—first discovered in 1879 by Neisser, of Breslau—to gonorrhea is now generally accepted. The very infectious nature of gonorrheal pus distinguishes it from all other pus-products.

The cocci, about 0.83 μ in diameter, are arranged singly, in pairs, and in groups, often closely set

against each other in the interior of the pus-cells surrounding the nuclei, and can be easily identified.

Cultivation experiments have been uniformly unsuccessful with all media except human blood-serum, and even in this the growth is very slow, the most favorable range being between 33° to 37° C. The death-point is 60° C.

The cocci increase by fission at right angles, aërobic, and are easily stained with the "Carbolized Double Stain." They do not respond to Gram's method.

Cover-glass preparations should be handled in the same manner precisely as directed for tuberculous sputum mounts.

Syphilis.—Lustgarten found small comma-bacilli, curved and somewhat resembling the tubercle bacillus, in the discharge of the primary lesion of syphilis, also in the gummata of the tertiary form of the disease, but the microörganism—the alleged *Bacillus of syphilis*—has not yet been successfully cultivated outside the animal body. Indeed, its pathogenic character has not been accepted without question as having true causal relation to syphilis.

While the presence of the Lustgarten microörganism affords a valuable indication of the disease, extreme caution should be exercised to prevent confounding it with the *Smegma bacillus* found in normal *smegma præputiale* and *vulvare*, which it so much resembles, both in appearance and staining reaction.

Kamen has reported the case of a child in whose sputum he found the Lustgarten bacillus.

The two forms of bacilli may be easily differentiated by the alcohol test. After staining, the syphilis bacillus parts with the stain very slowly in alcohol: the smegma bacillus soon becomes paled and a blank in alcohol.

The syphilis bacillus, so-called, may be stained with a solution of gentian violet in five per cent. carbolized water, used hot for both cover-glass and sections: then, after staining for a couple of hours, to go into absolute alcohol; then into one and a half per cent. solution of permanganate of potassium, which deprives the tissues of their color while the bacilli retain their violet tint. To

FIG. 23.

Bacilli of Syphilis. × 1000. (*Gould.*)

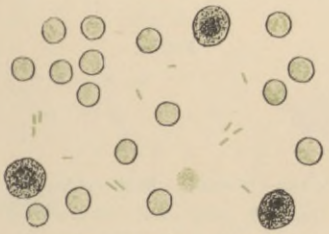
remove the precipitate of manganese which forms upon the specimens, they are immersed in an aqueous solution of sulphurous acid. This is "Ehrlich's Solution" with carbolized water instead of anilin water.

A far more simple and equally effective method may be accomplished with Löffler's methyl-blue poured on hot, decolorized with water, and then double stained with a watery solution of safranin.

Glanders.—The frequent occurrence of glanders in the human body is sufficient excuse for the mention of the disease in these pages. The specific microörganism is a slender bacillus, with rounded ends. Baumgarten

and Rosenthal claim that it is spore-producing, as shown by means of double staining; but it requires further observation to settle the question. It is from 2 to 5 μ long and 0.5 to 1.4 μ broad, or about the size of the tubercle bacillus, but a little thicker. It was first discovered by Löffler and Schütz, and may be found in the nodules and ulcers which form in the nasal passages and neighboring lymphatic glands, also, sometimes, in the blood and internal organs.

FIG. 24.



Bacillus of Glanders. (*Jaksch.*)

In a dried state it may retain its infective power for several months. It grows in various media,—agar-agar, glycerin-agar, and on potatoes, at a temperature between 30° and 40° C. It does not thrive well on gelatin, because its development is suspended at a temperature above 42° C. It is very motile. Its thermal death-point is 55° C.

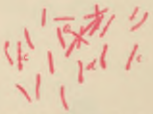
Cover-glass preparations may be made of the pus-discharge in the usual way, and stained either with "Car-

bolized Double Stain " or Löffler's Solution. Sections should be dealt with as directed for mounting enteric or typhoid fever tissues,—stained in the same way, and dehydrated with benzol instead of alcohol.

Leprosy.—The microörganism of leprosy is a slender rod with somewhat pointed ends, and probably not quite as long as the tubercle bacillus, its length being, upon an average, about two-thirds the diameter of a human blood corpuscle, or 4–6 μ long, and less than 1 μ wide. It contains two or three spores, and, in tissue, presents a beaded appearance. The bacilli are immo-

FIG. 25.

Bacillus lepræ. × 1200. (*Gould.*)



Bacillus of Leprosy. × 800 Diam. (*Coplin.*)

tile, and principally distinguished from tubercle bacilli by staining readily in aqueous solutions of the anilin dyes. Beautiful preparations may be made with the carbolized double stain (No. 16).

The specific bacillus is found in all leprous processes and products, in the cutaneous connective tissue, in the spleen, kidneys, liver, testicles, and lymphatic glands, but not in the blood. Cultivation-experiments have not been generally successful. It thrives best at a temperature from 37° to 38° C., and is very sensitive to some of the basic anilin colors.

Tetanus.—The importance of this disease of wound-infection, with a clinical history distinguished from all other affections, makes necessary its brief description.

The specific microörganism is a very slender rod, of a peculiar "pin-shape," having a spore at one end which gives the body a drumstick appearance. It was discovered by Nicolaier in pus from wounds of persons who had died of the disease, and in garden mold.

It has also been found in old, crumbling walls, putrescent fluids, and other decaying substances, including

FIG. 26.

Bacillus tetani. × 800 Diam. (*Coplin.*)

manure heaps. The discovery of the last-named source no doubt gave origin to the opinion of some French investigators that the disease develops in persons who frequent stables or are in contact with horses.

Many authorities believe that tetanus is an infectious disease and that the pin-shaped bacillus is the factor of its communicability. Brieger and Nissen have experimentally demonstrated the presence of several ptomains in the blood, with which they have induced tetanic symptoms and poisoning in various animals. To de-

stroy the spores requires exposure for five minutes, at least, to the action of steam at 100° C. It is slightly motile, and can withstand a temperature of 80° C. without losing its pathogenic power; grows in various culture-media and liquefies gelatin; rigidly anaërobic and thrives best at a temperature from 36° to 38° C.

It colors equally well with several of the anilin dyes, and may be demonstrated by Gram's method. Here, also, the "Carbolized Double Stain" may be employed with very satisfactory effect (No. 16).

Influenza.—The alleged discovery of the bacillus of influenza by Pfeiffer and confirmed by Kitasato,

FIG. 27.

Bacilli of Influenza. × 1000. (*Gould.*)

Canon, and Babés, is probably the very latest addition to the list of pathogenic bacteria cultivated outside the animal body. The disease is of such universal importance—having invaded whole continents within the last several years, and is now, at the beginning of the year 1894, wide-spread in its visitation in the United States and over Europe—that we may confidently expect very soon more exact knowledge on the subject of the bacteriology of the disease.

The influenza bacillus is the smallest of the rod bacteria, very slender, and not thicker than the bacillus of

mouse-septicemia. Kitasato succeeded in cultivating it to the fifth generation in glycerin-agar. Canon found the same bacterium in the blood of patients suffering from the disease, and cultivated it from that source. The diminutive rods occupy for the most part, the white corpuscles, and may be stained with Chenzynski's solution of methyl-blue and eosin (No. 5). By this process the red blood-corpuscles are stained red, the white corpuscles and bacilli blue.

Anthrax.—Although first thoroughly studied by

FIG. 28.

Bacillus anthracis. × 800 Diam. (*Coplin.*)

FIG. 29.

Bacillus of Symptomatic Anthrax, Flagellate Form. × 1000. (*Gould.*)

Koch, the *Bacillus anthracis* was seen by Pollender in the blood of animals suffering from the disease as early as 1849. It is found in the blood and tissues of animals dying or dead of the disease. Pasteur made the discovery that it is spread by earth-worms; but the statement has not been confirmed by other observers. The rods are arranged in chains of varying length, from 3 to 20 μ long, and 1.0 to 1.25 μ broad, and remarkable for their evenness of outline and squarely cut ends.

They are immotile, aërobic, and may be grown in

gelatin (which it liquefies), agar-agar, on potatoes, and blood serum. The multiplication is by egg-shaped spores, springing from the long axes of the maternal cells, the thermal death-point of which is 100° C.

The *Bacillus anthracis* meets every experimental requirement to prove that it is the cause of the disease, and is one of the best examples of a disease due to microörganisms.

For the demonstration of the bacilli in sections, the "carbolized double stain" may be used successfully. Very beautiful preparations also may be made according to Gram's method.

Amœba coli—*Amœba dysenteriæ.*—This protozoön

FIG. 30.

Amœba coli.

has been invested with so much interest since the studies of Councilman and Lafleur, Osler and Dock, that a brief description of its character should not be passed. Lösch was the first to connect this protozoön with dysentery in a causal relation, and his observations have been fully confirmed by the distinguished American authorities just named. It may be described as follows: Cellular body of circular form having a diameter of 20

to 35 μ contractile, consisting of a hyaline and coarsely granular protoplasm, with a round nucleus and hyaline vesicle, but no cell wall.

According to the observations of Councilman, "the amœba when at rest are round or slightly oblong bodies, consisting of an outer pale, homogeneous substance enclosing a somewhat greenish, highly refractive mass, which contains vacuoles of various sizes and a nucleus. Movement is their distinctive feature, however, and consists, first, of a progressive motion, and, secondly, of a protrusion and withdrawal of pseudopodia, both of which vary in activity. The pseudopodia are formed from the outer homogeneous part, which may, however, be otherwise invisible both in the resting and moving state. The amœba often contain foreign bodies, such as red corpuscles, pus cells, blood pigment, micrococci, bacilli, and their spores.

"Entering probably with the food, they pass on until the large intestine is reached, where the alkalinity necessary to their growth is obtained. Here they penetrate and undermine the mucous membrane, producing their effect by liquefying the tissues, and thus causing ulceration and necrosis. In the mucous membrane they are found chiefly in the submucosa, in the lymph-spaces and blood-vessels, and in the gelatinous contents of the ulcers. They may penetrate to the liver either by the portal vessels or through the peritoneum—sometimes causing peritonitis,—and set up abscesses which in the former case may be multiple, in the latter lie close to the surface of the right lobe, the commonest

position." According to Councilman and Lafleur, the liver shows no inflammatory reaction, and the abscess-cavity is filled, not with pus, but with debris of liver tissue, or sometimes a necrosed mass; the contents may, however, be old pus, the suppuration being due to the action of microörganisms conveyed by the amœba (Kartulis). The liver abscess may extend directly so as to involve the lung, or the amœba may traverse the diaphragm and set up an abscess by liquefying the tissue; but here the cavity is surrounded by an area of interstitial inflammation. That the microörganisms do not travel by the lymphatics is shown by their absence from the mesenteric glands, and they have no special preference for the lymphoid follicles.

"*Ante-mortem* they may be found in the stools, particularly the gelatinous particles, in the pus from liver abscesses, and in the sputum in cases of abscess of the lungs, and may be examined in the fresh state, best on the warm stage or in cover-glass preparations, or sections may be cut from portions of feces hardened and embedded in celloidin. Councilman and Lafleur obtained the best results with sections of tissue hardened in alcohol and stained in Löffler's methyl-blue, by which method the amœba are colored dark-blue, but unevenly. The nuclei are best brought out by hardening in Flemming's solution.

"Kartulis succeeded in obtaining pure cultures by inoculating alkaline infusion of straw with some of the contents of a liver abscess in which no bacteria were present." (Dawson.)

Plasmodium malariæ (*Polymitus malariæ*, Danilewsky). The first successful step toward the present exact knowledge of malarial intoxication was made by Laveran in 1880, whose name is indissolubly connected with the affection. From that well-established starting point, Marchiafava and Celli began their brilliant investigations which resulted in the discovery of the particular parasite, or hematozoön, which is now accepted with remarkable unanimity of medical opinion as the determining cause of the disease, and generally believed to stand in close relation to soil.

In this country the careful studies of Councilman, Abbot, Sternberg and Osler, have abundantly confirmed the descriptions furnished by Laveran, Danilewsky, Marchiafava, Celli, Golgi, Guarnieri, Crookshank, and other distinguished foreign observers, and given the subject a practical turn of the very highest clinical importance from the stand-point of differential diagnosis.

As indicated by Laveran, there are several developmental or evolutionary processes which successively take place in the life-history of the micro-parasite, giving a variety of body or shape corresponding with the well-recognized three stages of the disease. The different phases of the hematozoön have been grouped as *intra*-corpuscular and *extra*-corpuscular, or those within the red blood-corpuscle and those free in the blood serum.

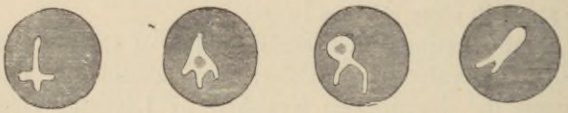
The **intra-corpuscular bodies** are of three forms or kinds:—

"*First*, structureless protoplasmic bodies, much

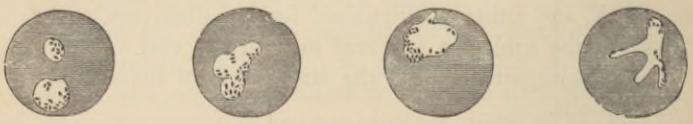
smaller than, and within or attached to, the red blood-corpuscles (Fig. 31). These rapidly change their shape, exhibiting ameboid movement," and were named by Marchiafava and Celli *Plasmodium malariæ*.

" *Second*, minute masses of finely granular or of hyaline protoplasm enclosing granules of pigment (Fig. 31). These forms are sometimes present in large numbers, and at other times can be found only with difficulty.

FIG. 31.



Non-pigmented Amœboid Forms.



Pigmented Amœboid Forms.

They are more or less spherical, but exhibit ameboid movement, and rapidly change their form. The pigment granules are also in active movement. There may be one or more of these ameboid bodies to a blood-corpuscle, and they vary in size; one may occupy the whole of the corpuscle. In cases of pernicious malaria similar bodies may be seen in tissue sections, in the corpuscles filling the capillaries.

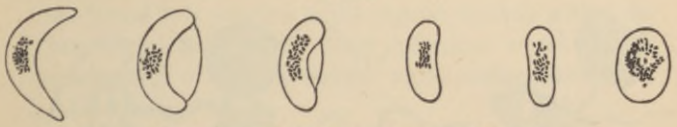
" *Third*, forms which appear like isolated grains, and

larger homogeneous bodies surrounded by clear spaces which change in outline.

"**Extra-corpuscular Bodies.**—These are the most striking and perhaps the most interesting forms.

First, the semi-lunar bodies of Laveran. These are crescent-shaped bodies, sometimes pointed at the extremities, but more usually rounded off (Fig. 32). They are not always curved; some, indeed, are almost spherical, and others sausage-shaped. They are motionless. In many specimens a delicate line is visible on the concave side of the crescent, connecting

FIG. 32.



Plasmodium malariæ (Extra-corpuscular Bodies).

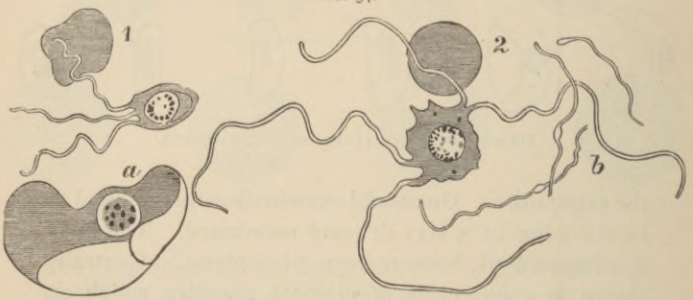
the extremities. On careful examination this is found to be the edge of a very delicate membrane. The body is composed of homogeneous protoplasm. Centrally placed is a collection of pigment granules, which on careful examination can be distinctly seen to be in movement. The semi-lunar bodies vary in number in different cases. Sometimes several can be seen in the field at the same time, and in other cases they are only observed after a long and patient search. They are, as a rule, free in the serum; but they have also been seen within the red blood corpuscles.

"*Second*, finely granular masses of protoplasm, which arise, according to Golgi, from the intra-corpuscular pigmented bodies. The pigment is collected in a rosette, and the protoplasm by segmentation gives rise to a number of small spherical forms, which are ultimately set free (Fig. 33). Golgi believes that these changes

FIG. 33.

Rosette Forms with Segmentation.

FIG. 34.



Flagellated Forms. 1. A flagellated spherule; (*a*) the same in the interior of a phagocyte; (*b*) free motile filaments.

occur in definite relation to the development of the paroxysm.

"*Third*, spherical, pear-shaped, or ovoid bodies, rather smaller than the red blood corpuscles, and provided with one or more actively motile flagella (Fig. 34). These

flagella are long, lash-like filaments, which by their activity set the neighboring blood corpuscles in motion. Free filaments in active movement have also been observed.

Fourth, small spherical pigmented bodies about one quarter the size of a red blood corpuscle, which exhibit ameboid movement." (Crookshank.)

The process of segmentation and multiplication, according to Golgi, covers a period from two to three days. At first the new plasmodia adhere to the edge of the blood-corpuscle, next become free, and subsequently invade other corpuscles.

And thus it is seen that by a proper examination of the blood it is possible to distinguish malaria with absolute certainty from all other affections which closely resemble it, or cases of obscure sepsis, endocarditis, and tuberculosis.

Artificial cultivation of the malarial parasite has not been successful, neither has its pathogenic character been established, notwithstanding the assertion made by Marchiafava and Celli that inoculation of a healthy person with blood containing the parasite will produce a paroxysm with development of the specific hematozoön.

Staining.—Various methods may be employed for the demonstration of the malarial parasite. To make a permanent preparation, a very thin layer of blood should be dried on either the slide or cover-glass in the usual way, and stained with Plehn's solution (No. 6). By this method the red corpuscles appear a light red, leu-

kocytes light blue, and their nuclei a deep blue, the eosinophil granules of the leukocytes a deep red, while the parasites are stained blue.

Malachowski's method is very easy to follow. He lays the cover-glass preparation in alcohol and stains it in a mixture of equal parts of a one per cent. solution of eosin and dilute aqueous solution of borax and methyl-blue (No. 31), by which method the red corpuscles show yellowish-red, the nuclei of the leukocytes violet, and the plasmodium blue.

FIG. 35.

Spirillum of Relapsing Fever. × 800 Diam. (*Coplin.*)

For immediate diagnosis the method recommended by Jaksch is of great value. Methylene-blue is dissolved in normal (0.6 per cent.) salt solution until the fluid is deeply colored, which is then filtered, sterilized, and sealed in small quantities in thoroughly sterilized test-tubes.

The point of the finger is carefully cleansed, a drop of the staining fluid applied, and through this drop the finger is pricked with a needle. The flowing blood thus mixed with the stain is spread as thinly and quickly as possible upon either the slide or the covering-glass,

and examined with a 1–12 oil-immersion lens and Abbé condenser. Evaporation may be prevented by sealing the edge of the cover-glass with paraffin.

Actinomycosis.—The wide distribution of this disease of cattle, principally, and the increasing number of cases of the same affection in human beings from accidental inoculation with the specific fungus in the pus-product developed in a lower animal, has made the affection a matter of so much public concern that the general knowledge on the subject of the exact

FIG. 36.

Actinomyces (Ray Fungus). × 800 Diam. (*Coplin.*)

nature of the disease has been greatly improved within the last ten or twelve years; so that now no longer any doubt exists concerning its communicable character from animal to animal and from animal to man.

The fungus character of the disease was discovered as early as 1845 by Langenbeck, but it was not until 1877 that the specific parasite—*Actinomyces bovis*—was discovered and isolated by Bollinger.

Following Bollinger's discovery of the parasitic nature

of the disease as it occurs in cattle and hogs, Ponfick and Israel furnished the proof of its easy communicability to man, and since the publication of their careful investigations many such examples of transmission from cattle to man have been reported.

The disease has long been familiarly known to stock-growers as "big-head," "big-jaw," or "lumpy-jaw," and, in surgical parlance, medullary sarcoma, osteo-sarcoma, etc. The presence of the seed-like granules in bovine pus is sufficient to make sure the diagnosis, even without the aid of the microscope.

That the disease "lumpy-jaw," or actinomycosis, in cattle as it is seen in this country, and fully described by Dr. D. A. Salmon, Chief of the Bureau of Animal Industry (see eighth and ninth annual reports, 1893), is the same affection described by Bollinger, has been clearly shown by the distinguished studies of Dr. W. T. Belfield, of Chicago, to whom belongs the credit of showing the unity, beyond all question.

In cattle, the lower jaw is the usual site of the disease, and the infectious fungus is generally believed to effect entrance by the mouth and in some manner find lodgment either in a carious tooth or on an abraded gum. But no matter what the mode of introduction of the pathogenic microörganism, a focus of inflammation is soon established and a nodular growth, composed chiefly of round cells, granulation tissue, and fibrous bands, follows in more or less active order. These infective nodules are of various sizes according to the age or luxuriance of growth, but soon break down in

suppuration and result in pus-cavities. Between these centers of suppuration, fibrous tissue of varying degrees in density constitutes the structure of variously sized tumors which soon form and give the characteristic appearance. These masses may reach the size of the fist, or larger, in the jaw of a bullock; in the human subject the soft parts of the neck, the mediastinal tissue, and the lungs are the parts most frequently involved. In some cases the histologic structure of a bovine specimen may so closely resemble tuberculous tissue that but for the central presence of the fungoid masses the differential diagnosis would be most difficult, if not impossible. This is very true, as shown in a specimen nodule which I have in my possession, sent from the Michigan Agricultural Experimental Station, Lansing, by Professor Grange.

The quality of the pus and discovery in it of the seed-like sulphur-colored particles—constituting groups of Actinomyces, or the club-shaped degeneration forms of the parasite—will clear up the diagnosis.

According to Israel and Wolff, the disease is classed with the polymorphic fission-fungi.

Artificial cultures on glycerin-agar and potato have been successful in the hands of various observers. Whatsoever the medium employed—glycerin-agar, potato, meat-broth, gelatin, eggs, etc.,—masses of closely packed yellowish-colored granules varying in size, but not larger than a hempseed, are developed in a short time.

Cover-glass preparations of pus may be made in the

usual manner and variously stained. Sections may be successfully stained by several methods—Gram's, Weigert's, Plaut's, or Ehrlich's. A method not heretofore published is as follows:—

Place the slide, with section fixed, in "Carbolized Hematoxylin Comp." (No. 22) for ten minutes; then wash in acidulated water for two or three minutes; then in plain water; then in alcohol for five or six minutes; then cover with "Carbolized Fuchsin Comp." (No. 16) for ten minutes; then decolorize in alcohol, clear up with xylol, and mount in balsam and xylol, precisely as directed for the demonstration of the bacillus tuberculosis in tissue.

XI. THE EXAMINATION OF NEOPLASMS.

The importance of clinical microscopy finds many examples in the differentiation of tumors and other abnormal growths to determine whether the particular neoplasm is benign or malignant, so that the physician or surgeon in charge of the case may have due notice thereof and govern himself accordingly.

In the practice of medicine and surgery the necessity of such examinations of diseased tissues comes next in frequency to sputum examinations, and should always, if possible, precede the use of the knife. Hence the value of the rapid method detailed on a preceding page of preparing a perfect and permanent mount of any tissue specimen for microscopic examination and

differential diagnosis, within the space of four or five hours from the time of its removal from the living body.

A tumor in strict histo-pathologic sense represents a swelling caused by a new growth, and should thus be distinguished from a simple inflammatory swelling, the protrusion of an abscess, a hernia, or simple enlargement from hypertrophied muscular tissue.

The classification most useful for the purposes of this volume is that founded upon the microscopic character of the neoplasm, as follows:—

Tumors made up of normal adult human tissue, either entirely or in modified form, are—

The Fibromata,	The Adenomata,
The Lipomata,	The Lymphomata,
The Chondromata,	The Myomata,
The Osteomata,	The Neuromata,
The Papillomata,	The Angeiomata, and

The Lymphangeiomata.

Each of these different forms may have its subdivisions and blendings with another.

1. **The Fibromata.**—These tumors may either be hard or soft. *Hard fibrous tumors* are always firm and encapsuled. On section, they present a glistening surface of grayish or pinkish color, and even to the unaided eye may show the concentric arrangement of their component interlacing bands. They occur in various parts of the body, are neither painful nor tender on pressure—unless involving a nerve-sheath or terminal

—and in some instances it may not be easy to distinguish such an innocent tumor from a spindle-celled sarcoma. A distinctive feature of hard fibromata is, that though often multiple they show little or no tendency to return after complete removal, and but rarely ulcerate. They are liable to various forms of degeneration, the most common being partial mucoid softening and calcification. They are essentially innocent growths.

Soft fibrous tumors are simply masses of connective tissue occupying submucous and subcutaneous sites, and, as a rule, are more or less pedunculated. The scalp, labia majora, scrotum, and buttocks are more frequently involved by such soft fibromata, which may reach great size and be multiple in character. The ugly growths often seen on the face and scalp, called wens, belong to this variety. In cases of molluscum fibrosum we have another example, and in this form the loose fibrous tissue may attain great volume, as seen in the immense masses that sometimes occupy the buttocks and other parts. These growths are often edematous in appearance, more or less fatty, thus resembling the lipomata. In this class, cheloid growths should be included.

The simple polypi of the nose, ear, uterine neck, and meatus urinarius are variously made up of modified fibrous tissue, and have usually a large blood-supply, so that they bleed easily and sometimes profusely when their mucous covering is broken. In the particular character of the connective-tissue cells and mucous

quality of the matrix, they resemble the myxomata ; or, by containing in their interior the gland-structure from which they spring, may resemble the adenomata in histologic quality.

2. **The Lipomata.**—These tumors are composed of normal adipose tissue, and are met with in all parts of the body in which adipose tissue is normally found ; they are often multiple.

The true lipoma should not be confounded with a local hypertrophy of the subcutaneous fatty layer. In the true lipoma, the dimpling of the skin-covering when the tumor is moved or shaken is very characteristic. Such tumors are made up of variously sized fat lobules and involve no danger to life. Sometimes they are of congenital origin. In other cases, they develop as the result of pressure, and may become very painful. They vary in amount of connective tissue according to the size and number of lobules. Secondary changes are not common. In some rare cases mucoid softening occurs ; in others the fibrous septa may show calcareous degeneration.

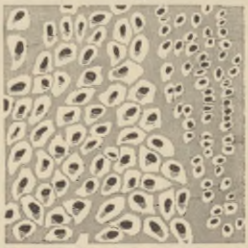
When removed by the knife, the operation should be a thorough enucleation, for otherwise recurrence is likely to take place.

3. **The Chondromata,** or Cartilage-tumors.—These may be divided into those which grow in connection with bone and those which develop in the soft parts. When the growth is from the bone it is called ecchondroma ; when from a sheath of cartilage, it is an enchondroma. The last named variety is the simplest

form, and usually commences its growth in the fingers, toes, and other parts during the period of adolescence. The tumors, with but few exceptions, are multiple, and never exhibit malignancy of character. The ecchondromata belong usually to a later period of life; they may involve any of the bones, often attaining immense size, particularly in the shafts of the long bones, and present a high degree of malignancy.

Cartilaginous tumors may involve the soft parts, such

FIG. 37.



Osteoid Chondroma. (*Gould.*)

as the parotid gland, the testis, and more rarely the breast, the ovary, the submaxillary and lacrymal glands, the kidney, and even the lung; but such examples as the last mentioned are variously mixed tumors, and more or less malignant according to the particular cell-admixture. In density, some of them are so hard as to be appropriately named fibro-chondromata, others so soft that they are denominated myxo-chondromata. Besides these, there are the chondro-sarcomata and osteo-chondromata. Softening may take place at the

center and give rise to one or more cysts; or the degeneration may be either that of calcification or a true ossification. Finally, the matrix may be hyaline or fibrous, with variously shaped cells.

4. **The Osteomata** are tumors composed of bone, usually appearing in adult life, and more frequently involving the bones of the face than other parts. They have been divided to suit each phase of their growth.

5. **The Papillomata** are divided as soft and moist, hard and dry, according to their character, which depends upon the particular structure from which they spring. The soft or mucous variety occurs on the lips, tongue, soft palate, in the larynx, about the anus, on the glans penis, glans clitoridis, and vulva (condylomata); at the orifice of the female urethra, in the uterus, vagina, bladder, and intestines. The epidermic papillomata are distinguished by their dense structure, and include warts and corns of all descriptions.

Besides these two varieties, there is another, the serous and synovial growths. Many of the papillomata are of gonorrheal and syphilitic origin. They are made up of connective tissue, numerous vessels, and epithelial elements, exactly corresponding with the structure of the part from which they grow.

6. **The Adenomata** of typical character are made up of the particular gland-structures from which they grow, and are non-malignant. These tumors, however, are always unknown quantities for the reason that in their growth they may suddenly depart from the benign type and assume malignancy. Upon this well-known

fact is based the practice of all wise surgeons of removing such tumors, especially of the breast, with the knife as soon as possible after their discovery.

Adenoma of the breast is a rounded tumor, occurring oftener near the axillary border than elsewhere, completely encapsuled, and showing no tendency to recur after removal. On microscopic section it differs but little from normal mammary gland structure, and is frequently met with in young women, usually during the child-bearing period. When admixed with some other heteroplastic growth, the form may be an adeno-fibroma, adeno-myxoma, or adeno-sarcoma. The most frequent secondary changes are fatty degeneration and mucoid softening. The parts more frequently involved besides the breast are the ovary, testis, prostate, thyroid, parotid, glands of mucous membranes, sebaceous and sweat-glands.

7. **The Lymphomata.**—Tumors of this class most frequently occupy the cervical, submaxillary, axillary, and inguinal glands; and, as a rule, are perfectly innocent. In some cases they grow to enormous size, and thus produce great deformity. Occasionally they assume malignant properties, and are followed by secondary growths distant from the initial tumor. Microscopically, the structure—that of an ordinary lymphatic gland—differs but little from a small round-cell sarcoma.

8. **The Myomata.**—Just as there are two kinds of muscle, so there are two forms of muscle-tissue tumors: the leiomyoma, representing the smooth or unstriped

muscular fiber, and the labdo- or rhabdomyoma, representing striped muscular fiber. The wall of the uterus, either on the external or internal surface, is a favorite site for tumors of the smooth or unstriped variety, which are often pedunculated.

In some congenital tumors of the heart and kidney, striped muscular fiber—the labdo- or rhabdomyoma—has been found.

The secondary change most likely to take place with

FIG. 38.

Leiomyoma of the Uterus. (*Gould.*)

the myomata is calcification. Now and then mucoid softening and the formation of cysts, accompanied with more or less hemorrhage, are met with. These tumors are always innocent.

9. **The Neuromata.**—These painful tumors are, fortunately, very rare. In the majority of cases they cannot be easily distinguished from fibromata, because of their immediate contact with nerve fibers. They are of small size and slow growth, hard, generally multiple, and confined to the branches of some particular periph-

eral nerve. In the traumatic variety—the *amputation-neuromata*—the tumor occupies the end of the divided nerve and is embedded in the cicatricial tissue. In the idiopathic form, a clinical feature worth remembering is that the tumor may be easily slipped and moved in the lateral direction, to and fro, while in the vertical direction its position can scarcely be changed.

While these little tumors are exceedingly painful, they are entirely innocent in character.

10. **The Angeiomata.**—These are tumors made up principally of blood-vessels, and commonly known as "claret-cheek," or "mother's marks." In professional parlance such tumors or growths are called *nevi*, and may be divided into two classes—the cutaneous and the subcutaneous,—according to the volume or character of the blood supply, whether from a mesh of capillaries, or from larger vessels.

In the cutaneous or capillary variety the color of the "mark" is bright-red, while in the subcutaneous variety it is a dark purple.

The growth of these ugly tumors and disfigurements is often very rapid, but they involve no danger to life. They are liable to either cystic or ulcerative degeneration; sometimes they spontaneously disappear.

11. **The Lymphangeiomata.**—Our knowledge of the pathologic histology of this interesting variety of tumors is yet extremely unsatisfactory, and the most that can be said at present may be briefly told as follows: These tumors are probably cavernous angeiomata made up of lymphatic vessels. As to their origin, they

may be either congenital or acquired. In the former class, the tongue, lips, and genital labia are the parts most frequently involved. In the latter class of cases, tumors as large as an orange are sometimes met with occupying the subcutaneous tissue, especially on the thigh and thorax.

THE SARCOMATA.

Unlike the group of tumors just described, sarcomata do not consist of any of the tissues of the adult body, but in structure follow the modified type of some one or other of the connective tissues of the embryo. For this reason these fleshy tumors are closely related to some of the simple growths described in the preceding sections of this chapter.

Following the type of the various connective tissues of the body, we have large and small round-cell sarcomata, large and small spindle-cell sarcomata, also the giant-cell sarcoma, the mixed-cell sarcoma, the alveolar sarcoma, and the melanotic sarcoma.

Again, we may have such an admixture of cell-elements as to warrant the compound names, fibro-sarcoma, myxo-sarcoma, glio-sarcoma, chondro-sarcoma, osteo-sarcoma, melano-sarcoma, myo-sarcoma, neuro-sarcoma, and lympho-sarcoma.

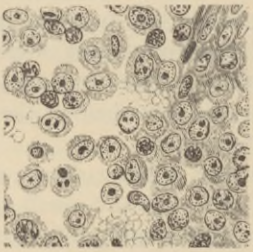
Theoretically, the sarcomata should without exception spring from a connective-tissue structure ; but as every gland contains a considerable amount of connective tissue, a glandular origin of sarcoma is not uncommon.

Sarcomatous tumors present all degrees of malignancy,

and have a peculiar tendency to incorporate connecting and adjacent tissues in their growth, thus molding themselves upon invading structures. It is a well recognized fact that the higher the degree of development of the tumor the less likely is recurrence after removal. And, further, with each recurrence the growth may show a more rudimentary structure and greater malignancy.

This group of tumors may be further described as follows:—

FIG. 39.



Round-Celled Sarcoma. (*Gould.*)

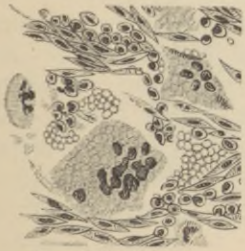
1. **The Round-cell Sarcomata.**—This variety includes both small- and large-cell growths. They are of varying density—sometimes being very soft; they are of a whitish or pinkish color, seldom encapsuled, and while the most rudimentary in structure, they are as a rule the most malignant.

2. **The Spindle-cell Sarcomata.**—This variety must also be subdivided into the small spindle-cell and the large spindle-cell sarcomata. The small-cell variety may sometimes, by their firm texture and well-

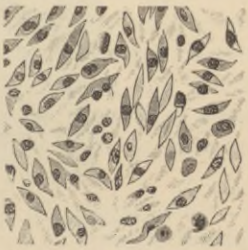
defined outline, approach the fibromata. These tumors are the "recurrent fibroids" of the surgical pathology of long ago. They consist of broad, interlacing bands of elongated cells, with but little intercellular structure; and after complete removal they show comparatively little tendency to recur.

The large spindle-cell variety is a softer growth than the small spindle-cell tumor, and far more malignant in character. This form of sarcoma—with its long-tailed, large, nucleated cells and but little intercellular sub-

FIG. 40.



Giant-Celled Sarcoma. (*Gould.*)



Small Spindle Celled Sarcoma. (*Gould.*)

stance,—while rather more common in connection with the periosteum, may arise in any fibrous structure. Usually, they are but imperfectly encapsuled. These are the "fibro-plastic" tumors described by the older writers.

3. **The Giant-cell Sarcomata.**—This form of sarcoma occurs more often in young persons, and involves by preference the long bones, although a very frequent site is the alveolar border of the jaws. To the

naked eye a fresh section of such a tumor is pinkish in color, but always more or less mottled with darker spots from extravasations of blood. Microscopically, the so-called giant-cells are irregularly rounded collections of granular protoplasm containing numerous round or oval nuclei having a well-defined nucleolus.

In this form of sarcoma, after thorough removal recurrence is not probable. In some cases, however, the disease is malignant in a high degree.

FIG. 41.

Melanotic Alveolar Sarcoma of Skin. (*Gould.*)

4. **The Mixed-cell Sarcomata.**—As the name implies, in this form are presented all sorts of cells above described.

5. **The Alveolar Sarcomata.**—These are rare growths, and essentially malignant in character. Microscopically, they bear a close resemblance to cancer, by the coarse stroma which forms the alveolar spaces and incloses many or few round nucleated cells.

6. **The Melanotic Sarcomata.**—This form is really of mixed-cell character, but presents a striking

difference from the ordinary mixed-cell sarcoma in that it has a brownish or even blackish appearance from the presence of pigment in the cells. Secondary growths of like character may take place in any tissue of the body. I have known the disease to develop on the big toe from a sore corn, and quickly kill the patient. These tumors, though often completely encapsuled, show a high degree of malignancy.

7. **Glioma.**—This is, in fact, but another name for a small round-cell sarcoma originating from the neuroglia or connective tissue of nerve.

8. **Psammoma.**—This rare tumor is found only in connection with the membranes of the brain or spinal cord. It is made up of flattened cells and is characterized by the peculiarity of containing the so-called "brain-sand." The calcified corpora amylacea are held together by loose fibrous or highly cellular tissue containing many vessels.

9. **Teratoma.**—This is a congenital tumor. In structure it consists of various imperfectly developed fetal or mature elements of the body mixed in a heterogeneous manner. Dermoid cysts belong to this group.

THE CARCINOMATA.

To Virchow belongs the credit of establishing the sharp line of difference between sarcoma and cancer, namely:—

Sarcomata are tumors whose structure follows the type of the connective tissues.

Cancers are tumors whose structure follows the type of the epithelial tissues. And thus, with but few exceptions, they may easily be distinguished by definite microscopic characters.

The exceptions referred to have been partially stated in the section descriptive of alveolar sarcoma, which so closely resembles cancer in microscopic structure as to render it very difficult, if not impossible, in some cases to make a differential diagnosis without the aid of the clinical history. Other examples of difficulty in diagnosis could be furnished; for instance, it is sometimes hard to distinguish between *papilloma* and *epithelioma*.

When, however, there is a well-formed stroma along with the epithelial masses, there will be but little difficulty in making the distinction; but in the study it should be remembered that the connective tissue-stroma may vary both in quality and quantity, from strong fibrous bands and walls around the alveolar spaces, to an extremely loose fibro-cellular structure. The alveolar spaces containing the epithelial or cancer cells are of all shapes and sizes, and differ greatly in their arrangement.

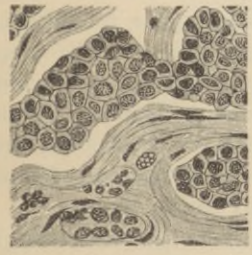
Cancers never occur elsewhere probably than in connection with the skin, mucous membranes, and secreting glands: in other words, the epidermic or epithelial structures—situations where epithelium exists. There may be offered some apparent exceptions to this rule, and the alleged occurrence of cancer growing into bone given in proof; but such extremely rare cases may be accounted for by accidental inclusion or graft of embryonic epithelium at such unnatural sites.

These malignant tumors are not enclosed in capsules, as are many of the more benign growths, and hence their increase in size by infiltration.

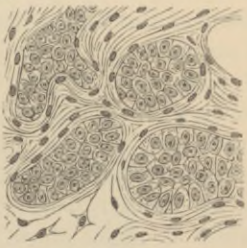
The glandular type embraces **Hard Cancer**, or **Scirrhus, Soft Cancer**, or **Encephaloid**,—including all grades of density between the extremes of **hard** and **soft.**

The epithelial and epidermic type includes **Cylin-**

FIG. 42.



Scirrhous Carcinoma. (*Gould.*)



Medullary Carcinoma. (*Gould.*)

drical Epithelioma and **Flat-celled Epithelioma**, corresponding with the two principal forms of epithelium.

Besides these two main divisions, we have **Colloid Cancer, Melanotic Cancer**, and **Mucous Cancer.**

Hard Cancer is characterized by a preponderance of connective tissue, and occurs most frequently in the mamma; but other parts may be the seat of the disease, such as the stomach, kidney, ovary, and testicle. As this form grows by infiltration and invasion, the organ

or part involved may be contracted rather then enlarged.

On section of such a cancer, the cut surface is grayish and glistening in appearance, while the tissue is dense and elastic, with yellowish lines or markings from fatty degeneration of the cells. This form is less malignant than the soft variety.

Soft Cancer is characterized by a very delicate stroma and alveoli rather loosely packed with cells, usually of smaller size than those found in hard cancer. Cancers of this variety may rapidly grow to great size, and are malignant in the highest degree. The organs and parts most frequently invaded are the ovaries, testicles, kidneys, and sometimes the mamma. Owing to their soft structure they are freely supplied with blood-vessels, and sometimes bleed profusely, forming what was formerly called *fungus hematodes*.

While it might theoretically be claimed that all cancers are epithelial in character, by common usage those which invade the skin and mucous membranes, and whose malignant tissue proliferates the epithelium normally present, are called *epithelial*, or *epithelioma*.

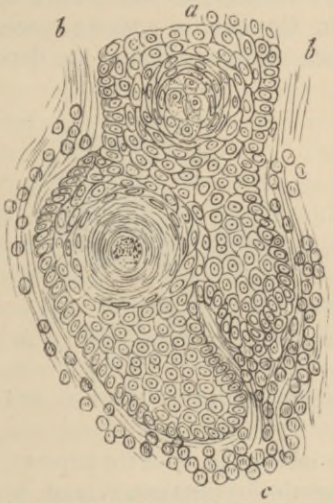
The Cylinder-celled Epithelioma occupies those parts covered normally with cylindrical epithelium, and has its origin in the mucous membrane, giving the diseased tissue a glandular appearance. From this fact, cylindrical epithelioma may be mistaken for adenoma. Indeed, it has been so classed by some writers.

This form of cancer is chiefly found in the stomach, in the intestine—particularly in the rectum,—and very

rarely in the uterus. It grows by infiltrating the muscular trabeculæ. When occupying situations exposed to movement or friction, ulceration may take place.

The Flat-celled Epithelioma occurs on those surfaces where there is profuse growth of pavement

FIG. 43.



Section of a Cylinder of Epithelial Cells. × 500. *a*. The cylinder itself with the characteristic stratification of its cells, a younger and an older pearly globule. *b*. The stroma, very rich in cells at *c*, and contributing directly to the enlargement by apposition of the cylinder.

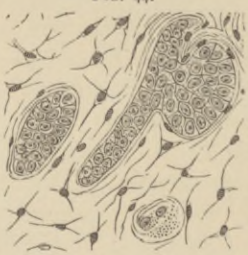
epithelium; and so the skin, lips, mouth, pharynx, esophagus, larynx, vagina, glans penis, urinary bladder, etc., are the sites most frequently invaded. The common epithelioma of the lip is a good example of this form of

cancer, with its closely packed globes and laminated capsules.

Colloid Cancer is met with chiefly in the stomach, intestines, and kidney, rarely in the mamma. Macroscopically, the growth has a gelatinous appearance. So distinct are its characters, even to the naked eye, that it can scarcely be mistaken for any other form of tumor.

Melanotic Cancer is nothing more than a soft cancer in which pigment granules are deposited in the

FIG. 44.



Colloid or Myxomatous Cancer. (*Gould.*)

cells and also in some parts of the stroma. It produces secondary growths by metastasis, and is exceedingly malignant. The parts most frequently invaded are the skin and eyeball.

Mucous Cancer in many particulars resembles colloid cancer. Instead of cell-degeneration into masses of colloid material, we have in this form cell-degeneration into mucoid tissue. The growth presents a gelatinous appearance, and attains its greatest size in the

ovary. But this form of cancer, in any part, is a great rarity.

Mucous and colloid growths arise from the same chemical principles—the albuminates—and, probably, are the results of the conversion of normal tissue-albumin. It is mostly in fatty tumors and sarcomas that mucoid degeneration takes place; but in some cases it may be difficult, if not impossible, to say which of the elements —mucus or colloid—is the leading character of the growth or degeneration. While the chemical principle of mucus is definitely known, colloid is not yet entirely understood in its chemical reactions. They may, however, be distinguished by their difference in chemical reaction: *mucin* forming a precipitate with acetic acid, alcohol, and chromic acid, while colloid is not sensibly altered by these reagents.

The Parasitic Theory of Carcinoma.—This idea, suggested by the resemblance of some cancers to certain infective diseases, such as tuberculosis, actinomycosis, leprosy, etc., has recently engaged the attention of learned pathologists throughout the entire medical world.

Nearly fifty years ago (1847) Virchow—the Great Commoner in Pathology—foreshadowed in his plates descriptive of his observations on tumors similar bodies to those now claimed as parasitic protozoa, but it was not until three or four years ago that the important subject attracted much attention. In this country the question has been most ably discussed by Adler, Councilman, Coley, Gibbes, McFarland, Montgomery, Smith,

and Van Cott, with a result not in accord with the parasitic theory. But bacteriologic science has given so many surprises within the last ten years—so many possibilities for the near future—that many of us, though unable to give a reason for the faith within us, like the patriarchs of old, "look forward to the coming time" to make plain all these things.

There seems to be no doubt that a peculiar body is practically always present in some of the cancer cells, but its unstable quantity is misleading. It is claimed by some observers that the same "parasite" may be found also in sarcoma. These inclusions are variously rounded, measuring from 2 μ to 10 μ in diameter, and may be single or in eights or tens, and surrounded by a capsule. Sometimes the inclusions are seen in the cell nucleus, or may occupy any position from the center of the cell-nucleus to the intercellular space.

Cultivation experiments have not yet succeeded, neither has the necessary proof been furnished, that cancer may be transmitted by direct inoculation.

The best results in staining sections of tumors of any kind may be accomplished with the *Hematoxylin Double Stain*, as directed on a preceding page. It differentiates the so-called cancer "inclusions" in a remarkable manner.

XII. URINARY EXAMINATIONS.

How to Collect a Specimen.—A perfectly clean four or six-ounce bottle, well stoppered with a clean cork, should be first provided. If the patient or subject be a male person, he should be instructed to first wash out the urethra by permitting the escape and waste of a little urine, and afterward urinate directly into the bottle and cork it tightly. If the subject be a female, she should first of all cleanse herself of any discharge from the vagina by careful washing of the parts, and also wash out the urethra by passing a little urine into the "chamber," after which she should collect the remainder in a sterilized bowl or glass, from which it may then be poured into the bottle and immediately corked. In no case should the "chamber" vessel be used to collect a specimen for microscopic examination, unless it be a new one never before used.

If the specimen cannot be immediately examined, or must be kept for several days, the bottle provided for this purpose, before being filled, should be thoroughly sterilized either in boiling water for five or ten minutes, or well baked in the stove-oven. If such necessary care be taken and the bottle filled up to the neck as soon as possible after collecting the specimen, and tightly corked, it will keep without deterioration for many days —even weeks.

To yield a fair average result the specimen should be a mixed one, showing both morning and evening urine;

but if such mixed urine cannot conveniently be collected, two specimens should be taken, one a part of what is passed in the morning immediately after rising from bed, another a part of what is passed on retiring.

The urinary excretion expresses the amount of *ash* or waste nitrogenous products eliminated from the body. It is perpetually changing in sensible qualities to meet the sum of varying impurities, habitual or accidental, physiologic and pathologic, of the circulating blood; but the normal average diurnal quantity passed by an adult person may safely be set down at from forty to fifty ounces.

Every person understands the direct influence of the weather in promoting or restricting the amount of urine discharged in twenty-four hours, also the influence of large quantities of water taken into the stomach, and that from these causes, singly or conjoined, the urine may vary both in quantity and quality without being inconsistent with good health. If the weather is cold and the general surface of the body chilly, there is frequent micturition; if the skin is warm and freely perspiring, or the bowels loose, then less urine is discharged than on the other hand; while if much water be drunk, the amount of urine discharged is correspondingly increased and paler in color.

Any cause which raises the blood-pressure in the vessels, such as by contracting the arterioles, by exposure to cold, by mental excitement, the influence of food, or by the action of drugs, such as digitalis and

scoparius, increases the secretion of urine. On the contrary, external warmth, nervous shock, or anything else which lessens the blood-pressure in the *glomeruli*, or raises the pressure in the *tubules*, diminishes the secretion of urine.

The composition of normal urine per thousand parts is as follows:—

Organic.	Water,	950.00
	Urea,	26.20
	Creatinin,	0.87
	Sodium and potassium urates,	1.45
	Sodium and potassium hippurates,	0.70
	Mucus and coloring matter,	0.35
Inorganic.	Sodium biphosphate,	0.40
	Sodium and potassium phosphates,	3.35
	Lime and magnesium phosphates,	0.83
	Sodium and potassium chlorides,	12.55
	Sodium and potassium sulphates,	3.30
		1000.00

These proportions, it should be stated, are unstable and greatly depend upon age, sex, occupation, diet, etc. The formula, however, is sufficiently precise to show the fact that water, urea, and the chlorides are the chief ingredients of the urine. In other words, that the urine is simply a watery solution of urea and organic and inorganic salts.

The color of normal urine is that of wheat-straw, pale sherry, or amber; but the color or tint of the vessel containing the specimen should not be overlooked in describing and comparing the specimen.

The following very instructive table from Halliburton, taken from Prof. Jaksch's "Clinical Diagnosis," shows

the nature and origin of the chief variations in tint of urine:—

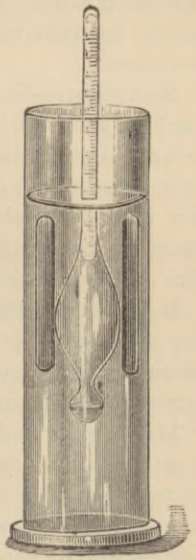
Color.	Cause of Color.	Pathologic Condition.
1. Nearly colorless.	Dilution or diminution of normal pigments.	Various nervous conditions, hydruria, diabetes insipidus, granular kidney.
2. Dark-yellow to brown-red.	Increase of normal or occurrence of pathologic pigments.	Acute febrile diseases.
3. Milky.	Fat globules. Pus-corpuscles.	Chyluria. Purulent disease in the urinary tract.
4. Orange.	Excreted drugs, *e. g.*	Santonin, chrysophanic acid.
5. Red or reddish.	Unchanged hemoglobin.	Hemorrhage or hemoglobinuria.
6. Brown to brown-black.	Pigments in food (logwood, madder, bilberries, fuchsin). Hematin. Methemoglobin. Melanin. Hydrochinon. Catechol.	Small hemorrhages. Methemoglobinuria. Melanotic sarcoma. Carbolic acid poisoning.
7. Greenish-yellow, greenish-brown, approaching black.	Bile pigments.	Jaundice.
8. Dirty green or blue.	A dark-blue scum on the surface with a blue deposit, due to excess of indigo-forming substances.	Cholera, typhus; seen especially when the urine is putrefying.
9 Brown-yellow to red-brown, becomes blood red on addition of alkalies.	Substances introduced into the organism, as senna, rhubarb, and chelidonium.	

The Specific Gravity of healthy urine varies between 1017 and 1023. When for any lengthened

period the mark is found below 1017 or above 1023, it is, according to my observation, the sign of a departure from the standard of health. In other words, I am induced to believe that the standard of perfect health carries a urine whose specific gravity is not lower than 1017 nor higher than 1023. In pathologic conditions the range may be widely extended in either direction of the scale.

Perfect accuracy of specific gravity can only be attained by testing the urine at the exact temperature for which the urinometer was constructed, namely, at 60° Fahr. At any temperatures *above* this a lower specific gravity is indicated, while at temperatures *below* a higher than the true one is the result. A new urinometer should always be tested in distilled water to see if it mark correctly 1000 on the scale.

FIG. 45.



Urinometer.

In using the urinometer care should be taken to see that it is clean and dry before dropping it into the test-tube containing the urinary specimen, also that the cylinder or tube is large enough to float the urinometer without touching the side of the cylinder. Any froth or bubbles on the surface should be absorbed and removed

with a slip of blotting paper. When, as often happens, the quantity of the specimen brought for examination is too small to float the urinometer in its accompanying cylinder, it should be exactly measured and as many volumes of water added as may be found necessary to take the specific gravity. After that, the decimal figures should be multiplied by the number of times the urine has been diluted, which will give the true specific gravity. The transitory variations of specific gravity between 1017 and 1023 are of no clinical importance.

Reaction.—Fresh normal urine—unless passed immediately after a hearty meal, when it may be neutral or even slightly alkaline—always exhibits a more or less acid reaction and reddens litmus, not that it contains a free acid, but probably from the presence of the acid phosphate of soda. It is diminished by a vegetable diet and by alkalies with vegetable acids.

It has been estimated by Taylor that the acidity of the urine during twenty-four hours is equivalent to about 14 grains of carbonate of sodium or to 30 grains of oxalic acid.

How to Handle the Specimen.—On receipt of a specimen for microscopic examination, enough of it to measure three or four ounces should be poured into a very clean conical glass, which, after the reaction and specific gravity have been taken, should be covered with a paper cap to prevent the entrance of dust and dirt of all kinds, and then set aside to stand undisturbed for

eight or twelve hours, in order that any morphologic constituents present may subside.* Even with the greatest care in collecting and subsequent handling, foreign matter of some kind is likely to gain entrance, such as hairs, fibers of wool, cotton, and flax, minute particles of wood, soot, etc. It is, therefore, highly important that the observer should first become entirely familiar with the appearance of all such common objects in the field of the microscope before sitting in judgment upon the character of a urinary deposit. (See Fig. 6.)

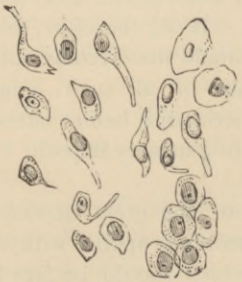
What has just been said of the great necessity of cleanliness in handling a specimen applies with equal importance to the pipette, which should be free from the possibility of any organized matter carried from a previous urinary examination.

Organized Constituents.—With the pipette, a small drop of the deposit is placed at the center of the slide and covered with a thin glass. If too much fluid has been dropped to hold the cover-glass in place, the slide should be put aside for a little while, or until sufficient evaporation has taken place to permit it to be turned on its edge without slipping the cover. Care should be taken that no pressure is made upon the cover, lest the object to be studied be unduly com-

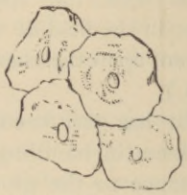
* All reagents and apparatus necessary for urinalysis may be obtained from the reliable house of Bullock & Crenshaw, Philadelphia.

pressed. It is really necessary sometimes, especially when the deposit contains renal casts of large size, to give support to the cover-glass to prevent compression.

FIG. 46.



Epithelium from the Bladder, Ureter, and Pelvis of the Kidney.



Vaginal Epithelium.

Renal Epithelium, Healthy and Fatty.

This may be easily accomplished by placing on either side of the drop of urine a bit of a fine hair, say a half inch in length, which will answer instead of a shallow cell, if not better.

If the sediment is stained before the drop is placed

on the slide, it will greatly facilitate the examination. This is readily done by drawing up a pipetteful of the sediment and transferring it to a very small vial. A drop or two, or as much as may be necessary to give appreciable color, of aqueous solution of safranin is then added, and the vial shaken for a moment. By this simple means all organized matters are more or less deeply stained, and the microscopic field can be searched more rapidly.

Epithelial Cells.—If one believe what the books say about the different kinds of urinary epithelium, there is enough difference in size and shape to distinguish one from the other and say of a certainty, *this* form of flattened, tesselated epithelium comes from the renal pelvis; *that* form of spheroidal or polyhedral cells is from the convoluted tubules; *this* form of columnar epithelium is from the ureter and the greater portion of the urethra, or that *this* flattened or pyriform cell is from the bladder. Unfortunately, in practical work no such sharp distinctions are present in the microscopic field to localize the affection in the urinary tract.

It is very true that the superficial layers of the mucous membrane furnish epithelial cells of polygonal or elliptical shape with a single large nucleus and granular protoplasm, while those from the middle and deeper layers are of rather oval shape, sometimes running out into long protoplasmic tails or processes having also a single large nucleus and granular protoplasm—yet all this is inferential rather than absolute proof. *Quality* of epithelium without excessive *quantity* is not of much

value in differential diagnosis. But when both are present, there is strong foundation for localizing the disease.

When the kidney cells are found loaded with fat it is the indication of fatty degeneration in the renal tissues.

In women who suffer from leukorrhea, or other disease of the vagina and uterine cervix, the urinary deposit is usually loaded with large pavement epithelial cells, which are sometimes found lying in masses and overlapping one another, like the slates on a roof.

Before closing this section it should be said that the most accurate knowledge on the subject does not warrant the conclusion that a differential diagnosis can be safely founded upon the presence or absence of epithelial cells, unaided by other manifestations of the urine and the clinical history.

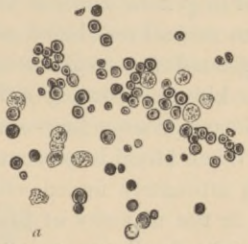
Mucus.—The meaningless flocculent cloud which separates from all urines is well known to every medical examiner, and has little if any clinical value. It is not a pathologic condition. When, however, mucus (nucleo-albumin) in large quantities is passed, it is significant of catarrh of some part of the urinary tract and then becomes a matter of much importance. When this occurs, its presence forms a viscid or gelatinous looking sediment which needs no chemical manipulation to determine its character.

Mucin is always abundantly present in leukemia and jaundice, and may be detected chemically by treating the urinary specimen with an excess of acetic acid. If much mucin is present the urine becomes turbid.

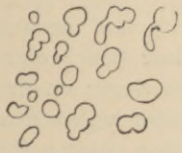
Red Blood-corpuscles.—If blood be present in moderate quantity the characteristic reddish or smoky color cannot well be mistaken by an experienced ob-

FIG. 47.

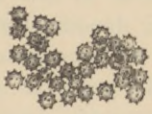
Shrivelled Blood-corpuscles in Urine (catarrh of the bladder), with numerous lymph-corpuscles and crystals of triple phosphate. × 350. (*Landois.*)



Colored and (*a*) Colorless Blood-corpuscles of various forms. (*Landois.*)



Peculiar Changes of the Red Blood-corpuscles in Renal Hematuria. (*Landois.*)



Crenated Red Blood-corpuscles in Urine. (*Landois.*)

server; but when the red corpuscles are but few in number, and do not sensibly affect the color, they may escape notice without the aid of the microscope. In some cases, they may be present in such great abund-

ance as to form a layer at the bottom of the glass. The shapes and appearances of the red corpuscles may vary as much. When they are but few in number, some of them may retain their proper form; but usually they are shrunken in appearance, of pale yellowish color, and in general contour look more like washed-out rings than normal red blood-cells. In this condition, there is ground for suspicion that the blood was effused in the kidney, pointing either to acute nephritis—either primary or secondary—or tuberculosis.

When blood is present in large quantity without being intimately mixed with the urine, the hemorrhage is, in the majority of cases, from the bladder. When the blood-cells are so thoroughly mixed that the specimen is deeply tinged, yet no deposit is found after several hours' standing, it may be inferred that the source of the hemorrhage is the substance of the kidney.

In urine of low specific gravity and ammoniacal reaction blood-corpuscles soon lose their color and present the appearance of colorless rings; on the contrary, in urine of normal and even higher than the normal specific gravity, with reaction either neutral or acid, the cells may retain their color for several days.

After excluding as factors menstruation, both normal and vicarious, purpura, scurvy, mental emotion, etc., a careful study should be made to find out if possible the exact source of the hemorrhage. To arrive at a just conclusion on this point—whether the blood is from the substance of the kidney, renal pelvis, ureter, blad-

der, or urethra—other constituents of the urine must be carefully examined. While any one of them, *per se*, may be valueless in aiding the differential diagnosis, yet when studied all together the inquiry may often result in correctly localizing the hemorrhage.

Profuse and repeated hemorrhage usually accompanies malignant disease either of the kidney or bladder. In cases of renal abscess, impacted calculus, tuberculous infiltration and softening, embolism, or the presence of parasites, the hemorrhage is, as a rule, not very profuse.

FIG. 48.

Pus-cells in Urine, Unaltered, and Affected by Acetic Acid. (*Ralfe.*)

However, I have known profuse hemorrhage to follow the passage of a renal calculus.

Leukocytes—Pus-cells.—It is truly "a distinction without a difference," and most confusing to the student, to call these bodies, which are one and the same, by different names. When the number found in a urinary specimen is but small, they may be called *leukocytes*; when so profuse that they form a thick, creamy deposit at the bottom of the collecting-glass, they are called *pus-cells*.

In every specimen of urine that may be brought for

examination a few cells of this character will be found, and may be easily recognized with the microscope. They are about one-third larger than a red blood-corpuscle, and colorless. They are made up of cell-wall, granular contents, and nuclei. By the addition of a drop of acetic acid, the cell-wall is rendered quite transparent and the nuclei more decided. Should doubt arise in any case as to their identity, it may be quickly dispelled by either the *iodo-potassic iodide solution*, or Vitali's guaiacum tincture test. The former colors the cells a deep mahogany brown, and the epithelium with which they are occasionally blended a light yellow color; the latter gives a deep blue tint.

The only deposit with which pus can be confounded is mucus; but the difference may be discovered in a moment by the addition of a little liquor potassa. If it be pus, the mass is at once converted into a semi-solid viscid precipitate, which when poured out of the test-tube holds together like the white of an egg. This is Donné's test.

While pus-cells may come from an inflammatory condition in any part of the urinary tract, they are never so abundant as in cystitis, unless in case of the sudden bursting of an abscess into the tubules or the pelvis of the kidney. In cystitis the local symptoms will sufficiently indicate the origin; while if the suppurating surface be the urethra no excuse can be offered for a mistake, because the discharge takes place quite independently of urination.

In females, care should be taken to avoid mistake as

to the source of pus in the urine. The precautions given on a preceding page concerning the collection of a specimen, if observed, will prevent admixture of a leukorrheal discharge with the urine.

Casts.—Nothing in the whole range of urinary pathology is of greater clinical importance, perhaps, than the subject of casts. For convenient study they may be divided into two classes,—the *Unorganized* and the *Organized.*

The Unorganized Class includes the "False-Casts," those formed of crystals and urates and found principally in cases of rheumatic or gouty habit, also in the urine of infants. Pathologically, these have but little significance—at least, no serious importance.

The Organized Class includes those derived from the loops of Henle and the collecting tubes of the kidney, namely:—

1. **Blood-casts**—consisting of coagulated fibrin enclosing blood-corpuscles. These are indicative of hemorrhage into the tubules, whether it be due to intense arterial hyperemia or venous congestion, as in acute Bright's disease. They are soluble in acetic acid.

2. **Epithelial Casts**—made up of columnar epithelium or of round cells. They are found in the earlier stages of nephritis. The character of the epithelium fixes their significance. They are usually abundant at first; but at a more advanced period they give place in appreciable degree to the hyaline variety.

3. **Hyaline Casts** are made up of a translucent,

homogeneous, slightly refractive, and often barely visible, flexible, proteid material. The large forms represent chronicity of the affection, and therefore are of graver import. Occasionally, however—but the exceptions are very rare,—they are found in acute cases. They come both from tubules that have been denuded of epithelium, and those that have become dilated from contraction of the interstitial substance.

Small, very pale hyaline casts are sometimes found in non-albuminous urine, but this is extremely rare. In jaundice, cancer of the liver involving the kidney, and in diphtheria they may also be found; so, it is seen, their presence has no necessary connection with renal disease. They are unaffected by acetic acid.

4. **Waxy Casts** are made up of very refractive and brittle proteid matter. As a rule, they are longer than the others, and when perfect have been aptly compared to portions of the segmented body of a tapeworm. They are so often broken after leaving the kidney that in the microscopic field they are seen in short fragments, notched, and bearing upon their surface, in some cases, white and red blood-corpuscles, fatty globules, arranged separately or in confluent masses, either a coating of urates or dotted with crystals of various kinds, and fungi. They are named from their supposed resemblance to molten beeswax. They are found in all the phases of chronic nephritis, in contracted granular as well as in amyloid kidneys. In other words, they are not characteristic of any particular disease of the kidneys. They are unaffected by acetic acid, but frequently

exhibit the amyloid reaction with methyl-violet and iodo-potassic-iodid solution.

5. **Granular Casts** are variously dark and opaque bodies composed of granular material or covered with granular cells, and formed by the degeneration of hyaline or waxy casts. They differ much in character, and no positive diagnosis can be founded upon them alone. In color they may be of all shades, from pale-yellow to reddish-brown. They are usually seen in fragments of various lengths and widths with well-defined borders, but the bodies are variously tapered or bent. Now and then they are coated with leukocytes or pus-cells, fatty globules, and crystals. It has been thought probable that they originate in the degeneration of blood and epithelial casts. A similar interpretation may reasonably be put on casts whose granulation is due to fat molecules. This theory has been credited to Rindfleisch and Langhans.

When granular casts in large quantities are found in the urine, an inflammatory condition of the kidneys is indicated.

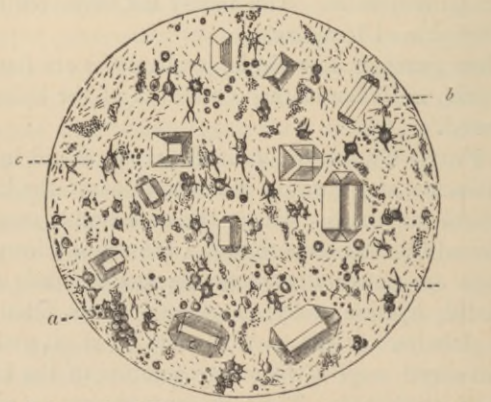
6. **Fatty Casts** are most frequently found in cases of sub-acute and chronic inflammations of the kidney of protracted course; hence the unfavorable prognosis warranted by their detection in a urinary specimen.

They are powerfully refracting bodies made up of epithelial, hyaline, waxy, or granular casts, filled with fatty globules. If the cast be made up of oil globules, an advanced stage of fatty degeneration of the kidney is fairly indicated. Their presence, however, may be

FIG. 49.

Deposit in "Acid Fermentation" of Urine. *a*. Fungus; *b*. amorphous sodium urate; *c*. uric acid; *d*. calcium oxalate.

FIG. 50.



Deposit in Ammoniacal Urine (alkaline fermentation). *a*. Acid Ammonium Urate; *b*. Ammonio-magnesium Phosphate. *c*. Bacterium ureæ.

misleading in this: that while in the majority of cases they are of the gravest import, they may be *found during convalescence* from acute nephritis.

From the foregoing descriptions it may safely be said that the presence of casts implies disease of the kidney, and the advancement or stage of the disease may be correctly determined by the association of a particular variety of cylinders with certain other bodies in the urine. In the microscopic field much difference is perceptible in the length and breadth of the cylinders. In diameter they range between 1000th of an inch and 1-500th of an inch,—the medium being about the 1-700th of an inch. Their length must be a matter of accident, from being broken up after their escape from the kidney. They are mostly cylindrical in shape, variously tapered, bent, or crooked, and have somewhat rounded ends.

Before Dr. Bright no one had searched the kidneys *through* the urine for the cause of the perilous organic malady which has since been distinguished by his name, and of which there are often no direct signals excepting those furnished *by* the urine. And this brings the questions, incidentally mentioned in the preceding pages, concerning one of the most distinctive marks of Bright's disease, namely:—

"Does albuminous urine always imply the presence of 'Bright's disease'?"

"Is Bright's disease, when present, always accompanied by albuminous urine?"

To both of these important questions the distinguished

old medical philosopher of fifty years ago has given an emphatic "No." And then he goes on to give his reasons, which are as cogent and as fresh from the garner of scientific truth as if written for 1894 instead of 1843:—

"I believe that some articles of food and some medicines have the effect, in some persons, of rendering the urine for a time albuminous: perhaps it would be more correct to say that certain forms of indigestion may cause this change. Albumen has also been detected in the urine after a blister upon the skin, or under that general state of irritation of the surface called *eczema rubrum*, which is produced occasionally by mercury. In the crisis of some febrile disorders, in some cases of pregnancy, of heart disease, and of delirium tremens, and in epidemic cholera, the same phenomenon has been observed. Whenever blood, proceeding from any part of the long tract of mucous membrane which lines the urinary organs, mingles with the urine, that fluid of necessity contains albumen, and coagulates if tested by heat or by nitric acid.

"On the other hand, when the kidney is really affected in the way already described, the admixture of albumen with the urine is apt to disappear for a while, even suddenly. I have known it to vanish for several hours immediately after the effectual application of a hot air-bath, and after profuse purging by a full dose of elaterium. Sometimes it is absent for a longer period.

"Another important question, therefore, now arises: Finding albumen in the urine, how are we to know

whether it does or does not indicate the presence of Bright's kidney?

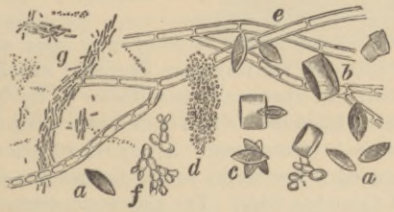
"We may judge, in part, by frequently testing the urine, and noticing whether the albuminous impregna-

FIG. 51.

Micrococcus ureæ.

tion be transitory or persistent. If week after week it remain steadily present, it is almost surely indicative of that renal disease. *Almost surely*, I say, because it is held by M. Rayer, and thought not improbable by Dr.

FIG. 52.



Fungi in Urine. *e*, mould; *f*, yeast; *d*, *g*, micrococci and bacilli; *a*, *b*, *c*, uric acid. (*Landois.*)

Owen Rees, that uric acid crystals, occurring in the urine of gouty persons, may sometimes, by irritating the urinary tubules, give rise to enduring albuminuria when

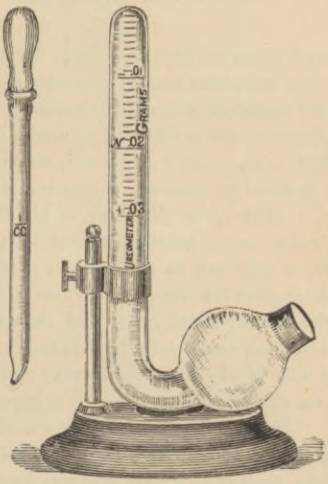
there is no degeneration of the kidney. Certain it is that in a very few cases albuminuria goes on even for years without any serious inconvenience to the patient or much visible impairment of his general health. If M. Rayer's pathological doctrine be true at all, it probably is true in these cases of abiding albuminuria; and in such cases the albumen will readily disappear under alkaline treatment, which forms a test of their nature. Partly, again, we form our judgment by the absolute amount of the albumen in a given measure of urine. If the water be deeply charged with that unnatural ingredient, the presumption is strong that the kidney disease is in progress; and when that disease is confirmed, another remarkable change is found to have taken place in the urine: its specific gravity is very low, and strikingly in contrast with that of diabetic urine. This is, therefore, a very cogent additional diagnostic circumstance."*—*Watson's Practice of Physic.*

* In clinical medicine great surprises never cease, and in no department of pathology are they more frequently witnessed than in renal affections. In other words, fatal disease of the kidneys may be so completely latent that no sign of its presence is given until the subject is suddenly struck down. A very remarkable case exactly in point occurred a few weeks ago in the practice of Dr. J. F. Baldwin, of Columbus, Ohio. The pathologic specimen was sent me for microscopic examination, accompanied with the following history from Dr. Baldwin:—

"The patient was 56 years of age, a well-developed man of active business habits, hearty and strong in appearance, who regarded himself as in perfect health. I had been the family physician for several years, but he had never needed my professional service. He

Urea is by far the most abundant as well as the most important of the organic constituents of urine, the quantity passed per diem by a healthy man of average weight being 512.4 grains. It constitutes 70 or 80 per cent. of the entire nitrogenous waste excreted by the kidneys.

FIG. 53.



Graduated Ureameter.

A ready method of estimating approximatively the quantity of urea present in urine, when in excess of the normal, is by the addition of an equal part of nitric acid. The test-tube containing the urine and the acid is set in cold water, after which—if urea be in excess—the hexagonal crystals of

---

was taken sick on *Wednesday*. I saw him on *Thursday*, and found him with a pulse of 112, strong and hard; temperature 102°. He was suffering with an acute bronchitis, and complained of much muscular aching and soreness, *with great weakness*. Owing to his age and general condition I at once obtained a bottle of his urine for examination. The reaction was acid, and s. g. 1.021; no trace of albumin.

"The next day, *Friday*, he was more comfortable in every re-

nitrate of urea soon make their appearance. Or, another simple method, and a very interesting one, too, is the following: take an inch of a small thread of cotton, dip one end into the urine, and place it with its hanging

---

spect; and the next day, also. He had no headache, and made no other complaint than of *muscular weakness*. Owing to this continued complaint of muscular weakness, I still suspected a kidney complication, and at this visit secured a second urinary specimen. This had a sp. gr. of 1.025—still, no trace of albumin. A slide was examined for casts with negative result.

"*Sunday*, the fifth day of his illness, he was inclined to be drowsy and at times a little delirious. When pressed by the family for a statement as to the exact nature of his condition, I said: 'I can regard his case as only one of grippe, with bronchitis; but if the urinary examination had shown any evidence of Bright's disease, that would fully explain his entire condition.' He had taken a dose of physic on Wednesday which operated freely. At no time was there vomiting; appetite unimpaired.

"*Monday*, the sixth day, he was more stupid, and about midnight could not be roused. He then had a temperature of 105°, pulse 160, contracted pupils, and was bathed in profuse perspiration; in other words, he presented a very perfect picture of *uremic coma*. He died at 5 A. M., Tuesday.

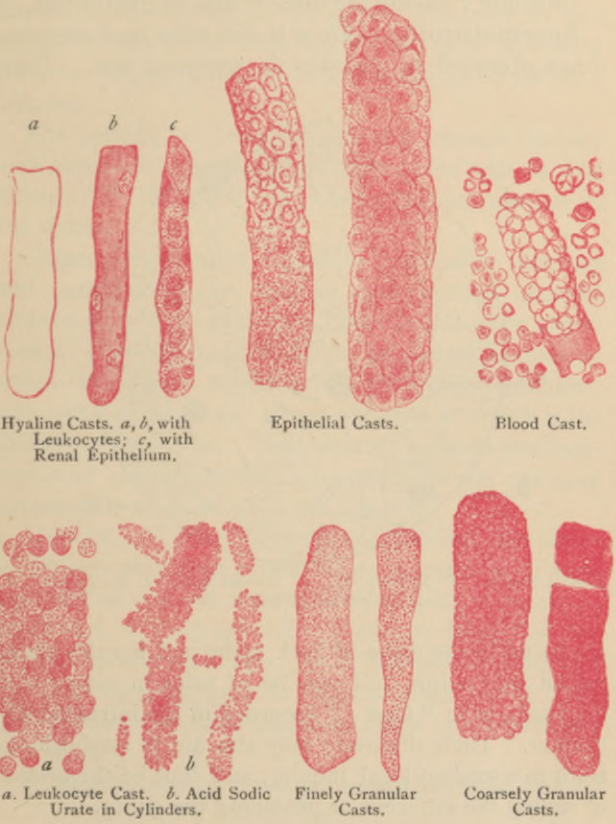
"A specimen of urine passed on Monday evening had a sp. gr. of 1.035, and showed a mere trace of albumin.

"*Post-mortem*, held Wednesday morning, revealed kidneys larger than normal and very pale. There was marked thickening of the left ventricle, but no evidence of *atheroma*. Certainly there was not the least evidence, by naked eye appearances, of ulcerative endocarditis."

The structure of the kidney was found literally riddled with hemorrhagic infarctions and abscesses, from the size of a millet seed to a large bean, with marked changes along the lines of the capillaries and around the Malpighian bodies.

drop at the center of a slide, then cover with a thin glass, leaving half of the thread free. Upon this free

FIG. 54. (*After Landois.*)



Hyaline Casts. *a*, *b*, with Leukocytes; *c*, with Renal Epithelium.

Epithelial Casts.

Blood Cast.

a. Leukocyte Cast. *b*. Acid Sodic Urate in Cylinders.

Finely Granular Casts.

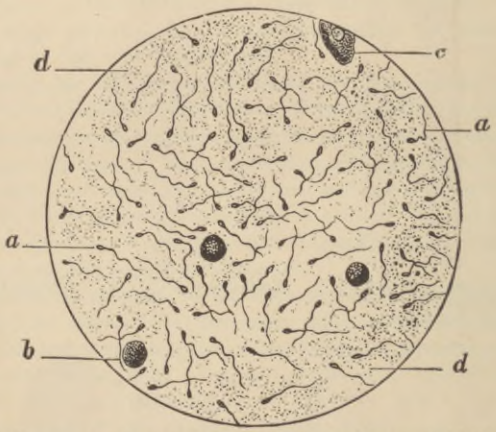
Coarsely Granular Casts.

end let fall a minute drop of nitric acid, and place the slide under the microscope. The formation of the plate crystals will afford an interesting field.

In Bright's disease the urine is usually diminished.

Spermatozoids.—These bodies when once seen can never afterward be mistaken for anything else. They

FIG. 55.



Normal Semen. *a*. Spermatozoa. *b*. Seminal cells. *c*. Epithelium. *d*. Seminal granules.

are found in the urine of both males and females when passed after coitus, and may be of value in aiding the diagnosis, as in "Case 1," recorded in the introductory chapter. Their discovery may also aid in establishing truth in a medico-legal inquiry, and thus be the means of saving the innocent or punishing the guilty.

Tubercle Bacillus.—The recognition of tubercle bacilli in the urine is a matter of the very highest pathologic importance. A case has just passed from under my observation in which the discovery of this microörganism in the urine was the means of informing the attending physician of the true nature of his patient's ailment.

The method of demonstrating the tubercle bacillus and other microörganisms in urine is the same as that already fully described for a cover-glass preparation of the sputum.

Other Organisms.—Healthy urine after standing and undergoing the alkaline fermentation contains swarms of bacteria exhibiting their characteristic movements. Various forms of torula are found in diabetic urine—the *Torula cerevisiæ* and *Penicillium glaucum;* also certain *entozoa*, the most important of which is the *Bilharzia hematobia*. Besides these, hooklets and fragments of *echinococci* from a ruptured hydatid cyst may occasionally be detected in the urine.

Urates.—If after standing and cooling, the urine, which was clear when passed, becomes muddy in appearance and soon shows more or less sediment of a pinkish, brick-dust, or deep-red color, it may be taken that the deposit consists of urates. If it dissolve by heat and the urine becomes again as clear as when passed from the bladder, then there can be no doubt of the presence of urates.

Brick-dust colored urates are inseparable from an acid

urine. The murexid test for uric acid is equally applicable to urates. This condition of the secretion is commonly seen in concentrated urines.

If the urine be acid and contain a white flocculent deposit, the sediment probably consists of pus, or is made up of alkaline urates called the "Pale White Urates." If such be its composition, the deposit is insoluble by heating, but clears by the addition of acetic acid. As a rule, the sediment is phosphatic if the urine when passed is of alkaline reaction.

An abundant deposit of urates accompanies the febrile state, gout, rheumatism, disease of the liver and kidneys, and some forms of dyspepsia. It is frequently seen in healthy subjects after great muscular exercise and profuse perspiration.

On the other hand, alkaline urine and phosphatic sediments accompany nervous exhaustion, "nervous dyspepsia," and the vigils of care-worn business men. It is also common in the nursery, during the period of dentition, in the form of "white phosphates," and, likewise, in nursing women of run-down habit.

Uric Acid.—Some specimens of urine are so surcharged with uric acid that cayenne-pepper-like grains adhere to the sides of the bottle and are also thrown down in the deposit. In microscopic appearance the crystals vary greatly both in size and shape. Some of them are six-sided plates, others four-sided rhombs, others oval, others barrel-shape, others comb or whetstone shape, and still others in rosettes,—appearing

either singly or in heaps. In color, they are brownish yellow (due to uroerythrin), owing to the affinity of the urinary pigment for uric acid and its salts.

If free uric acid shows itself in freshly passed urine, a deposit in the bladder or in the pelvis of the kidney

FIG. 56.

1. Rhombic Plates; 2. Whetstone Forms; 3. Quadrate Forms; 4, 5. Prolonged into Points; 6, 8. Rosettes; 7. Pointed Bundles; 9. Barrel Forms precipitated by adding Hydrochloric Acid to Urine. (*Landois.*)

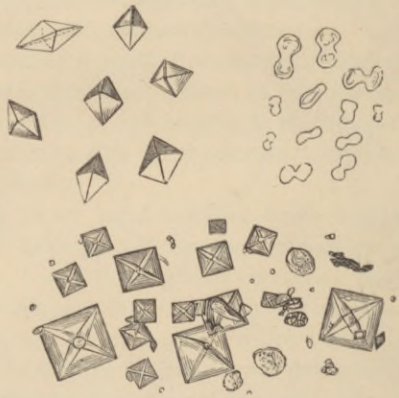
may be taking place and lay the foundation of a calculus.

After standing for some time, if the vessel containing it was not properly sterilized, the acidity of the specimen

becomes fainter and fainter until at length it is neutral; this quickly gives place to alkalinity, and then a putrescent ammoniacal odor is given off.

Oxalate of Lime.—Crystals of this substance are exceedingly common in both acid and alkaline urine. They occur as strongly refracting octahedra, or four-sided pyramids of various sizes, also as colorless dumb-

FIG. 57.



Oxalate of Lime.

bells, and when transient, have no clinical significance. They have been found in healthy urine, especially after the ingestion of fruits and vegetables containing a large proportion of oxalic acid, such as asparagus, rhubarb, tomatoes, etc. They are soluble in hydrochloric acid, but are unaffected by acetic acid.

The characteristic form of the crystals scarcely admits

of confusion with other forms. The only crystals with which it is possible to confound them are the triple phosphates, which are larger. Besides other differences, acetic acid dissolves the triple phosphates but has no effect on the oxalate of lime.

Persons whose urine is constantly marked by the presence of crystals of the oxalate of lime are moody and more or less hypochondriacal. This condition has been termed the "oxalic acid diathesis," and the particular disease, oxaluria, has a long train of troublesome symptoms; but the chief significance belonging to the deposit is the possible formation of the mulberry calculus.

Triple Phosphates.—The precipitates of the earthy phosphates of lime and magnesium so commonly encountered in urinary examinations present themselves in three forms, namely—

The amorphous lime phosphate.

The crystalline lime phosphate.

The ammonio-magnesium phosphate.

The *amorphous lime phosphate* is insoluble in water, but soluble in acetic acid. Urine containing it has a milky appearance, and on standing soon deposits a grayish-white sediment, which the beginner may mistake for pus. Donne's test will show the distinction. Heat precipitates the lime salts in flakes resembling albumin, and in this way I have known mistakes to be made.

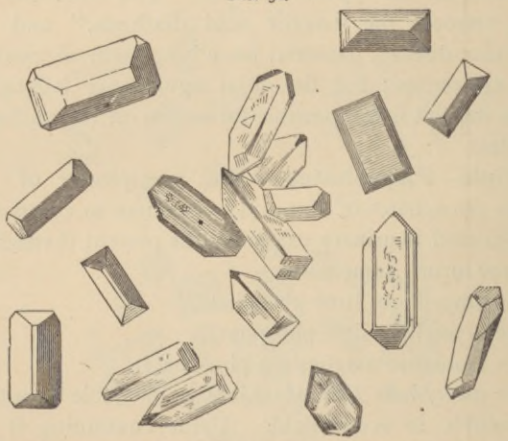
This character of urine is usually the sign of nervous exhaustion from any cause, especially from pro-

longed mental worry and anxiety, loss of sleep, and excessive venery.

The crystalline lime phosphate presents itself in colorless needle-like crystals, called stellar phosphates, which arrange themselves in radiating bundles.

The *ammonio-magnesium phosphate* is the result of

FIG. 58.



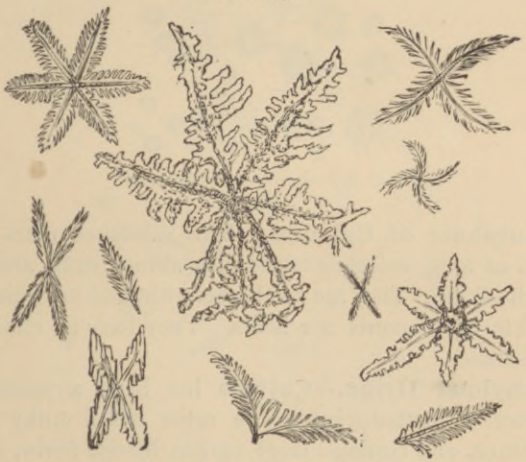
Forms of Crystals of the Ammonio-magnesium Phosphate. (*Tyson.*)

alkaline fermentation and the decomposition of urea. These crystals of basic magnesium phosphate are very characteristic and are easily recognized by their many-sided angles, size, beveled edges, large, strongly refracting, elongated rhombic tablets, and coffin-lid crystals. Although usually found in alkaline urine,

still they are sometimes met with in feebly acid urine. A greasy-looking scum frequently forms on such urine. In some examples, beautiful stellar and feathery crystals are shown, as in the accompanying illustrations.

Clinically, their presence is of but little consequence.

FIG. 59.

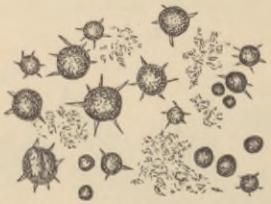


Stellate and Feathery Crystals of Triple Phosphate. (*Tyson.*)

Urates of Ammonium and Sodium.—Crystals of urate of ammonium are easily recognized by their spherical form, dark color, and radiating spicules, known as hedgehog crystals. Crystals of sodium urate are met with in the chalky concretions common in the bodies of gouty persons, and also in the urine, where

they assume a globular form, with irregular projections over the surface. The pathologic significance of the crystalline urates is much more important than that which attaches to the amorphous deposits.

FIG. 60.



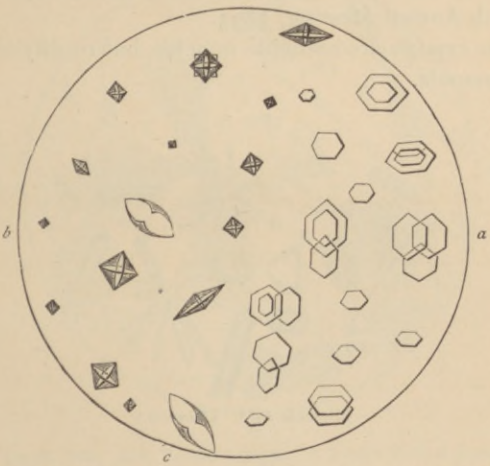
Acid Ammonium Urate. (*Landois.*)

Sulphate of Calcium.—This substance takes the form of long, colorless tables with abrupt ends, also in needle-shape. They are rarely met with, and are neither soluble in ammonia nor acids. They have no clinical importance.

Chylous Urine.—Chyluria has been a puzzling subject to pathologists. The urine has a milky appearance, and contains more or less blood, fibrin, and albumin. Spontaneous coagulation has been known to take place in the bladder and block up the urethra. Renal casts have been searched for in vain, and it is believed by some authorities (Roberts among them) that the chyle and lymph are discharged directly into the urinary passage from the lymphatic vessels. It is, fortunately, a rare affection. In all of my experience I have known but one case, a passenger conductor on the

B. & O. R. R., who, though discharging a large quantity of chylous urine every day, was in the enjoyment of ordinary good health. His run was from Baltimore to Wheeling—379 miles—and when on duty the quantity was always much increased. After sound sleep, the flow was, as a rule, sensibly diminished.

FIG. 61.



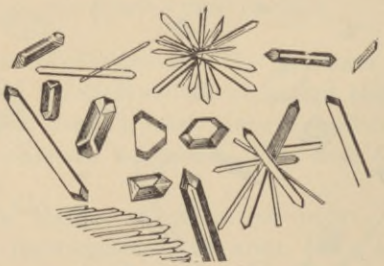
a. Crystals of Cystin. *b*. Oxalate of Lime. *c*. Hour-glass Forms of *b*.

Cystin.—Urine containing cystin is usually feebly acid, of a yellowish-green color, and of peculiar odor, which has been compared to sweet briar, has an oily appearance, and decomposition takes place very soon after being voided. The deposit is a light rose-colored

powder. The crystals are symmetrical six-sided plates of various sizes, and either appear in overlapping masses, or are contiguous to one another. The liver is supposed to be the source of this substance. Its most important clinical significance is its liability to form a calculus. But such cases are, fortunately, very rare, as shown in the interesting paper read by Prof. James Tyson, of Philadelphia, before the Association of American Physicians, Eighth Annual Meeting, 1893.

The crystals are insoluble in acids, but readily soluble in ammonia.

FIG. 62.



Hippuric Acid. (*Landois.*)

Hippuric Acid.—Hippuric acid may be encountered as a crystalline deposit during the acid fermentation of the urine. It may occur in considerable quantity after the exhibition of benzoic acid, or the ingestion of green gages, whortleberries, and cranberries, but it has no clinical significance.

Xanthin.—This occurs in the form of whetstone

crystals, which are insoluble in acetic acid and soluble in ammonia.

Tyrosin and Leucin.—Tyrosin crystals have the form of beautiful sheaves of very fine needles, while leucin, though mainly held in solution, presents itself

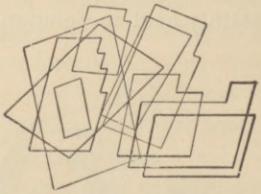
FIG. 63.

a. *a*. Leucin Balls. *b*. *b*. Tyrosin Sheaves. *c*. Double Balls of Ammonium, Urate.

in the form of variously sized spheres. Tyrosin and leucin have been found in the urine of persons poisoned with phosphorus, also in cases of acute yellow atrophy of the liver, yellow fever, and several other infectious diseases.

Cholesterin.—Crystals of cholesterin are very rarely seen in the urinary sediment.

FIG. 64.



Cholesterin. (*Landois.*)

Summary.—With certain precautions the following summary may be useful to remember :—

1. Heat precipitates albumin and phosphates, and dissolves urates.

2. Nitric acid precipitates albumin, urea, and uric acid and dissolves phosphates.

3. Liq. potassa precipitates phosphates, dissolves albumin, and glutinizes pus.

4. Acetic acid precipitates cystin and dissolves albumin.

5. Nitrate of silver precipitates chlorides.

6. Barium chloride precipitates sulphates.

XIII. THE BLOOD.

The volume of crimson liquid, whose office is to carry nutriment and oxygen to the tissues, is about eight per cent. of the total weight of the body. It is of alkaline reaction, has a specific gravity of from 1.059 to 1.062, and composed of three classes of cells, namely :—

(*a*) Biconcave circular yellowish discs.
(*b*) White blood-corpuscles (leucocytes).
(*c*) Blood-tablets, or platelets.

The red blood-cells have a diameter of 1–3.200 (7.5 μ) of an inch ; the white cells 1–2.500 (10 μ) of an inch in diameter ; and the blood-platelets, the third class of formed elements, about one-third the diameter of a red blood-corpuscle. These are, of course, average measurements.

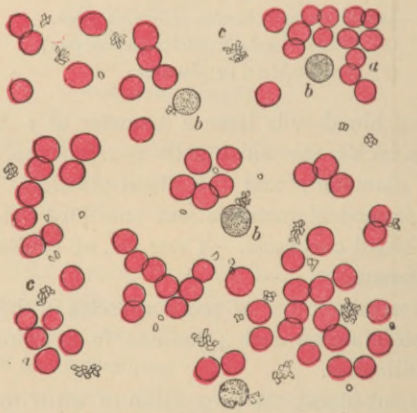
The normal number of red corpuscles in the blood is 5,000,000 in a man and 4,500,000 in a woman to the cubic millimeter.

In normal blood, the proportion of white to red corpuscles is about 1 to 300. The white corpuscles (leukocytes) are granular spheroidal bodies possessing ameboid movements, and perform the office of phagocytes in taking up bacteria in the circulating blood. One or more nuclei are present, but it may require a little weak acetic acid to be run under the cover-glass to detect them. To demonstrate the blood-platelets, requires the addition of some fixing medium, preferably

Hayem's solution, as represented in the following formula :—

Chlorid of sodium,	1 grm.
Sulphate sodium,	5 grm.
Corrosive sublimate,	0.2 grm.
Distilled water,	200 grm.

FIG. 65.



Blood-corpuscles, and Blood-plates, from Normal Human Blood. *a*. Red Blood-corpuscles. *b*. Colorless Corpuscles. *c*. Blood-plates. (*Jaksch.*)

Wash the end of the finger in clean water, then prick it with a needle and let the first drops of blood be allowed to flow off. After this is done, take a clean slide and at its center touch the hanging drop without bringing the glass in contact with the finger, then add a drop or two of the solution to the blood, and, as quickly as

possible, cover the sample with a thin glass. The plates will then be shown. To prevent evaporation, the cover glass should be run around with oil or balsam.

Arterial blood derives its scarlet color from the presence of oxygen which controls the amount of hemoglobin contained in the red corpuscles. In other words, when the blood is rich in oxygen the coloring matter is increased. In the capillaries the blood gives up oxygen to the tissues and becomes the dark venous blood. Anything which interferes with the absorption of oxygen in the lungs and the giving off of carbonic anhydride produces instant and marked change in the chemical quality of the circulating blood. But it should be remembered that in certain morbid states arterial blood may assume even a brighter than the normal color, *e. g.*, in carbonic oxid poisoning, in which condition it becomes of a bright cherry-red, alike in the arteries and veins.

In venous blood there is less oxygen, and hence the color is darker, or bluish red. The blood taken from the tip of the finger for microscopic examination is usually of venous character.

The chief diseases of the blood are anemia, pernicious anemia, and chlorosis, in which the red corpuscles are deficient; melanemia, in which pigment-masses are formed, with destruction of the red corpuscles; leukocytosis, in which the white corpuscles are moderately increased, and leukocythemia, in which they are inordinately increased; and conditions in which morbid substances are present, such as the poisons of uremia,

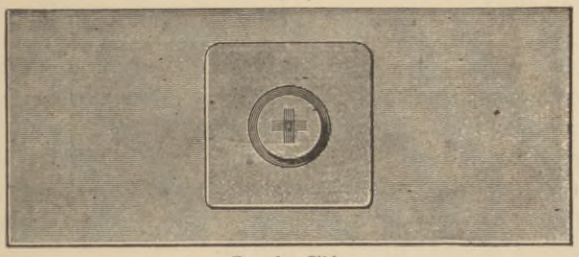
FIG. 66. Capillary Tube. Thoma-Zeiss Apparatus for Counting the Blood Corpuscles. (*Jaksch.*)

cholemia, etc., or microörganisms and their products, such as pyemia, septicemia, etc., "blood poisoning" in the ordinary sense.

Various costly instruments have been devised for counting the precise number of the red and white blood-corpuscles or the relative quantity of hemoglobin present in a given specimen, but the principle on which they are constructed is the same. Probably the simplest and best instrument is the Thoma and Zeiss apparatus for counting blood-corpuscles. It consists of a capillary tube (Fig. 66) of glass, about 10 centimeters long, expanding in its upper third to a bulb, in which lies a small glass ball. The lower end of the tube is furnished with a scale, graduated in parts, number 0.1, 0.5, 1, up to 101. With this instrument is used a counting-chamber, invented by Abbe and Zeiss. This is a glass receptacle cemented upon a glass slide (Fig. 67); it is exactly 0.1 mm. in depth, and its floor is marked out into microscopic squares. The space overlying each square, 1–4000 cubic mm., and the squares, are portioned out in groups of 16 by plainer lines (Fig. 67).

"**Application of the Process.**—A puncture is made in the tip of the finger, with the precautions already indicated, and the blood then sucked into the pipette from the exuding drop to division 1. The point of the pipette is wiped, and a three per cent. solution of common salt sucked in until the fluid has risen to the point marked 101. The contents of the tube are then thoroughly mixed, and the column of fluid in the capillary tube is removed by blowing into the tube, as

FIG. 67.



Counting Slide.

the blood does not mix with the solution of common salt. The neglect of this precaution, therefore, would vitiate the experiment.

"The hollow cell of the slide is next filled with the mixed blood-and-salt-solution, care being taken to guard against the admission of air bubbles, and the cover-glass is accurately adjusted in such a manner that Newton's color-rings are produced. The preparation is left to stand a few minutes, so as to allow of an intimate admixture of its parts, after which it is placed under the microscope, and examined with a power of 30–70

diameters, when it will be seen whether any air-bubbles or foreign bodies are present in it, and whether the corpuscles are pretty evenly distributed through the fluid. The latter are then counted under a high power. In doing this, the number present in sixteen squares is counted, and from this the average is estimated. The greater the number of the squares taken, the more accurate will be the result attained."

After use, the capillary tube must be thoroughly cleansed, first with water, then with alcohol, and lastly with ether.

To estimate the number of white corpuscles in a specimen of blood it should be diluted with water containing one-third per cent. glacial acetic acid in the proportion of 1 : 10. In this way the red corpuscles are destroyed, and the white alone remain in the field of vision. In mixing the fluids, a mixing glass specially devised by Zeiss for the purpose may be used. The process may be carried out thus :—

"By means of a pipette of 1 c.c. contents, and accurately graduated in 0.1 c.c. units, 0.9 c.c. of the acetic acid solution is measured out into a watch glass; with another pipette holding exactly 0.1 c.c., the blood is added to this and the two well mixed. A drop of the mixture is placed within the counting-chamber of the cytometer prepared as above ; and now, since the number of corpuscles is relatively fewer, the entire field, and not the marked-out divisions, is taken as the basis of calculation, greater accuracy being so obtained. To the same end, a lower power will be used, so as just to

bring the marks in the floor of the chamber clearly into view. Before beginning to count the corpuscles, however, it will be well to focus with the fine adjustment of the microscope, and to make sure that the cells have all settled.

"When there is a very great increase in the number of leukocytes, as in leukemia, their number can be estimated in the same manner as that of the red corpuscles, and the relative proportion of the two can be determined at the same time with sufficient accuracy, if only an adequate number of squares is taken into account. Great assistance in such experiments may be derived from the use of a three per cent. salt solution colored with gentian violet, in which the leukocytes are stained, and become readily discernible from the red blood-corpuscles, which are usually somewhat paler than normal. For the same purpose Toison employs a staining fluid of the following composition :—

"Distilled water,	160 c.c
Glycerin,	30 c.c.
Sulphate of soda,	8 grm.
Chlorate of sodium,	1 grm.
Methyl-violet,	0.025 grm."

(*Jaksch's Clin. Diagnosis.*)

Test for Hemin Crystals.—The supposed blood-coloring matter must be dried, finely powdered, and placed upon a slide. A crystal of common salt is then added to it and over all a cover-glass is laid. A few drops of glacial acetic acid are then allowed to flow

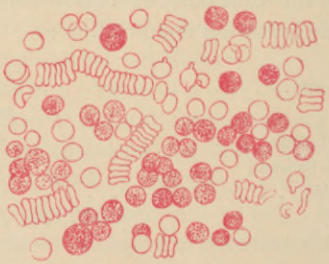
under the thin glass. The slide is then placed on a heating table, and the temperature run up to 200° F.,

FIG. 68.

Hemin or Teichmann's Crystals. (*Landois.*)

or a little below the boiling point, for a moment. If the suspected specimen contains blood-coloring matter the microscopic field will show hemin crystals.

FIG. 69.

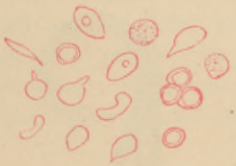


Leukæmic Blood. (*Landois.*)

Poikilocytosis.—By this term is indicated a remarkable condition of the red corpuscles. It was first noticed in pernicious anemia, and by some authorities

is regarded as pathognomonic of that affection. The red corpuscles are of all sizes and shapes, so that the

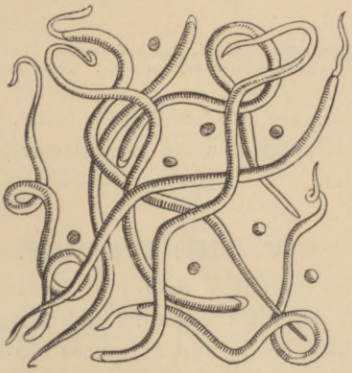
FIG. 70.



Blood in Poikilocytosis.

condition is easily recognized with the microscope. Such condition, however, is not confined to any one

FIG. 71.



Filaria sanguinis hominis. Lewis. (*From Leuckart, after Lewis.*)

disease, and it is possible that the poikilocytes do not exist in the circulating blood.

Animal Parasites.—These are the filaria sanguinis hominis (Fig. 71) and the bilharzia hematobia (Fig. 72).

FIG. 72.

Bilharzia hematobia, Cobbold, Male and Female. The latter in the Canalis gynæcophorus of the former. (*After Leuckart.*)

These parasites are also found in the urine, but instances either in the blood or urine are extremely rare in the United States.

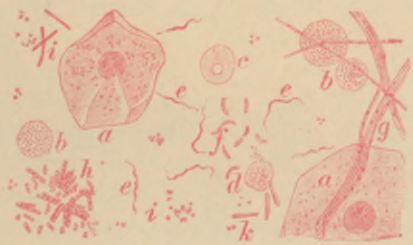
XIV. THE SPUTUM.

It has now become a matter of routine in clinical medicine to examine the sputum microscopically in all cases in which cough and expectoration are present. In a preceding chapter, full instructions have been given for the most important examination that can be made of the sputum, namely, that for the demonstration of the tubercle bacillus; and as the technique is

the same for all other cover-glass preparations, the reader is referred to page 116.

Diphtheritic Membrane and Other Exudates.—Examination of such specimens may be made by spreading them out on the slide, and staining with aqueous solution of either methyl-blue or fuchsin before applying the cover-glass. But permanent mounts are so easily made of such material and the demonstration

FIG. 73.



Microscopic Characters of Mixed Saliva and the Buccal Secretion. *a*. Epithelial cells. *b*. Salivary corpuscles. *c*. Fat droplets. *d*. Leukocytes. *e*. Spirochæta buccalis. *f*. Comma bacillus of the mouth. *g*. Leptothrix buccalis. *h*. *i*. *k*. Different forms of fungi. (*Landois*.)

of the microörganisms so much more satisfactory when thus treated, that all such specimens should be cast in paraffin and given the highest differential staining.

Crystalline Forms.—Various crystals are found in the expectoration, and among them none more common than the Charcot-Leyden crystals expelled by asthmatic patients. They are diamond-shaped bodies, long and pointed (Fig. 74). These crystals are soluble in

alkalies, mineral acids, and warm water; but insoluble in alcohol, ether, or cold water. Although their chemical composition is not yet definitely understood, it is supposed that they are the result of decomposition of organic matter in the bronchioles, probably Curschmann's "spirals." While frequently found in large

FIG. 74.

Charcot-Leyden Crystals. (*Landois.*)

numbers in asthma, their presence is not positively diagnostic of that disease.

In phthisis, chronic pneumonia, pulmonary abscess, etc., cholesterin crystals (Fig. 64) are frequently met with.

Crystals of the fatty acids, often seen in rosette form, are sometimes found in connection with bronchiectasis and phthisis, also in gangrene of the lungs.

They consist chiefly of palmitic and stearic acids, and have but little diagnostic value.

Besides the forms just described, leucin and tyrosin, oxalate of lime, triple phosphates, and concretions of lime salts are found among the matters coughed up.

XV. FECAL DISCHARGES.

The feces have been aptly compared to "a garden full of weeds." The quantity passed by a healthy man in twenty-four hours averages from five to seven ounces, and is composed of a great variety of refuse-substances derived from the food, viz., vegetable cells, muscle fibers, elastic fibers, connective tissue, fat, starch granules, coagulated proteids (especially in the stools of young children fed on milk and in persons suffering from diarrhea); red blood-cells and leukocytes, epithelium; non-pathogenic and pathogenic vegetable parasites; animal parasites—Protozoa and Vermes. In the last named class (Platodes) are the following tapeworms:—

Tænia saginata or "beef" tapeworm.

Tænia solium, sometimes called the "pork" tapeworm.

Tænia nana.—This is very common in Italy and Sicily, particularly attacking children and young persons.

Tænia flavopunctata, bearing a close resemblance to T. nana, but of greater length.

Tænia cucumerina (elliptica).—This parasite is

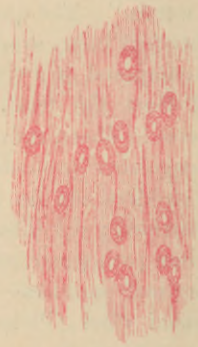
common in human beings, being acquired from dogs, and especially infests children.

Bothriocephalus latus.—This worm has recently been much studied and acquired clinical importance from having been found frequently in cases of pernicious anemia.

In the **Class Annelides**, or round worms, we have

FIG. 75.

Cephalic End of Tænia solium. Linne. (*After Leuckart.*)



Measly Pork. (*After Leuckart.*)

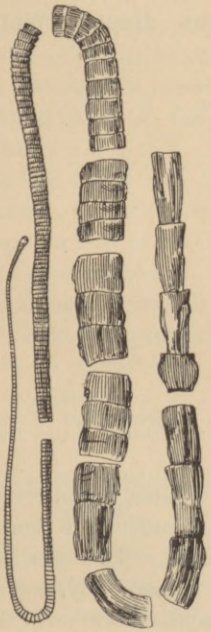
the Ascaris lumbricoides, common to all climates, and in persons of all ages. It also infests cattle and sheep, but is without special clinical import, notwithstanding the general impression among unprofessional people that its presence causes belly-pains and cramps and spasms in children.

Oxyuris vermicularis, or common thread-worm.

—The presence of this worm gives uncomfortable itching and other disagreeable sensations about the anus.

Dochmius (Anchylostoma) duodenale.—This

FIG. 76.



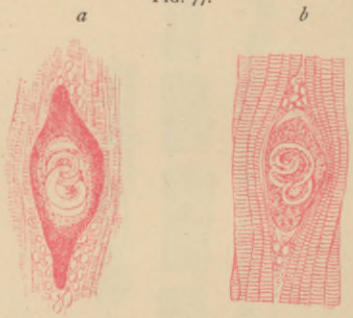
Tænia saginata. Gœze. (*After Leuckart.*)

worm was long since reported as occurring both in America and the West Indies; (Louisiana, Chalbert, 1830; Duncan, 1840; Alabama and Georgia, Lyell,

1849). No recent observations seem to have been made, and a careful search for the eggs in the feces of patients presenting symptoms of pernicious anemia without apparently sufficient cause should be carried out.

Trichocephalus dispar (Whip Worm).—This

FIG. 77.



Trichina spiralis. Owen. *a*. Encapsulated with connective tissue covering (in situ): *b*. Calcified. (*After Leuckart.*)

worm is supposed to have causal relation with the beriberi disease which is endemic in Sumatra.*

Trichina spiralis.—This pest occurs in two different forms in the human body, according to its particular site in the muscular tissue or in the intestine.

* Report of the Ceylon Commission, 1887.

XVI. MUCOUS CYLINDERS AND CRYSTALLINE BODIES.

The cases in which mucous formations and crystalline bodies are found in the feces are exceedingly common. The passage of casts or cylinders is usually accompanied with abdominal pains and tenesmus. The presence of such a specimen by stool implies catarrhal inflammation of some part of the intestinal tract, usually the large intestine.

All of the crystalline forms that have been named as occurring in sputum, including hematoidin crystals, are more or less common also in the feces.

The microscopic appearances of the feces may be studied by pressing a minute particle between a cover-glass and the slide. If to the specimen is added a drop of aqueous solution of methyl-blue, the examination will be much more satisfactory.

XVII. MICROÖRGANISMS OF THE SKIN.

Most of the microörganisms having their habitat on the skin in the cutaneous secretions are saprophytes, but pathogenic varieties are also here found. The space beneath the finger nails affords a rich source for various germs. Such specimens, after being freed from fat by means of alcohol and ether, may be stained with borax and methyl-blue (No. 7) for a few minutes; then for half a minute or a minute in a one-half to

one per cent. aqueous solution of resorcin, and lastly for a few minutes with alcohol.

XVIII. MICROÖRGANISMS IN FOODS AND DRINKS.

Many food-stuffs, owing to exposure to various sources of contamination, particularly milk and meat, become sources of infection. Of all the food-carriers of bacteria, milk is the most dangerous. It is the most active vehicle for the dissemination of tuberculosis and enteric or typhoid fever, except dried sputum, which science has discovered and exposed.

Besides contamination either during milking or in the subsequent handling, various pathogenic microörganisms may be imparted to milk from the animal furnishing it. To examine a specimen of milk, a drop should be mixed with another of distilled water upon the slide. After drying in the air of the room, the film should be fixed by heat, but not scorched. It is now ready to be stained with a few drops of alcoholic solution of methyl-blue with an equal quantity of chloroform. After the evaporation of the chloroform, any excess of the blue is washed away in alcohol, and the mount finished in the usual way.

THE BACTERIOLOGIC EXAMINATION OF DRINKING-WATER.

In *The Medical News* for June 14, 1890, p. 641, and in the *American Journal of the Medical Sciences* for August, 1892, p. 167, Dr. Victor C. Vaughan details

the method used in the Hygienic Laboratory of Michigan University. This method consists briefly of the following steps:—

First. The water is collected in sterilized bottles.

Second. Beef-tea tubes are inoculated with water, from one drop to one cubic centimeter being added to each tube.

Third. The inoculated tubes are kept at 38° C. for twenty-four hours.

Fourth. Many germs found in drinking-water will not grow at so high a temperature. Waters containing only such germs are pronounced safe. Certainly it must be admitted that a germ which will not grow at the temperature of the human body cannot possibly induce disease.

Fifth. Of the germs which do grow at 38° or higher, some are toxicogenic to animals, while others are not. Whether the germs in a given sample are toxicogenic or not is determined by injecting the prepared cultures subcutaneously or intra-abdominally in rats, guinea-pigs, rabbits, or mice.

Sixth. Waters containing only the non-toxicogenic germs growing at 38° or higher are reported as safe.

Seventh. Waters containing toxicogenic germs are condemned. In testing the virulence, a germ is not pronounced toxicogenic unless it be found growing and multiplying in the animal inoculated with it.

This method has been employed in the Hygienic Laboratory of the University of Michigan since October, 1888.

GLOSSARY.

Taken and Abridged from Gould's "Illustrated Dictionary of Medicine, Biology and Allied Sciences."

A

Aberration (*ab-er-a'-shun*). In optics, any imperfection of focalization or refraction of a lens. **A., Chromatic, A., Spherical.**

Acetonuria (*as-et-ön-u'-re-ah*). The presence of acetone in the urine.

Achromatic (*ah-kro-mat'-ik*). **A. Lens,** one without color, exactly neutralized by another lens having the same curvature but of unequal refractive index.

Achromatin (*ah-kro'-mat-in*). The substance in the nucleus of a cell prior to division. So called because not readily stained by coloring agents.

Actinospora chartarum (*ak-tin-o-spo'-rah char-ta'-rum*). A parasitic fungus developing on paper and books.

Adenogenesis (*ad-en-o-jen'-es-is*). The development of a gland.

Adrenals (*ad-re'-nalz*). The supra-renal capsules.

Adventitia (*ad-ven-tish'-e-ah*). The external covering or coat of the blood-vessels.

Aërobic (*a-er-o'-bik*). Requiring oxygen (air) in order to live. A term applied to those bacteria requiring free oxygen.

Agar-agar (*a'-gar-a'-gar*). A kind of glue made from certain seaweeds, used in bacteriological studies to make a solution in which microörganisms are bred or kept.

Albinuria (*al-bin-u'-re-ah*). 1. Chyluria; whiteness of the urine. 2. Albuminuria.

Albuminuria (*al-bu-min-u'-re-ah*). The presence in the urine of albumin, a mixture of serum albumin and serum-globulin in various proportions.

Allotoxin (*al-o-toks′-in*). Any substance, produced by tissue metamorphosis within the organism, that tends to shield the body by destroying microbes or toxins that are inimical to it.

Ameba or **Amœba** (*am-e′-bah*). A colorless, single-celled, jelly-like protoplasmic organism constantly undergoing changes of form, and nourishing itself by surrounding objects. *A. coli*, ameba of dysentery.

Amicrobic (*ah-mi-kro′-bik*). Not due to, or associated with, microbes.

Amyloid (*am′-il-oid′*). Starch-like pathological products.

Anaërobic (*an-a-e-ro′-bik*). A term used of microörganisms that live in the absence of free oxygen or air.

Antimycotic (*an-te-mi-kot′-ik*). Destructive of fungal microorganisms.

Antitoxic (*an-te-toks′-ik*). Antidotal; counteracting poisons.

Antitoxin (*an te-toks′-in*). A substance formed in the body of animals, either naturally or in consequence of inoculation with some pathogenic bacteria, that neutralizes the toxic products of these organisms.

Aplanatic (*ah-plan-at′-ik*). Not wandering; rectilinear. **A. Lens**, a lens corrected for all aberration of light and color. A rectilinear lens.

Apochromatic (*ap-o-kro-mat′-ik*). Without color. **A. Lens**, a lens for microscopic and optical purposes, with high correction of spherical and chromatic aberrations, and better "definition." **A. Objective.**

Aseptic (*ah-sep′-tik*). Free from pathogenic bacteria, or septic matter.

Autotoxic (*aw-to-toks′-ik*). Self-empoisonment through the absorption of noxious products of katabolism, as in *uremia*.

Azotemia (*az-o-te′-me-ah*). The presence of nitrogenous compounds in the blood; uremia.

Azoturia (*az-o-tu′-re-ah*). An increase of the urea and urates in the urine.

B

Bacillar, or Bacillary (*bas′-il-ar; bas′-il-a-re*). 1. Relating to bacilli or to a bacillus. 2. Consisting of or containing rods.

Bacteriology (*bak-te-re-ol′-o-je*). That department of science that is concerned with the study of bacteria.

Bacterium (*bak-te'-re-um*). 1. A term used to distinguish in a general way some of the simplest microscopic fungi, the *Bacteriaceæ*, Fission-fungi, or Schizomycetes, and other closely allied microbes. 2. A genus of short, cylindrical, motile Fission-fungi.

Binocular (*bin-ok'-u-lar*). In optics an instrument with two eye-pieces for use with both eyes at once. **B. Vision**, the faculty of using both eyes synchronously and without diplopia.

Biogenesis (*bi-o-jen'-es-is*). The doctrine that living things are produced only from living things—the reverse of *abiogenesis*.

Biologos (*bi-o-log'-os*). A designation proposed for the intelligent living power displayed in cellular and organic action and reaction.

Biology (*bi-ol'-o-je*). The science embracing the structure, function, and organization of life-forms.

Bioplasm (*bi'-o-plazm*). Any living matter, but especially germinal or forming matter; matter possessing reproductive vitality.

Bioplast (*bi'-o-plast*). A mass or cell of bioplasm which is a unit of living matter.

Blastema (*blas-te'-mah*). The formative lymph or pabulum of capillary exudation. A synonym of protoplasm.

C

Cacemia (*kas-e'-me-ah*, or *kak-e'-me-ah*). An ill-condition of the blood; depravity of the blood.

Cachexia (*kak-eks'-e-ah*). A term used to designate any morbid tendency, dyscrasia, depraved condition of general nutrition, or impoverishment of the blood, etc.

Celloidin (*sel-oid'-in*). A concentrated form of collodion for use in imbedding objects for histologic purposes.

Charlatan (*shar'-lat-an*). A quack; a pretender to medical skill; an advertising doctor.

Chromatin (*kro'-mat-in*). The tingible portion of the protoplasm, forming a delicate reticular network of fibrils permeating the achromatin of a typical cell in process of division. It is called also Karyomiton.

Chromation (*kro-ma'-shun*). The process of tingeing or staining.

Chromatism (*kro'-mat-izm*). 1. Abnormal coloration of any tissue. 2. Chromatic aberration.

Chromidrosis (*kro-mid-ro'-sis*). A rare condition of the sweat in which it is variously colored, being bluish, blackish, reddish, greenish, or yellowish.

Chyluria (*ki-lu'-re-ah*). The passage of milky-colored urine.

Cladothrix (*klad'-o-thriks*). A genus of bacteria, having long filaments, in pseudo-ramifications, with true spores.

Coccidia (*kok-sid'-e-ah*). The so-called *psorospermiæ*—minute oval structures about 0.035 mm. long, with a thick capsule and coarsely granular contents. The organism is more properly called *Coccidium oviforme*, while the spores that it forms are termed psorospermiæ.

Contagion (*kon-ta'-jun*). The process by which a specific disease is communicated between persons, either by direct contact or by means of an intermediate agent. Also the specific germ or virus from which a communicable disease develops.

Contagium (*kon-ta'-je-um*). Any virus or morbific matter by means of which a communicable disease is transmitted from the sick to the well; any living vegetable or animal organism that causes the spread of an infectious disease.

D

Desmobacterium (*des-mo-bak-te'-re-um*)[*pl. Desmobacteria*]. A group of microbes, so-called by Cohn, corresponding to the genus *Bacillus* of Klein.

Diplococcus (*dip-lo-kok'-us*). A micrococcus whose spherules are joined two and two.

E

Eosinophile (*e-o-sin'-o-fil*). In bacteriology and histology, applied to microbes or histologic elements showing a peculiar affinity for eosin-stain.

Epithelioma (*ep-e-the-le-o'-mah*). Carcinoma involving skin or mucous membrane.

F

Fuchsin (*fook'-sin*) [after Leonhard *Fuchs*], $C_{20}H_{10}N_3$.

Fungicide (*fun'-jis-id*). 1. Destructive to fungi; bactericide. 2. An agent that destroys fungi or bacteria.

G

Gemmation (*jem-a'-shun*). In biology, asexual reproduction by budding, as distinguished from fission and free-cell formation.

Genesis (*jen'-es-is*). The act of begetting; development; origin; formation; generation.

Genetic (*jen-et'-ik*). Pertaining to generation, or to anything inherited. **G. Affinity**, relationship by direct descent.

Germ (*jerm*). In biology, (*a*) a portion of matter potentially vital and having within itself the tendency to assume a definite living form; a spore, a seed, an embryo. (*b*) A microbe or bacterium.

Germicide (*jer'-mis-id*). A microbicide; an agent that destroys germs.

Germiculture (*jer'-me-kul-chūr*). The artificial culture of bacteria.

Gonococcus (*gon-o-kok'-us*). A microbe, the specific cause of gonorrhea.

H

Hemameba (*hem-am-e'-bah*). A white blood-cell, so called from its resemblance to an ameba.

Hematoblast (*hem'-at-o-blast*). Blood-plate; a rudimentary or immature red blood corpuscle.

Hematocyst (*hem'-at-o-sist*). A cyst containing blood.

Hematozoön (*hem-at-o-zo'-on*). Any living organism or animal in the blood.

Hematuresis (*hem-at-u-re'-sis*). The passage of bloody urine.

Hemocyte (*hem'-o-sīt*). One of the protistan organisms found in the blood of man and animals, *e. g.*, the parasite of malarial fever.

Heteroblastic (*het-er-o-blas'-tik*). In biology, arising from a different or abnormal source.

Histopathology (*his-to-path-ol'-o-je*). The study of minute pathologic changes or states.

Hydruria (*hi-dru'-re-ah*). Excessive excretion of water by the kidneys.

Hyperplasia (*hi-per-pla'-ze-ah*). The excessive deposit or augmentation of the elements of the tissue composing an organ.

I

Immersion (*im-mer'-shun*). **I., Homogeneous,** a fluid between the objective of a microscope and the cover glass, having about the same refractive and dispersive power as the glass. **I., Objective,** a microscope-objective, usually of high power, the lower lens of which is immersed in a drop of water, glycerin, or oil, placed on the cover-glass of the object under examination.

Immune (*im-mūn'*) [*immunis*, safe]. 1. Safe from attack; protected by vaccination, or some analogous procedure, or by previous illness. 2. A person who is protected against any special virus.

K

Karyokinetic (*kar-e-o-kin-et'-ik*). In biology, applied to the active stages of nuclei.

Karyomitosis (*kar-e-o-mit-o'-sis*). The division or splitting of the nuclear mass of chromatin-fibers.

L

Latericious, Lateritious (*lat-er-ish'-us*). Pertaining to an urinary sediment resembling brick-dust.

Leukoblast (*lu'-ko-blast*). 1. The germ of a leukocyte; also, a leukocyte itself. 2. A cell in bone-marrow, of a type that is believed to become developed into a red blood corpuscle.

Leukocyte (*lu'-ko-sīt*). The colorless or white corpuscle of the blood.

Leukomain, or Leucomain (*lu-ko'-ma-in*). The nitrogenous bases or alkaloids necessarily and normally developed by the vital functions or metabolic activity of living organisms, as distinguished from the alkaloids developed in dead bodies, and called ptomains.

Lipogenous (*lip-oj'-en-us*). Fat producing.

Lipuria (*lip-u'-re-ah*). The presence of fat in the urine.

Lithuria (*lith-u'-re-ah*). A condition marked by excess of lithic acid, or its salts, in the urine.

Lymphocyte (*lim'-fo-sīt*). 1. A lymph-cell. 2. One of Ehrlich's classes of leukocytes, comprising those small cells having large nuclei and a very small amount of protoplasm.

M

Macrochemistry (*mak-ro-kem′-is-tre*). Chemistry in which the reactions are observable with the naked eye.

Macroscopic (*mak-ro-skop′-ik*). Large enough to be seen by the naked eye; gross; not microscopic. **M., Morbid Anatomy,** naked-eye or gross morbid anatomy.

Megalocyte (*meg′-al-o-sīt*). A red blood-corpuscle larger than the average; especially the form that characterizes pernicious anemia.

Mesobacteria (*mez-o-bak-te′-re-ah*). Medium-sized vegetable microörganisms.

Microbe (*mi′-krōb*). The generic name for microörganisms, whether animal or vegetable. In ordinary use the term *microbe* is equivalent to *schizomycete*, and designates a vegetable microorganism.

Microbicide (*mi-kro′-bis-īd*). 1. Destructive to microbes. 2. An agent that destroys microbes.

Microbiology (*mi-kro-bi-ol′-o-je*). Bacteriology, or the science of microörganisms.

Micro-chemistry (*mi-kro-kem′-is-tre*). The chemic investigation of the more minute substances of nature.

Micrococcus (*mi-kro-kok′-us*). A genus of schizomycetous microorganisms, having spheric elements, isolated, united in two's or in larger numbers, or disposed in chaplets, or masses of zooglea. Sometimes they are united in such a way as to resemble a bunch of grapes and are then called **Staphylococci.** When united in couples they are called **Diplococci.** If arranged in strings or chaplets they are called **Streptococci.**

Micron (*mi′-kron*). The millionth part of a meter or a thousandth of a millimeter. It is the equivalent of $\frac{1}{25400}$ of an English inch, and its symbol is μ.

Microphyte (*mi′-kro-fīt*). Any microscopic plant, especially one that is parasitic in habits.

Microscopist (*mi-kros′-ko-pist*). One who is skilled or expert in the use of the microscope.

Microscopy (*mi-kros′-ko-pe*). The use of the microscope; microscopic study or observation.

Microtomist (*mi-krot′-o-mist*). One who cuts sections with the microtome.

Monochromatic (*mon-o-kro-mat'-ik*). Having but one color.

Mordant (*mor'-dant*) [*mordere*, to bite]. A substance that fixes the dyes used in coloring textures, or in staining tissues and bacteria.

Mucinoid (*mu'-sin-oid*). Resembling mucin.

Mucinuria (*mu-sin-u'-re-ah*). The presence of mucin in the urine.

Mucous (*mu'-kus*). A term applied to those tissues that secrete mucus.

Mucus (*mu'-kus*) [L.]. The viscid liquid secretion of mucous membranes, composed essentially of mucin holding in suspension desquamated epithelial cells, leukocytes, etc.

N

Neoplasm, Neoplasma (*ne'-o-plazm, ne-o-plaz'-mah*). A new growth of tissue marked by histologic difference from its matrix; a tumor.

Neuroplasm (*nu'-ro-plazm*). That form of bioplasm exhibited in living brain-tissue.

Nidus (*ni'-dus*) [L., nest]. A central point or focus of infection; a place in which an organism finds conditions suitable for growth and development.

Nigrosin (*nig'-ro-sin*). A blue-black anilin-dye, useful in staining sections of brain-tissue.

Nosogeny (*nos-oj'-en-e*). The development and progress of diseases.

Nosomycosis (*nos-o-mi-ko'-sis*). Any disease due to the presence of a parasitic fungus, or schizomycete.

Nucleolus (*nu-kle'-o-lus*). The small spheric body within the cell-nucleus.

Nucleus (*nu'-kle-us*). The essential part of a typical cell, usually round in outline, and situated near the center.

O

Oidium (*o-id'-e-um*) [dim. of ὠόν, egg]. A genus of parasitic fungi. **O. albicans** is found in thrush, upon the tongue. **O. lactis**, the white mold found on milk, bread, etc.

Organism (*or'-gan-izm*). A living being, animal or vegetable, simple or composed of many organs; also the assemblage of

organs constituting a living being. **O., Micro-**, a minute or microscopic body or organism; a schizomycete; a bacterium.

Organoid (*or'-gan-oid*). A term applied to tumors composed of several tissues and resembling an organ, as carcinoma, which somewhat resembles an epithelial gland.

Orgasm (*or'-gasm*). The crisis of venereal passion.

Osler's Method. A method of studying blood-plaques; a drop of osmic acid is placed on the cleansed finger, which is then pricked and the drop transferred to a slide.

Oxaluria (*oks-al-u'-re-ah*). A term used to indicate the presence of calcium oxalate in the urine in an undue amount. There is a white deposit on standing. It occurs in the urine of hypochondriacal and depressed patients, and in that of gouty patients. Excessive venery and masturbation will produce it, as also will the ingestion of certain foods, as rhubarb.

P

Paludism (*pal'-u-dizm*) [*palus*, a marsh]. Malarial poisoning; impaludism.

Paraffin (*par'-af-in*). A white, odorless, translucent, crystalline hydrocarbon obtained from coal-tar, or by the destructive distillation of wood. In a pure state it resembles white wax in physical properties.

Parasite (*par'-as-it*). In biology, an organism that inhabits another organism and obtains nourishment from it; it may be a *phytoparasite* or a *zoöparasite*, an *ectoparasite* or an *endoparasite*, *occasional* or *constant*, *temporary* or *stationary*, *obligate* or *facultative*, a *true parasite* or a *pseudo-parasite*.

Parasiticide (*par-as-it'-is-id*). Any substance destructive of parasites.

Pathogenic, Pathogenetic (*path-o-jen'-ik*, *path-o-jen-et'-ik*). Producing disease. **P. Microörganism**, any one of the various forms of microbic life which, when introduced into the system, causes disease.

Phagocyte (*fag'-o-sit*). Phagocytes are *fixed*—endothelial cells, fixed connective-tissue cells, and *free*—the wandering cells or leukocytes. In man the colorless blood-cells, as well as other kinds of cells, are credited with playing the rôle of phagocytes. They are believed to englobe wrecks of larval organs, degradation-products or excretion products, foreign particles, schizo-

mycetes, hematozoa, etc.—their activity varying as the logarithm of the excitation. They digest the soluble parts and reject the insoluble residue. They play an active part in the metamorphosis of tissues and organs, in inflammation, and as prophylactic agents.

Phagosite (*fag'-o-sīt*). An animal organism that feeds on but does not dwell within or on its host, *e. g.*, the leech, lamprey, camel-tick, vampire bat.

Phosphaturia (*fos-fat u'-re-ah*). A condition in which an excess of phosphates is passed in the urine. It can be diagnosticated by a quantitative analysis of the urine for phosphates by the uranium method.

Photomicrograph (*fo-to-mi'-kro-graf*). A photograph of a small or microscopic object, usually made with the aid of a microscope, and of sufficient size for observation with the naked eye.

Photuria (*fo-tu'-re-ah*). Phosphorescence of the urine.

Poikilocyte (*poi'-kil-o sīt*). A large, irregularly shaped red blood-corpuscle. Poikilocytes are most abundant in the blood in pernicious anemia, but also occur in other forms of anemia.

Polyuria (*pol-e-u'-re-ah*). Excessive secretion of urine. The causes of temporary polyuria are, excessive ingestion of fluids, cold, suppression of perspiration, the use of diuretics; it occurs in the crisis of fevers, and in certain neurotic conditions, as hysteria, and in nervous excitement. A permanent polyuria is met with in diabetes mellitus, diabetes insipidus, chronic interstitial nephritis, and in amyloid disease of the kidneys.

Protozoa (*pro-to-zo'-ah*). The lowest class of the animal kingdom, comprising organisms which consist of simple cells or colonies of cells, and which possess no nervous system, and no circulatory organs.

Ptomain (*to'-ma-in*). Any one of the active, inanimate septic or toxic substances resulting from processes of decomposition and disintegration of albuminous materials. Ptomains have been found in foods, as in mussels, oysters, eels, sausage, ham, canned meats, cheese, milk, ice-cream, etc. The pathogenic action of certain bacteria may be due to their production of ptomains.

Pyemia (*pi-e'-me-ah*). Phlebitic septicemia, with the presence of pyogenic microörganisms in the blood and with the formation wherever they lodge of secondary embolic or metastatic abscesses.

Pyogenic (*pi-o-jen'-ik*). Producing or relating to pus-formation.

Pyrotoxin (*pi-ro-toks'-in*). A toxic agent generated in the course of the febrile process.

Pyuria (*pi-u'-re-ah*). Pus in the urine.

Q

Quack (*kwak*). One who practises quackery; a pretender to medical skill; a peddler of his own medicines and salves.

R

Reagent (*re-a'-jent*). In chemistry, anything used to produce a reaction, or to test for the presence of an element. A test.

Rhabdomyoma (*rab-do-mi-o'-mah*). A rare form of myoma characterized by the presence of striated muscular fiber.

S

Sanatorium (*san-at-o'-re-um*) [*sanare*, to heal]. An establishment for the treatment of the sick; especially a private hospital.

Sanitarium (*san-it-a'-re-um*) [*sanitas*, health]. A health-station. A place or institution where the conditions are such as especially to promote health and vigor. The word is often incorrectly employed for sanatorium, which is a hospital or place for curing those who are sick. A sanitarium may be used as a sanatorium but it is not necessarily the same thing.

Saprogenic (*sap-ro-jen'-ik*). Causing putrefaction; caused by putrefaction.

Saprophytic (*sap-ro-fit'-ik*). In biology, growing on or in decaying organic matter.

Sarcina (*sar-si'-nah*). A genus of *Schizomycetes*, or bacteria, having spheric or ovoid cells dividing in three directions, thus producing cubic masses of greater or less size.

Schizomycetes (*skiz-o-mi-se'-tēz*). In biology, an order of *Fungi*; the so-called *Fission-fungi* or *Bacteria*.

Schizomycosis (*skiz-o-mi-ko'-sis*). A disease due to schizomycetes.

Scirrhus, or Scirrus (*skir'-us* or *sir'-us*). A scirrhous or hard carcinoma.

Septic (*sep'-tik*). Relating to putrefaction. **S. Infection**, infection with pathogenic microörganisms. **S. Intoxication**, absorption of septic matter. **S. Pestilence.**

Septicemia, Septicæmia (*sep-tis-e'-me-ah*). A condition induced by the absorption of septic products. *Pyemia* is septicemia plus the formation of secondary or embolic abscesses.

Septico-pyemia (*sep-tik-o-pi-e'-me-ah*). The condition of combined septicemia and pyemia; septic and purulent infection.

Septodiarrhea (*sep-to-di-ar-e'-ah*). Septic diarrhea.

Septodysenteria (*sep-to-dis-en-ter'-e-ah*). Septic dysentery.

Sequela (*se-kwel'-ah*). The consequence or abnormal condition following an injury or the abatement of a disease; any diseased or abnormal condition that follows an attack of disease or an injury.

Seralbumin (*sēr-al'-bu-min*). Serum-albumin; the albumin found in the blood, in distinction from that of the egg, *ovalbumin.*

Sewage (*su'-āj*). The heterogeneous substances constituting the excreta and waste matter of domestic economy and the contents of drains.

Sewerage (*su'-er-āj*). The collection and removal of sewage.

Society Screw. The screw at the lower end of the draw-tube or body-tube of a microscope for receiving the objective.

Streptobacteria (*strep-to-bak-te'-re-ah*). In biology, short, rod-shaped bacteria associated in chains.

Streptococcus (*strep-to-kok'-kus*). A genus of coccaceous schizomycetes, of which the cocci are arranged in strings or chaplets. Many of the species are believed to be pathogenic.

Streptothrix (*strep-toth'-riks*). In biology, a genus of *Schizomycetes*, the cells uniting into simple or branching threads.

Stroma (*stro'-mah*). The tissue forming the substratum or framework upon which the essential structures of an organ rest.

Substage (*sub'-stāj*). The arrangement beneath the stage of a microscope for the diaphragms, condenser, illuminator, and other accessories.

Supernatant (*su-per-na'-tant*). Floating upon the surface of a liquid.

T

Tabescence (*tab-es'-ens*) [*tabes*, wasting]. Wasting; marasmus; emaciation.

Telangioma (*tel-an-je-o′-mah*). A tumor composed of dilated capillaries.

Teniacide, Tæniacide (*te′-ne-as-īd*). Destructive of tapeworms; a remedy that destroys tapeworms.

Teniafuge, Tæniafuge (*te′-ne-af-ūj*). An agent that expels, without necessarily killing, tenia.

Teratism (*ter′-at-izm*). Any anomaly of conformation, whether congenital or acquired through disease or injury.

Teratoma (*ter-at-o′-mah*). A congenital tumor, which may contain various concretions of organic tissue, as teeth, hair, and other erratic material. Dermoid cyst.

Toxemia (*toks-e′-me-ah*). A condition of the blood in which it contains poisonous products, either those produced by the body-cells and not properly eliminated, or those due to the growth of microörganisms.

Toxicogenic (*toks-ik-o-jen′-ik*). Giving rise to poisons; producing a toxic substance, as a toxicogenic microörganism.

Trabecula (*tra-bek′-u-lah*). Any fibrous process, layer, or cord which goes to make up a framework in an organ or viscus.

Traumatism (*traw′-mat-izm*). The condition of one suffering from injury. The systemic condition following trauma.

Trichina (*trik-i′-nah*, or *trik-e′-na*). A genus of parasitic nematode worms.

Trichinosis (*trik-in-o′-sis*). A disease produced by the ingestion of meat, pork, or sausage, containing the *Trichina spiralis*.

Typhotoxin (*ti-fo-toks′ in*). A ptomain discovered by Brieger, and believed to be the special product of the Koch-Eberth typhoid-bacillus.

Tyrotoxicon (*ti-ro-toks′-ik-on*). A ptomain obtained by Vaughan from poisonous cheese, poisonous milk, poisonous ice-cream, etc.

U

Urinalysis (*u-rin-al′-is-is*). The analysis of the urine.

Urinology (*u-rin-ol′-o je*). The science of the analysis and diagnostic significance of urine.

Uroscopist (*u-ros′-ko-pist*). One who makes a specialty of urinary examinations.

V

Verrucose, Verrucous (*ver'-u kōz, ver' u-kus*). Warty; covered with or having warts.

Vestigium (*ves tij'-e um*). An anatomic relic of fetal or embryonic life. Thus, the thymus gland becomes in adults a *vestigium*

Virus (*vi'-rus*) [L.]. A poison that causes a morbid process or disease; any pathogenic microbe.

Viscous (*vis'-kus*). Glutinous, ropy, sticky.

Viscus (*vis' kus*) [L.: *pl.*, *Viscera*]. Any organ enclosed within either of the four great cavities, the cranium, thorax, abdominal cavity, or pelvis; as the brain, intestine, spleen, bladder, uterus, lungs, liver, etc.

W

Wilks's Kidney. The large white kidney of chronic parenchymatous nephritis.

X

Xylol (*zi'-lol*). Dimethyl benzene. A volatile hydrocarbon somewhat resembling benzol.

Z

Zooglea (*zo-o gle'-ah*). In biology, a stage in the life-history of certain *Schizomycetes*, or bacteria, in which they lie embedded in a gelatinous matrix secreted by the microbes themselves.

Zymotic (*zi mot'-ik*). In biology, pertaining to zymosis, or fermentative changes produced by an organized ferment, or zyme.

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