HEALTH PRIMERS.

No. 1.

EXERCISE AND TRAINING.

BY

C. H. RALFE, M.D.

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PREFACE TO THE AMERICAN EDITION.

ONE of the most encouraging signs of social improvement is the increasing attention that has been given of late years to the subject of personal and public hygiene. Information of great value to the community, regarding the conditions and care of health, has been disseminated among all classes, by means of books, periodicals, tracts, and lectures. But, as generally happens when public interest is strongly excited in any given direction, the publications called forth have many of them been of a very questionable sort. Though it is of the greatest importance that books upon health should be in the highest degree trustworthy, it is notorious that most of the cheap and popular kind are the mere crude compilations of incompetent persons, and are often misleading and injurious.

Impressed by these considerations, several eminent medical and scientific men of London have combined to prepare a series of HEALTH PRIMERS, of a character that shall be entitled to the fullest public confidence. They are to be brief, simple, and elementary in statement, and they will be filled with substantial and useful information, suitable for the guidance of grown-up people. Each primer will be written by a gentleman specially competent to treat his subject; while the choice of topics and the critical supervision of the books will be in the hands of an able and responsible committee. The series will deal with the chief hygienic subjects that are of vital importance to the individual and the family, and will form a cheap and compendious popular library of health-manuals which should find a place in every household.

As these little books are produced by English authors, they are naturally based very much upon English experience, and contain many local references. But it matters little whence illustrations upon such subjects are drawn, because principles and rules are applicable everywhere. Even the primer on "The House and its Surroundings," which is the one most affected by the circumstances and habits of English life, is full of most excellent instruction by which Americans can profit, on the relations of dwellings to health; while the various references in the different volumes to the English health-laws will be by no means without value to American readers. As respects local considerations, it is to be remembered that hygienic questions vary even in this country, North and South, on the coast and in the interior, in low-lying districts and in upland regions; yet the essential conditions of avoiding disease and preserving health are to a great degree everywhere the same.

The next number of this series will be on "Alcohol: its Use and Abuse," by W. S. Greenfield, M. D.; to be followed by "The House and its Surroundings," "Premature Death: its Promotion or Prevention," and other primers.

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EXERCISE AND TRAINING.

SECTION I.

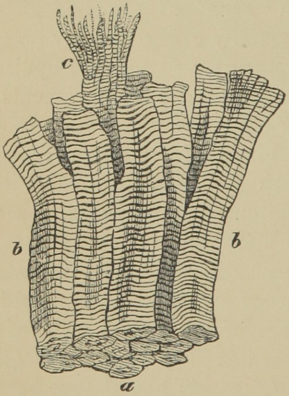
GENERAL PRINCIPLES.

1. *Definition.*—The term "exercise" is applied, physiologically, to the functional activity evoked in any part or organ of the body by an appropriate stimulus. Popularly, however, by exercise is understood the movements of the body which are effected by the contraction of the voluntary muscles. It is in this latter sense that we shall treat the term, though the secondary effect that muscular exercise has on circulation, secretion, and the nervous system will receive attention.

2. *Structure of Voluntary Muscles.*—The voluntary muscles, so called because they are under the control of the will, through the medium of the nerves supplied to them, constitute what is known as the "red flesh." They consist of bundles of fibres (*fasciculi*) bound together by a delicate tissue (*areolar*), each bundle being again subdivided into smaller bundles till only a single fibre can be separated. This ultimate fibre is invested in a fine

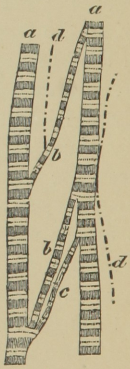
membrane (*sarcolemma*), distinct however in character from the tissue that surrounds the bundles. This solitary fibre in its turn can be again divided into delicate fibrillæ, each of which is marked transversely with fine lines (*striæ*). These lines appear to be produced by alternate dark and light particles, of which the dark probably constitute the muscular contractile element. These details will be rendered clear by a reference to the woodcut.

FIG. 1.



a. Fasciculus of muscular fibres.
b, b. Fibres.
c. A fibre split into fibrillæ.

FIG. 2.



Fibril showing alternate light and dark coloured particles.
a, b, c. A collection of small fibrils.
d, d. The smallest that can be detached.

(After Sharpey.)

Every muscle is supplied by nerves through which it receives the stimulus which excites it to contraction from the nervous centres—the brain and spinal cord. It is also abundantly supplied with blood by means of arteries, capillaries, delicate vessels that ramify among the fibres, and veins.

The voluntary muscles are attached to the bones on which they act by means of tendons, which consist of bands of fibrous tissue, and have a shining silvery appearance.

The muscles are kept in their places by a general investment of fibrous and connective tissue, which dips between them, and forms nearly a continuous covering of the body beneath the skin; to this investment or sheath the term *fascia* is given.

3. *Function of Muscle.*—The characteristic property of muscle is its *contractility*, and it is in virtue of this power of contraction that the external mechanical work of the body is effected.

When at rest a muscle is in what is termed its elongated condition, though even then there is a slight degree of tension of its fibres, which is of advantage in giving effect to the first part of the contraction. When the appropriate stimulus is applied, the elongated muscle shortens and becomes thicker, thus bringing the ends of the fibres together.

A muscle, after prolonged contraction or series of contractions, becomes fatigued; that is, a stronger stimulus (for instance, a greater effort of will) is required to produce the same degree of contraction. The more rapidly the contractions are induced, the quicker will the sense of fatigue manifest itself; and the greater the degree of fatigue, the longer will be the period of rest required before the muscle regains its full powers of contraction.

By use muscles increase in size, familiar instances of which are seen in the bulky arm of the blacksmith, and the leg of the ballet dancer. If disused, muscles dwindle and waste, as may be noticed in the limbs of persons crippled by disease or injury.

4. *Work done by Muscular Contraction.*—The work done in the body may be divided into three kinds. 1. *Internal work*, the nervous energy required for regulating the processes of the body, or for intellectual pursuits, and the force required to carry out the functions of secretion, digestion, assimilation, &c. 2. *Calorific work*, the production of heat for the maintenance of the animal temperature. 3. *External mechanical work*, or the force which takes the form of muscular activity.

Now the amount of force expended on each of these different forms of work varies with the individual, but the force is the same, however employed, or in whatever form it is developed.

From calculations made by different observers, the amount of force daily expended by an adult weighing 150 lbs. in the performance of the internal, calorific, and external mechanical work of the body has been estimated at about 3,400 foot-tons,* of which 260 are required for the internal or vital work of the body, 2,840 for the maintenance of the animal heat, and 300 for the ordinary external mechanical work.

Estimates have also been made showing the amount of work a man weighing 150 lbs. can accomplish in eight hours' vigorous occupation at different kinds of labour. Thus, eight hours' pile-driving is equal to the force expended in lifting 312 tons 1 foot; turning a winch, 374 tons lifted 1 foot; military prisoners at shot drill (three hours) and oakum picking and drill, 310 tons lifted 1 foot; and for rowing 1 mile at racing speed in an outrigged eight-oar, 18·56 tons lifted 1 foot.

And Professor Parkes has calculated that walking 1 mile on the level, unloaded, is equal to lifting 17·67 tons 1 foot; but if loaded with a knapsack weighing 60 lbs., the work done is equivalent to 24·75 foot-tons. Looking at these facts, and considering that the most healthy life is that of a man engaged in moderate labour in the open air, and that the daily work performed by him will pro-

* A "work unit" is the force required to raise 1 lb. 1 foot in height.

bably average from 250 to 350 tons lifted 1 foot, Professor Parkes thinks we can form an approximate idea of the daily exercise a healthy adult should take without incurring the risk of over-fatigue; and this he assumes would be equivalent to a walk of nine miles; but allowance must be made for the other exertion incurred by the ordinary business of life, which in many cases would cause a considerable reduction.

5. *Source of Muscular Force.*—Every action of the living body is attended by chemical changes in the composition of its tissues, and in these chemical changes a quantity of force is liberated, which, either in the form of heat, maintains the temperature of the body, or, as motion, endues it with activity.

This force enters the body in a latent state (potential energy) in the form of the food that is being continuously introduced for the support of the body, and the oxygen that is drawn into the lungs at every respiration.

Now the constituents of the food—carbon, hydrogen, and nitrogen—in their early history were combined with a considerable proportion of oxygen, and existed in the air and in the soil in the form of carbonic acid, water, and carbonate of ammonia. Now the partial removal of oxygen was effected by the agency of the vegetable kingdom. The plant, under the influence of the sun's rays, liberates a quantity of oxygen from the carbonic acid, water, and ammonia, and converts them into those sugars, oils, fats, and flesh-forming materials which are ultimately destined to supply the animal with food. That plants exert this power of removing oxygen may be readily shown by a simple experiment. For if a bunch of fresh green leaves be plunged into a broad-necked bottle containing fresh spring water, or water containing carbonic acid in solution, and the bottle turned mouth downwards into a basin of water, so as to exclude air, and the whole exposed to strong sunlight for an hour or more, the leaves will become covered with minute bubbles; and these bubbles have been proved to be bubbles of oxygen, which is derived from the decomposition of the carbonic acid of the water: the oxygen is then set free, whilst the carbon is absorbed to form the tissues of the plant.

In this process of separation (de-oxidation), however, a considerable quantity of the heat derived from the sun becomes latent, one portion of it being taken up by the liberated oxygen, the other accumulated in the tissues and juices of the plant. And this heat will remain latent till the oxygen and the carbon are again united.

This reunion of carbon and oxygen is effected either by the direct burning of carbon in oxygen, as takes place when fuel is burnt in our grates—for coal is the carbon stored up in the vegetable kingdom ages ago under the influence of a tropical sun—or when the carbon elements of the food and tissues are submitted to the action of the oxygen of air introduced into the body by the act of respiration.

By this union the latent (potential) energy of the oxygen and the elements of the food and tissues are converted into an active force (kinetic), which takes the form of heat or its correlative motion.

6. *Relationship between Heat and Motion.*—We have already stated (paragraph 4) that the work done in the body may be divided into three kinds, and that the greatest part of the work, amounting to nearly 60 per cent. of the whole, is employed in the production of heat or in external mechanical work. And we stated that though the amount of force expended on each of these different forms of work varies with the individual, still the force is the same, however employed, or in whatever form it is developed. To make this statement clearer we will now refer to some experiments showing the correlation existing between heat and motion, and show how the one can be converted into the other.

Professor Joule, of Manchester, found that when water was agitated by means of a horizontal paddle-wheel made to revolve by the descent of a known weight, the temperature of the water was raised 1° Fahr. by the expenditure of an amount of force sufficient to raise 772 lb.

the height of 1 foot. When cast-iron was rubbed against cast-iron, the force required to raise 1 lb. of water 1° Fahr. was found to be about 775 foot-pounds. The conclusion to be drawn from these facts is, that the quantity of heat capable of raising the temperature of 1 lb. of water (between 50° and 60° Fahr.) 1° of temperature requires for its evolution an expenditure of a mechanical force adequate to raise 772 lb. to the height of 1 foot. Conversely, the steam-engine is an example of the change of heat into motion; and, as it has been shown in the foregoing example, that so much mechanical energy produces so much heat, so in the steam-engine it can be shown that a definite quantity of heat develops so much motion.

Our muscles, therefore, may be regarded as machines for converting the potential energy derived from the food and oxygen into mechanical force. Only, as Professor Odling has so well expressed it, our muscles are more perfect contrivances as motive machines, because they are more economical in their action. The most perfect steam-engine ever invented wastes quite 40 per cent. of its heat in producing motion. In muscle the loss is hardly appreciable.

Lastly, muscular exertion again produces heat, just as in the steam-engine heat is developed by the friction of the revolving wheels and the piston; part of this heat goes to maintain the temperature of the body, and part, no doubt, is again used in the production of muscular motion: "for in nature no force is ever dissipated, and the operation of force is again force in its turn, and there is no progress unless force is continually changing its form."

7. *Force-values of Food.*—The amount of work done in the body has been stated (4) to correspond closely to the force required to raise 3,400 tons to the height of 1 foot. Now if we know what the effective force-value of the food is, we can calculate approximately the daily income and expenditure of force in the body.

The force-values of the different principles of food have been calculated by Professor Frankland by burning a definite weight of them in a dry state in oxygen; and by observing the "units of heat" furnished by their combustion, and converting these "heat units" into "units of motion" (6), he obtained the mechanical force of each principle of diet in foot-pounds, as follows:—

			Foot-pounds.
15	grains of	dry albumen (fleshy matter) .	= 13,851
15	,,	fat of beef	= 27,716
15	,,	starch	= 11,720

If, therefore, 1,800 grains of dry albumen, 1,350 grains of fat, and 4,900 grains of starch be daily consumed, an amount of force capable of lifting 7,910,045 lbs. to the height of 1 foot, or 3,530 foot-tons, will be derived from the food; a result closely corresponding with the calculated estimate of the total work done in the body, viz., 3,400 foot-tons.

This close correspondence between the energy taken in and the active force expended is most interesting. And it is to be hoped that an extension of the inquiry will eventually lead to a determination of the most suitable, or perhaps, as it would be better expressed, the most effective food or mixture of foods on which muscular exertion can be maintained. Formerly it was supposed that the combustion of the albuminous fleshy principles was the chief if not the sole source of muscular force. This view is now considerably modified; for as muscular exertion is always attended by an increased elimination of carbonic acid and water, which is chiefly derived from the destruction of the fats and starches, and as, moreover, great fatigue and exertion can be borne for some days on a diet composed entirely of these articles without the use of flesh, it is held that these articles furnish a much larger proportion of muscular force than has hitherto been admitted.* Professor Haughton† is of opinion that the

* It is important to notice the high force-value yielded by the combustion of fat—more than double the amount furnished by a similar weight of either albumen or starch.

† Address delivered at the British Medical Association at Oxford, 1868.

muscular qualities developed by the two kinds of food (flesh and farinaceous) differ considerably from each other. Thus the deer will outstrip the leopard in fair chase because the force supplied to its muscles by its vegetable food is capable of being used continuously for a long period of time, but the leopard in its sudden spring has the advantage over the deer, because its fleshy food forms a store of force capable of being given out instantaneously.

Professor Haughton has also pointed out that miners, labourers, and others whose exertions are continuous, instinctively prefer the fatty and farinaceous articles of diet; whilst the athlete, whose muscular exertion is more sudden and less continuous, prefers a diet consisting chiefly of flesh. The weight-drawing cart-horse fed on beans and grass, and the racehorse fed on corn, which contains a large percentage of albuminous matter, may be cited as another illustration of this point.

8. *Action of Muscles on the Skeleton.*—Muscles, by their power of shortening, bring the movable parts of the skeleton towards each other, and thus give rise to a variety of movement. The muscles which act on the bones and cartilages of the body act nearly always as on levers, since these parts are generally arranged so as to be movable round a point (the joint).

Joints may be divided into two classes—fixed* and movable.

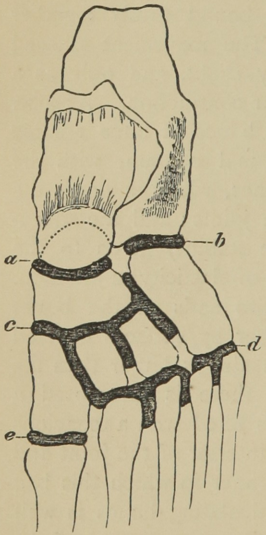
A fixed joint (synchondrosis) is formed by the closely opposing surfaces of two bones, a layer of cartilage intervening between them, and bound firmly together by strong bands of ligament. The movement allowed by such an arrangement is very slight, and only as a consequence of powerful muscular contraction. As soon as this contraction is over, the bones at once resume their original position. The spinal column, with the exception of the two upper bones, which support the head, consists of a series of such joints; and the advantage of the arrangement is the stability given to the trunk, with a considerable degree of elasticity in addition.

In the movable joint, the two ends of the bones forming the joint oppose each other by surfaces covered by true cartilage, one of which is always larger than the other. Between these surfaces there is interposed a closed membranous bag, which is filled with a tenacious viscid fluid, which lubricates the interior of the joint and promotes free mobility. The manner in which this bag fits between the ends of the articulating bones is well seen in Fig. 3, which represents the arrangement of the

* The term "fixed" is only relative: the only absolutely immovable class of joints are the *sutures* by which the bones of the skull are connected.

synovial membranes in the foot, especially in the complicated arrangement of membrane *c*, which is interposed between no less than eight bones.

FIG. 3.

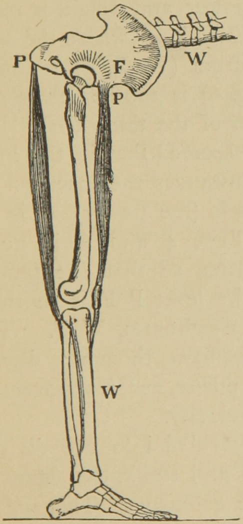


Arrangement of synovial membrane of the foot. The synovial membrane is coloured black (from Erichsen's Surgery).

The motion of the joint, however, is checked, and the bones which compose it kept in apposition, by means of the ligaments, which are bands of fibrous tissue stretching from one bone to the other, either as narrow cords or spread out to form a capsule, which entirely surrounds the joint. The tension of the surrounding muscles also helps in keeping the surfaces of the joint in contact.

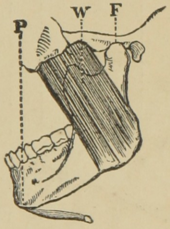
Examples of the three kinds of lever are met with in the human skeleton, though those of the second and third kind are the most common. Fig. 4 represents the body in a stooping position; in order to restore it to the erect position, the hamstring muscle, P, which represents the power, acts on the haunch bone (pelvis) to overcome W, the weight of the body, and raise by the axis of motion, F, the hip-joint. The hip-joint, therefore, is a lever of the first kind, since the arrangement is power, fulcrum, and weight (P, F, W).

FIG. 4.



Hip.

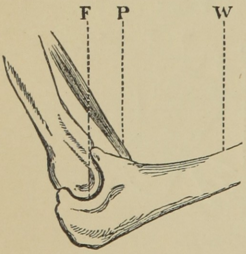
FIG. 5.



Jaw.

In *opening* the mouth (Fig. 5) we have a lever of the second kind, the small muscle, P, being the power that depresses the lower jaw, the weight being the tension of the strong muscle, W, that keeps the mouth closed, and the fulcrum, F, the joint situated behind this muscle; consequently the arrangement in this case is power, weight, fulcrum (P, W, F). In the act of closing the mouth, the position of the power and weight is reversed, and we have a lever of the third kind, where the arrangement is weight, power, fulcrum (W, P, F). The elbow (Fig. 6) is another example of a lever of the third kind. It is to be observed that in the majority of instances the insertion of the muscle (the power), as is shown in Figs. 4 and 6, is near the fulcrum, so that the power-arm of the lever P F is shorter than the weight-arm, W F. This arrangement, though it diminishes the power, enables movements to be performed with greater velocity.

Fig. 6.



Elbow.

Muscles may be broadly divided into two divisions—those that bend, the limbs and trunk, the flexors; and those that extend them, the extensors. This action can be shown in the arm by bending the forearm, when it will be found that the large muscle, the biceps, in front of the arm, swells up into a firm hard mass, and on forcibly extending the forearm the swelling disappears and the muscle becomes elongated ; whilst at the same time it will be noticed that the muscle, triceps, at the back of the arm, has become fuller and harder. The biceps, therefore, is the flexor of the forearm, and the triceps the extensor.

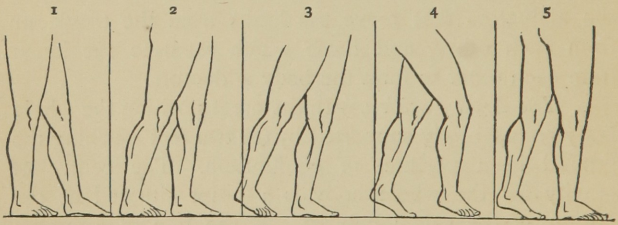
There are also other muscles which, though they may be accessory to the acts of flexion and extension, perform particular actions, as bringing the limbs closely against the trunk, or toward each other, *adductors;* as, for instance, the muscles that grip the saddle in riding, or the abductors that move the limbs from the trunk, or from each other, and those which separate the limbs from each other to form the body adductors.

9. *The Erect Position.*—In the erect position the whole body rests entirely supported by the two feet touching the ground in a position of equilibrium. The centre of gravity for the whole body is a point situated at the bottom of the spinal column. If the line of direction drawn perpendicular from the centre of gravity should fall within the basis of support, viz. between the two feet, the erect position can be maintained without much difficulty, the muscles only coming into use to supplement the somewhat unstable equilibrium. When the line drawn from the centre of gravity falls outside this basis, the tendency is for the body to fall. Up to a

certain point, however, strong muscular action overcomes this tendency.

10. *Walking.*—In walking the trunk is regularly and alternately supported by only one of the two legs; the active leg being dragged forward a certain distance, the length of the step, just sufficiently bent to avoid contact with the ground, while the passive leg acts as a support to the trunk. The various movements that occur in the performance of the act may be made intelligible by reference to Fig. 7.

FIG. 7.



(From Kirke's Physiology, by Morrant Baker.)

At the commencement, the person standing firmly with the left foot in advance, the first act consists in raising the heel of the right foot (2), which is accomplished by the powerful muscles of the calf. At the same time the weight of the body is transferred to the left side, and the trunk is bent slightly forward; it is evident that this inclination forwards will, if carried much further, cause the body to fall forwards, unless the right leg is put forward to support it (3).

This is effected by the brisk swinging of the right leg forward, just sufficiently bent to clear the ground, the toe being the last to leave, and the heel the first to touch the surface. Three sets of muscles are used in the performance of this movement,—viz. those in front of the thigh, which draw the thigh forwards; the hamstring muscles at the back of the thigh, which raise the leg; and muscles in the front part of the leg, on the outside of the shin, which raise the foot and the toes.

By the time the right foot has reached the surface, the heel of the left foot is raised, throwing the weight of the body over to the right side, causing an inclination of the body forwards, and the necessity of a speedy advance of the left leg.

The constant transference of the weight of the body alternately from one leg to another gives a swinging motion to the trunk, which can be well observed by standing behind a person walking away from one. This swaying is much more exaggerated in some persons than in others.

The rapidity of walking depends on the length of the step and the rapidity with which the legs are swung (oscillation). Now the length of the step is directly proportionate to the length of the limb, which is greater when the active leg is well extended, and less when the limb is bent or flexed; whilst the shorter the active leg (the pendulum), the greater the rapidity of oscillation. A pedestrian, therefore, who "walks from his hips," *i.e.* properly extends both thigh and leg, would have considerable advantage over an opponent possessing the same length of limb, but who "walked with his leg," *i.e.* unduly raised his heel and bent his leg in the act of raising it from the ground, as he would have to expend more muscular force in effecting more rapid oscillation of the limb to compensate for the shortening of stride.

In order to calculate the length of each step, and the period occupied by each oscillation, the length of the limb, the rate of walking, and the number of steps taken in a given time must be ascertained: thus a man the length of whose leg was thirty-four inches, walking at the rate of four miles an hour, took 2000 steps every 15 minutes; consequently the length of each step must have been 2·64 feet, and the time of each oscillation 0·45 second.

11. *Running and Leaping.*—In walking, there is an interval of time during which both feet rest on the floor, viz. the heel of the leg that has just finished, and the toe of the leg that is just beginning oscillation. This interval, in very

quick walking, almost entirely disappears.* In running there is an interval in the period of the step when both feet are off the ground; that is to say, one leg has commenced to swing forward before the other leg has finished its oscillation: consequently there is a brief period when the body is unsupported. In order to prevent its falling during the time it is in the air, a kind of jerk or short leap is given, which is effected by flexing the active leg at the commencement of the step and forcibly extending it.

In leaping, this powerful action of the extensor muscles is much more developed, whilst at the same time the heels are raised by the action of the muscles of the calf of the leg.

12. *Rowing.*—In the sitting posture the trunk rests on the two prominences of the buttocks (*tubera ischii*), on which it can swing backwards and forwards. In rowing the body is alternately brought forward, and back again to a position a little beyond the vertical line of the erect position.

Now, supposing the rowers to be sitting in the erect position, the first act is the swing forwards, which is performed chiefly by the action of two muscles attached to the lower part of the trunk (*psoas magnus* and *iliacus*), and inserted into the upper part of the thigh-bone. At the

* In pedestrian matches fair walking is always "toe and heel."

same moment the arms are fully extended, the upper arm chiefly by the *serratus magnus*—a large, broad, flat muscle, arising from the upper part of the back and side of the chest—and inserted into the blade-bone, which by drawing the shoulder forward gives addi ional reach to the arm. The forearm is extended by the *triceps*, the powerful muscle at the back of the arm. Whilst in this forward position, the extensor muscles on the fiont of the thigh and the muscles of the calf of the leg are relaxed.

The second act is the restoring the body to the erect position, or somewhat beyond the vertical line. This is effected by the *glutæi* muscles, the large muscles of the buttock which raise the trunk, and the hamstring muscles which draw the *tubera ischii* forwards and downwards. At the same time they are drawn back by the action of the *trapezius* and *latissimus dorsi* muscles. The first muscle arising from a line extending from the lowest point of the back of the head, from the ligament of the neck, and from the spines of the seventh and all the dorsal vertebræ, is inserted into the part of the shoulder; the other muscle arises from the upper part of the haunch bone, from six lower dorsal vertebræ and by slips from the three lower ribs, and is inserted into the upper part of the arm-bone. It is evident that the fixed point of attachment of these two muscles being chiefly at the spine, the contraction of their fibres will tend to draw back the shoulder and arm. Then in bringing the handle of the oar to the chest, the arms are bent by the action of the *biceps*, and the arms and elbows brought nearly to the side, chiefly by the action of the *pectoralis major*, the large muscle springing from the front and upper part of the chest, and inserted into the upper part of the arm; this movement is also aided by the action of the *latissimus dorsi*.

At the commencement of the recovery, the extensor muscles in front of the thigh and the muscles of the calf of the leg become powerfully contracted, and pressing the foot firmly against the "stretcher" enables the body to retain its position during the action of the glutæi. In addition to these essential movements other muscles are employed, as in the act of depressing the handle of the oar, and in turning the wrist in the motion of the hands forwards, by which a considerable number of muscles in the body are continuously brought into play.

From the foregoing account it will be gathered that the muscles chiefly concerned in rowing are in the order of importance: 1. Those of the hip, the glutæi; 2. Those of the thighs and legs, the extensors of the thigh, the hamstring muscles, and the muscles of the calf of the leg; 3. Those of the loins and the upper and back part of the chest, the latissimus dorsi, serratus magnus, and trapezius; 4. Those of the arm and forearm, the triceps, which extends, and the biceps, which flexes the one on the other, and the muscles of the forearm brought into action by the movement of the wrist in feathering, &c.; and, 5. the muscle in front of the chest (pectoralis major), which aids in bringing the arms and elbow against the side.*

13. *Varieties of Exercise.*—In walking, running, and rowing, most employment is given to the muscles of the lower limbs and trunk; consequently, if these be the sole kind of exercise taken, the muscles of the chest and upper extremity do not become proportionately developed. It is difficult indeed to find a natural variety of exercise that can be practised sufficiently frequently, which calls equally into play the muscles of the whole body, or that gives sufficient action to the muscles of the upper extremity, so as to counterbalance the excessive employment of the lower.

* In the admirable accounts of "muscular action in rowing," given respectively by Mr. MacLaren in his work on 'Training,' and by Mr. Skey, in the *Lancet*, Oct. 2, 1869, the former seems to estimate too highly the work done by the legs, and regard too little the work done by the muscles at the upper and back part of the chest, the serratus magnus and trapezius; whilst Mr. Skey assigns the part played by the muscles of the thigh and leg too low a position. Since the introduction of sliding seats the work thrown on the muscles of the thigh and leg has greatly increased, especially with regard to the hamstring muscles.

Undue stress has, however, been laid on this point, and on the necessity for giving greater employment to the muscles of the upper half of the body than is at present the case. The lower limbs are designed especially for power and strength, and the support of the weight of the body, whilst the upper are chiefly engaged in performing acts of precision and dexterity; great muscular development is therefore not required, for what they would gain in power, they would lose in dexterity. In our opinion, the natural varieties of exercise of cricket, football, and rowing for boys; hunting, shooting, &c., for men, pursued at the different seasons of the year, are quite sufficient for a proper development of all parts of the body, in accordance with the uses of the different limbs, for the development of special muscles; or, where a great variety of exercise cannot be procured, a system of gymnastics may be pursued. To the advocates for the adoption of systematic physical education by means of gymnasia at our schools, whilst we concede the immense value of such establishments in large towns, where outdoor exercise and field sports are difficult of attainment, or in cases where from physical debility the muscles have to be gradually developed, still we maintain that the national games played by the English schoolboy are infinitely superior to any system of artificial exercise ever devised. All that is really required is that the exercise should be sufficiently brisk, so as to bring the respiratory muscles into action.

In the following list is given the different kinds of exercise, arranged in accordance to the parts of the body chiefly employed in their performance; and here we would insist on the importance of using as great a variety of exercise as is attainable:—1. *Exercise that brings into nearly equal action all the muscles of the body*—swimming, boxing, fencing, climbing. 2. *Exercise that gives considerable employment to the upper as well as the lower extremity*—cricket, rackets, tennis, fives, golf, shooting, football, rowing. 3. *Exercise which is chiefly performed by the lower limbs and trunk, and in which the muscles of the upper extremity are auxiliary*—leaping, running, riding, walking.

14. *Physiological Effect of Exercise.*—Increased action of the *respiratory and circulatory* systems is the most important of the physiological effects produced by muscular exercise.

In man, as in all animals in which the muscular apparatus constitutes an important part of the frame, a powerful incentive to respiration is created by its activity, more *oxygen* being introduced into the system in order to burn the carbon elements of the food and tissues, from which their mechanical force is derived; whilst more *carbonic acid*, produced by this oxidation by burning, passes out of the body. Indeed, it has been shown by direct experiment, that muscles themselves have the power of absorbing oxygen and exhaling carbonic acid; and further, that the power of muscular contraction is diminished if measures are taken to prevent the carbonic acid from passing off.

Professor Parkes, in his work on Hygiene,* has given a concise table, showing the effect exercise has on the absorption of oxygen and the evolution of carbonic acid, which shows that on a "work day" 8½ ounces of oxygen were absorbed in excess of a "rest day." And that 13 ounces in excess of carbonic acid were evolved on the "work day," although the so-called "work day" included a period of rest, the work being done only during working hours, and was not excessive.

The increase that takes place in the quantity of air inspired under a variety of movements has been studied by Dr. E. Smith, who showed that, taking the lying position to represent unit, 1; then, in standing, the quantity of air inspired rose to 1·33; walking at the rate of one mile an hour, to 1·9; and at four miles an hour, to 5. Riding and trotting raised it to 4·05; and swimming to 4·33.

* 'Practical Hygiene.' By Ed. A. Parkes, M.D., F.R.S., late Professor of Military Hygiene in the Army Medical School, Netley. Fifth edition, by Prof. du Chaumont, Professor of Military Hygiene in Army Med. School, Netley. London: Churchill, 1878.

Accompanying this increased action of the breathing powers there is also an increase in the number of respirations, *i.e.* the number of alternate acts of expansion and contraction of the chest. These in a healthy adult average from fourteen to eighteen a minute, but with exercise they are enormously increased, so that they often, as in rowing at racing speed, exceed forty a minute. Now it has been shown that the more quickly the movements of respiration take place, the smaller is the proportionate quantity of carbonic acid contained in each volume of the expired air. Thus, if we take six respirations a minute, the quantity of carbonic acid is about 5·5 per cent.; with twelve respirations it is 4·2; with twenty-four, 3·3; with forty-eight, 2·9. Although the *proportionate* amount of carbonic acid exhaled out is thus decreased, yet the *absolute* quantity exhaled into the air in a given time is increased, owing to the larger quantity of air breathed in the time.

So long, therefore, as the power of maintaining strong and rapid respiratory action continues, sufficient oxygen is drawn into the body, and the carbonic acid is withdrawn with sufficient rapidity; but when this power fails, then the absorption of oxygen diminishes, and carbonic acid accumulates in the blood, producing "breathlessness."

This condition is produced by three agencies, viz., (*a*) interference with the passage of blood through the lungs, (*b*) the consequent accumulation of blood in the right side of the heart, which (*c*) results in the circulation of impure blood, *i.e.* laden with carbonic acid.

The interference with the passage of blood through the lungs, which is the proximate cause of the condition, is owing to the increased action of the heart, both in force and frequency; consequently the flow of blood to all parts of the body is augmented. Now, till the arteries accommodate themselves to the strain of the increased pressure thrown on them by the violent action of the heart during exercise, the blood does not pass freely through them; consequently there is a blockage, and the impure blood coming from the body is not sent on quickly enough to the lungs in order to be replenished, that is, have its carbonic acid replaced with oxygen. When exercise is taken regularly, the arteries soon learn to accommodate themselves to this strong action of the heart; and, consequently, we find in training a gradual improvement in the breathing power as this concordant action between the heart and blood-vessels becomes established.

Two important facts are to be remembered with regard to the physiological effect of exercise on the lungs and heart:—*First*, that exercise, by increasing the breathing power, rids us of carbonic acid, and purifies our blood. *Secondly*, by increasing the action of the heart, after a concordant action between it and the arteries has been established, it quickens the whole of the vital processes throughout the body—renewing the tissues and removing the products of their waste.

Nor must the fact be overlooked, that when unaccustomed exercise is undertaken after a long period of rest, a "blockage" occurs in the arteries, not only of those going to the lungs, but to the whole body; so when violent exercise is engaged in without due preparation, instead of a beneficial result accruing, much harm is done, which in some cases has been permanent. Instead of the vital actions being quickened and the processes of repair and removal stimulated, they are brought almost to a standstill by the "blockage" that occurs in the arteries, the blood accumulates in the chambers of the heart, and additional stress is thrown on it; if, as is often the case, the walls of this organ are weakened from a deficiency of previous exercise, or from advancing age, dilatation of the cavities ensues —a very serious form of heart disease. Caution is the more needed, as the transition from sedentary habits to arduous and exhausting labour is of frequent occurrence. Every year a number of middle-aged men, who for years or months have been engaged in the sedentary occupations of a profession, of literature, or of business, at the commencement of the autumn holiday start for the Continent or the Highlands, and suddenly undertake immense fatigue in the ascent of Alpine heights, or the no less laborious work of a day on the moors, without the least preparation. So also we see every Bank holiday crowds of young men starting off for some tremendous walk, or "bucket" up the river, utterly unprepared for the task they undertake. Is it to be wondered at that men return complaining that their holiday has done them no good; that instead of vigour, they complain of exhaustion; that their appetite fails them, their nights are sleepless, their limbs ache, and they are jaded and spiritless? It is the evils produced from this erratic athleticism that give rise to the formidable indictments that from time to time have been urged against vigorous exercise and the pursuit of manly sports, which, if properly managed and undertaken systematically, are really the foundation of really healthy life.

When exercise is properly conducted, the effect on the *digestive system* is very marked. The appetite is increased, and more food is taken in order to supply the force necessary for the maintenance of the mechanical force. This increase of appetite is especially noted when the exercise is taken in open air.

When exercise is undertaken, however, without due preparation, or the bodily powers are exhausted by fatigue, the power of being able to take food is diminished. This condition, if the exercise is continued, and the power of taking food remains impaired, is one of considerable danger, and the health is often greatly affected, the force of the heart being much reduced.

It is of great importance, moreover, when great fatigue has been undergone, to see that the bodily powers are thoroughly recruited by rest before an attempt is made to take food, otherwise there will be no inclination to take it, and if forced down it will not digest. An hour's rest with a cup of warm tea will do much towards restoring appetite in these cases. Indeed, it should be a rule in all cases that a period of rest should intervene between work and food.

With increased work the *muscles* gain within certain limits in size, become harder, and at the same time act more readily. Dr. Parkes* states that when a single muscle or group of muscles is exercised to too great extent, it will, after growing to a great size, commence to waste. This does not seem to be the case when all the muscles of the body are exercised, probably because when all the muscles of the body are alternately used no one muscle can be over-exercised. This fact is only another illustration of the important law that monotonous repetition of the same act, whether muscular or mental, is one of the most potent causes of fatigue.

* 'Practical Hygiene,' p. 413.

Exhaustion of muscles from overwork is due principally to want of supply of oxygen brought to them to burn the carbon elements which supply their force, and also from the accumulation of the products of their combustion. This condition of things is brought about, first by general fatigue acting on the nervous system and on the heart, so that the blood circulates less vigorously, and the process of renewal and removal becomes slacker and slacker. A muscle that has undergone exhaustion has its nutrition seriously impaired, and one day of overwork under the hands of an injudicious trainer will perhaps not be recovered from for days. Muscular exhaustion, or "acute local fatigue" as it has been called, manifests itself, not merely in loss of power, but often causes irregular painful muscular contractions, *cramp*, *tremor*, a peculiar quivering and jerking of certain muscles, and muscular *pain*, distinct from cramp and also readily distinguishable from other kinds of pain.

SECTION II.

THE EXERCISE SUITABLE FOR DIFFERENT AGES, SEX, AND PHYSICAL CONDITIONS.

15. *Exercise in Infancy and Childhood.*—"A child in health," says Sir W. Jenner, "delights in movements of

every kind. It joys to exercise every muscle. Strip a child of a few months old, and see how it throws its limbs in every direction; it will raise its head from the place on which it lies, coil itself round, and grasping a foot with both hands thrust it into its mouth as far as possible, as though the great object of its existence at that moment was to turn itself inside out."

These apparently purposeless movements are the natural exercise of the young child; and our aim and object should be to afford its limbs free play for the performance; to see that its little body is not too tightly swathed, and that the arms and legs are not weighed down with heavy cloaks or long clothes. The child should not be carried more than is absolutely necessary, but should be encouraged to roll about and play with its limbs as much as possible.

As the child gets older it will begin to attempt combined movements, at first crawling on "all fours," and then, supporting itself against some object, learn to advance its legs and endeavour to balance itself. At this period of life the upper extremity of the body is considerably more developed than the lower, and consequently the latter has to sustain a disproportionate amount of weight; it is therefore advisable that these first efforts should not be too prolonged.

By the time the child is three years old systematie exercise should be commenced, and a degree of activity should be imparted to it by encouraging the child to run with a ball, and later on with a hoop, when out for its walks. At this age a rocking-horse is a useful adjunct in the nursery, and a moderate use of it, if stirrups are discarded, gives great employment to the muscles of the back and the abdomen. Care should, however, be bestowed on the fitting of the saddle, which should not be too wide, else it may cause bowing of the thighs, nor too narrow, so that no great muscular exertion is required to grip with the knees. The same may be said when the rocking-horse is exchanged for the pony. If this point be attended to, and if riding be not the chief exercise taken, then the fear of its causing deformity of the lower limbs may be altogether dismissed.

From five to eleven the child may participate in any active game which does not throw great strain on the joints; thus football or premature attempts to learn rowing should be prohibited.

16. *Exercise in Boyhood and Youth.*—We have already stated our opinion (13) that no system of artificial exercises can replace the natural movements obtained by the pursuit of the usual English pastimes of cricket, rowing, football, &c., for healthy lads. Still, gymnastics are useful substitutes when, from ill-health or other circumstances, natural exercise is not attainable. It ought, however, to

be a recognised principle at our schools that gymnastics should never be allowed to curtail the hours of natural play. This caution is needed, as it is rather the fashion at the present-day to extol the German system of physical education in schools of a certain class. We frequently hear comparisons drawn between the upright carriage of the German youth and the slouch of the English schoolboy; but critics forget that the slouch is almost a traditional characteristic, and is no sign of languor, debility, or of slack muscles; for the majority of English schoolboys can prove themselves, when roused into exertion, "as lithe as cats and as hardy as badgers." Indeed, we believe in any contest requiring strength and endurance, the English schoolboy, weight for weight and age for age, would be more than a match for the continental youth trained on the artificial system.

Whilst for healthy boys, as we have said, no restriction need be placed on the kind of natural exercise taken in the way of games, still consideration ought to be paid to the amount; and this we are sure, in many schools, is in excess of what it should be. But a source of still greater mischief is the neglect of any classification of games at school, and allowing weak and strong to engage in them indiscriminately, to the detriment of the physical well-being of the more delicate.

The study of the effect physical education and training has on the development of youth is as yet very incomplete; and till frequent and systematic records are kept at all our large schools, noting the height, weight, rate of growth, chest increase, and general development of different parts of the body of each boy, and the influence certain games have in promoting development of certain parts, any dogmatism on this subject must be founded on conjecture. Still, however, attention has been recently drawn to the subject in two excellent papers contributed to the St. George's Hospital Reports of last year: one by Mr. Roberts, F.R.C.S., on 'The Physical Development and Proportions of the Human Body;' the other by Mr. Street, F.R.C.S., entitled 'Notes on the Development and Growth of Boys between Thirteen and Twenty Years of age.' Mr. Street has based his observations on the examination of 3,695 boys at ages ranging from thirteen to nineteen, during the last five years, with regard to height, weight, &c. Thus starting at thirteen years, the greatest number of boys examined were 55 inches high, which may be assumed to be the normal height for boys of this age. At fourteen, the majority of examinees indicated an increase of 1 inch in height during the year; whilst from fifteen to sixteen there was a marked growth to the extent of 3 inches, and from sixteen to seventeen a still greater increase, viz. 4 inches. The stature subsequently shows a slow increase, seventeen to eighteen giving 1 inch, and from eighteen to nineteen another inch; whilst from nineteen to twenty there is hardly any increase at all. Mr. Roberts' conclusions are similar, though it will be seen from the table on page 43, taken from his valuable paper, that the increase between thirteen and fourteen is not so small, nor the increase from fifteen to sixteen so great, as that noted by Mr. Street.* Still there is abundant evidence to show that development is most active from fifteen to seventeen, which, judging from Mr. Roberts' table, manifests itself most strongly by increase in weight. Thus it is evident that the period of a boy's life between sixteen and seventeen becomes one of great consequence to him; and if he be at such a season subjected to great strain upon his strength, his development must suffer, perhaps his future growth interfered with, or the foundation laid of constitutional disease.

From a consideration of these facts, incomplete as they as yet are, we cannot help regretting the extension of violent competitive exercise in the form of "athletic sports" to our schools. It is not merely the evil caused

* The differences between Mr. Roberts' and Mr. Street's observations, with respect to increase in height, may be due to the different class of society from which the boys were drawn. We believe that Mr. Street's observations were made on boys drawn chiefly from the artisan class, candidates for Post Office appointments.

TABLE I.—SHOWING THE AVERAGE PROPORTION AND GROWTH OF THE HUMAN BODY FROM BIRTH TO MATURITY.

Age last Birthday.	Average Proportions of the Body (males).			Annual Rate of Growth.			Ratio of Increase. Height=Unity.		
	Height. Inches.	Chest-girth. Inches.	Weight. lbs.	Height. Inches	Chest-girth. Inches.	Weight. lbs.	Height. Inch.	Chest-girth. Inches.	Weight. lbs.
Birth .	19·34	13·25	7·55	..	..	..	..	..	..
1 year	28·50	..	..	9·16	..	..	..	..	..
2 years	31·60	..	..	3·10	..	..	..	..	..
3 ,,	35·00	..	..	3·40	..	..	..	..	..
4 ,,	38·45	..	31·10	3·45	..	..	..	..	..
5 ,,	41·15	21·26	37·71	2·70	..	..	..	..	..
6 ,,	43·18	21·68	40·67	2·03	0·42	2·96	1	0·20	1·45
7 ,,	45·15	22·25	44·00	1·97	0·57	3·33	1	0·28	1·70
8 ,,	46·92	22·66	47·15	1·77	0·41	3·15	1	0·31	1·80
9 ,,	49·52	23·27	51·20	2·60	0·61	4·14	1	6·24	1·60
10 ,,	51·52	23·77	55·50	2·00	0·50	4·21	1	0·25	2·10
11 ,,	52·87	24·33	60·15	1·35	0·56	4·65	1	0·41	3·44
12 ,,	54·45	24·81	64·52	1·58	0·48	4·37	1	0·30	2·76
13 ,,	56·56	26·30	71·00	2·11	1·49	5·48	1	0·70	2·60
14 ,,	58·55	28·18	79·57	2·00	1·88	8·57	1	0·94	4·28
15 ,,	60·77	29·70	91·43	2·21	1·52	11·86	1	0·68	5·36
16 ,,	63·42	31·19	107·86	2·65	1·49	16·43	1	0·56	6·20
17 ,,	64·95	32·80	118·08	1·53	1·71	10·22	1	1·10	6·67
18 ,,	65·69	34·03	127·25	1·74	1·23	9·17	1	0·70	5·27
19 ,,	66·37	34·76	131·48	0·68	0·73	4·23	1	0·10	6·22
20 ,,	66·80	35·13	135·28	0·43	0·37	3·80	1	0·08	0·90
21 ,,	66·80	35·42	135·03	0·00	0·29	0·00	..	0·00	0·00
22 ,,	66·80	35·41	134·50	0·00	0·00	0·00	..	0·00	0·00
23 ,,	66·80	35·45	134·08	0·00	0·03	0·00	..	0·00	0·00
24 ,,	66·95	35·43	133·26	0·15	0·00	0·00	..	0·00	0·00
25 to 30	67·07	35·48	135·00	0·12	0·03	0·00	1	0·13	0·00
30 ,, 50	67·03	..	138·33	..	..	..	..	..	..

by the struggle of the day, but the strain of preparation carried on for weeks beforehand. Again, the boys are allowed to enter for far too many trials, whereby the mischief is greatly increased. A protest has been made by sportsmen who are not influenced by a spirit of mere gambling, against the training and racing of "two-year-olds," as having a tendency to produce subsequent unsoundness and general physical deterioration; so would we raise a protest against overwork of any kind, whether physical or mental, at this most active developmental period of human life. The age when such contests may be undertaken without risk is the period when the activity of growth becomes checked—the age, in fact, when most youths enter at the Universities, or begin to engage in the active duties of life. Till then we would urge that the ordinary school games afford quite sufficient exercise for the growing lad.

Before quitting this subject we would urge parents, before sending their boys to school, to have them carefully examined by the family medical attendant with reference to the condition of the heart and lungs, and to determine their freedom from any constitutional taint. If there should be any tendency to heart or lung disease, or should the existence of struma be suspected, it is evident that the boy should not engage in active games which would throw too much strain on weak organs.

It is in these instances that gymnasia prove useful, and give a delicate boy an opportunity for physical development that is not otherwise attainable. The establishment of "naturalist field clubs" at many of our public schools is a step in the right direction, by providing a motive for exercise to those who are debarred by health from joining in the more active pursuits of the playground.

17. *Exercise for Girls.*—In these days, when so many women are engaging in intellectual pursuits of a high character, and even are desirous of competing with men in the cares and anxieties of professional life, the question of their physical training ought to receive more attention than it has hitherto done. In this respect girls stand at a great disadvantage as compared with boys. Up to a certain age, say eight or nine, a girl mixes often on equal terms with her brother in his sports; indeed, not unfrequently excels him both in skill and spirit; but after that age healthy exercise is sacrificed to the bondage of genteel deportment.

The growing child is confined in stays, and her feet crippled with tight boots. Anything like vigorous muscular movements are thus rendered impossible, and the sole exercise is the torpid regulation walk. Owing to this want of functional activity of the muscular system, the muscles dwindle and waste, and the nutrition of the body becomes impaired. Many of the troubles women suffer from in later life are undoubtedly due to impaired muscular vigour, and much suffering would be spared if proper attention were paid in early life to their physical development by a course of systematic training. We do not mean that our daughters should emulate their brothers in the cricket-field, or that female athleticism should become the vogue. But we would point out to parents and the managers of schools the danger entailed by the present neglect of exercise, and indicate the games that could be most easily adopted. Thus fives, rackets, and lawn-tennis are games for which no great space is required; the latter game ought to be taught systematically, just as cricket is to boys at public schools. To play these games with safety, however, stays and tight boots must be altogether discarded. Swimming, too, ought to be taught at all girls' schools, not merely because of the protection it affords, but also from its being in itself an admirable exercise, bringing into play all the muscles of the body.

There are few exercises so useful for imparting a graceful carriage as rowing, and it should be taught wherever opportunity affords. The strength imparted by the development of the muscles of the back would do away with the necessity of the artificial support of stays. Riding, too, is an excellent exercise. It ought, however, to be used in moderation till growth has nearly ceased. The great difficulty, however, in providing suitable exercise for women is the expense necessarily attaching to its pursuit. It is impossible for ladies to practise in open playgrounds like men; and even in gymnasia, or places set apart for them, the question of social disparity prevents the general adoption. It might, however, be possible for a few schools in large towns to unite in maintaining a joint establishment for the systematic teaching of swimming, rowing, lawn-tennis, and a few special gymnastic exercises. This gymnasium might be open also to private families who might wish to send their girls who were being educated at home. Of course such institutions would have to be under the supervision of a responsible committee, or else the fate which has befallen skating rinks would speedily overtake them.

18. *Exercise for Adult Life.*—The sports of youth may, with the majority of men, be safely pursued up to the age of forty. At that age the period of middle life is entered upon, and changes begin to take place in the body which render it desirable that all exercise which throws great strain upon the heart and great vessels should be abandoned. Employments which require violent exertion for a short space of time should be exchanged for more prolonged and slower work. Thus

hunting, shooting, golf,* and fishing should replace rowing, football, and Alpine climbing.

Although violent exercise might be given up, still at no time during life is the necessity for exercise so imperative as between forty and fifty. It is generally at this period that in previously healthy men dyspeptic troubles begin to make their appearance. The toils, cares, and anxieties of life have commenced to tell on the vital power of the most robust. The circulation is not so vigorous, and as a consequence there is a tendency to passive congestion, especially in the organs of the abdominal viscera. The assimilation of food is not thoroughly performed, and there is a tendency toward "functional derangements," especially of the liver ; and a series of symptoms manifest themselves, of which the most common are :—

(1.) "A feeling of weight and fulness at the pit of the stomach and in the region of the liver, flatulent distension of the stomach and bowels, heartburn, and acid eructation.

(2.) "A feeling of oppression, and often of weariness and aching pains in the limbs. or of insurmountable sleepiness after meals.

* Golf may be considered as the king of games for the middle-aged. Londoners ought to congratulate themselves on the successful introduction of this game to their suburban commons.

(3.) "Troublesome spasmodic cough, with a secretion of viscid mucus from the back of the throat and nostrils.

(4.) "Restless disturbed sleep at nights, bad dreams, sometimes attacks of giddiness and dimness of sight, palpitation of the heart, and irregularity of the pulse."

Now generally these unpleasant, and, to most men, alarming symptoms, speedily disappear when muscular exercise in the open air is had recourse to. It is, indeed, a matter of common experience with most middle-aged men how beneficial is the effect of a single day's hunting or shooting in clearing their complexion, and in ridding them of dyspeptic symptoms which they had been long combating before.

If, however, exercise is not taken and these premonitory symptoms be disregarded, it is not long ere graver symptoms make their appearance in the form of gout, gravel, stone, and fatty degeneration.

The products resulting from the disintegration of the food and tissues are not "burnt up," owing to the deficient supply of oxygen introduced into the body, and these accumulate in excess in the blood and tissues and form the *materies morbi* of the diseases above enumerated; whilst the tissues themselves, clogged as it were by these products, are unable properly to fulfil their functions and undergo degenerative changes with extreme rapidity; so that if the individual does not actually succumb to effects of induced disease, his life is shortened by an early entrance on the period of old age and decay.

The plea offered by most men of middle age for not taking regular and systematic exercise is the want of time and opportunity. We believe this plea to be utterly groundless. A brisk walk of three quarters of an hour before the business of the day, and half an hour at the end of the day, with a good stretch on Sunday afternoons some distance out of town, would be sufficient in most cases; whilst this brief curtailment of business hours might be met by an earlier hour of rising and retiring to rest. The men who most frequently urge this plea of want of time seem to find no difficulty in spending an hour or two before dinner at their club, in whist, in billiards, or in the smoking-room; and when taxed with this, and urged to employ this portion of the day in a "constitutional" round the park, plead the sense of fatigue and weariness induced by the labours of the day, forgetting that this sense of weariness is only subjective and speedily disappears after a few minutes of brisk exercise. Nor can the want of opportunity for exercise be urged with consistency in London or other large towns where the Saturday half-holiday is so universally recognised, and where the facilities for getting into the country by means of the numerous suburban railways, in a reasonable time, are so abundant.

One caution, however, should be urged with respect to exercise taken at this period of life, viz. the inadvisability of passing at once from a state of comparative inactivity to arduous exertion. During active exercise the heart beats more vigorously (14), and more blood is consequently sent through the great vessels to the lungs and the body generally. When exercise is taken regularly, this strong action of the heart is met by a corresponding dilatation of the vessels, so that no blockage occurs to the onward flow of the blood; but when exercise is suddenly resumed after a period of prolonged rest, this concordant action between the heart and blood-vessels is diminished and requires time for its perfect re-establishment. Consequently, on the resumption of strong exercise, there is more or less strain thrown on the cavities of the heart and walls of the arteries owing to the resistance of the onward passage of the blood, till the concordant action is thoroughly re-established. In youth, the strain thrown upon the heart and great vessels when passing suddenly from a state of inactivity to arduous exertion is little felt, the concordant compensation generally taking place rapidly; but in middle-age, when degenerative changes have commenced to affect the structure of the heart and arteries, the danger is exceedingly great. The softened muscular wall of the heart, instead of overcoming the resistance offered to the onward flow of blood, yields slightly, and, its elasticity being impaired, does not recover itself. Every succeeding strain aggravates the mischief, till serious dilatation of the heart is the result; or the sudden strain thrown on one of the great vessels of the chest may cause a bulging in its walls, and lay the foundation of the formidable disease known as *aneurism.*

19. *Exercise in Old Age.*—After sixty years, the period of old age has fairly commenced for most men, and the necessity for vigorous exercise gradually declines. Indeed the change that occurs in the voluntary muscles and other organs of the body renders motion often extremely difficult, whilst the waning energies of the body ought to be carefully husbanded in order to maintain the calorific processes by which the body is kept warm, and the force requisite to carry on the functions of digestion, assimilation, and circulation. The muscles of voluntary motion steadily diminish in bulk, their fibres becoming less elastic and contractile, and responding less readily to stimuli, and less under the control of volition, whilst the tendons and the sheaths are often ossified; all these changes tending to embarrass the movements more and more till actual decrepitude is arrived at.

Although the necessity and desire for exercise thus gradually declines, still some measure of activity should be insisted on, else the period of decrepitude will be reached too soon. Every endeavour should be made to prevent the individual becoming bed-ridden. As long as the vital powers permit he should be dressed and moved into another room, and when the weather is sufficiently warm, gentle movement in a carriage or wheel-chair should be encouraged; and even when the period of actual decrepitude is reached and the exhaustion consequent on movement so great that removal from the bed becomes dangerous, a degree of functional activity may be imparted to the muscles by gentle friction, and even by the occasional stimulus of a mild galvanic current.

SECTION III.

TRAINING.

20. *Object of Training.*—Training is the art which aims at bringing the body into the most perfect condition of health, making muscular action more vigorous and enduring, and increasing the breathing power. To use the words of the late Dr. Parkes,* " Training is simply

* 'Manual of Hygiene.' By Prof. E. A. Parkes. Fifth edition. Edited by Prof. du Chaumont. Chap. XII., sect. 3, "Exercise and Training." London: Churchill, 1878.

another word for healthy and vigorous living." The objects of training are obtained by the employment of a regimen, or system of diet, regular and systematic exercise, and a scrupulous attention to matters of personal and general hygiene. These points will now be considered in detail.

I. Diet or Regimen in Training.

21. *Classification of Foods.*—It has been stated (5) that every action of the living body is attended by chemical changes in the composition of its tissues, and that in these chemical changes a quantity of force is liberated, which, either in the form of heat, maintains the temperature, or, as motion, endues it with activity. The work done by the body is derived by burning the elements of the food, which is continuously being introduced into the body for the renewal of its tissues in the oxygen taken in at each inspiration. Naturally, when more work is done by the animal machine, more fuel is required; the question, therefore, arises, in what manner this fuel can be best supplied, so that the greatest effective force-value can be obtained.

All foods may be divided into four great classes.

TABLE II.

Class.	Type.	Force-value* of 15 grains in dry state.	Composition.	Chief Constituents of Articles of Diet.
I. Albumens.	White of Egg.	13,851 foot-pounds.	$C_{72}H_{112}N_{18}O_{23}$.	Flesh (myosin). Bread (gluten). Cheese (casein).
II. Fats.	Butter.	27,716 foot-pounds.	$C_{57}H_{104}O_6$.	Fat of Meat. Milk. Butter.
III. Starches. Sugars.	Starch. Grape-sugar.	11,720 foot-pounds.	$C_6H_{10}O_5$	Potatoes, Sago. Honey, Cane-sugar. Grape-sugar in beer and wine.
IV. Inorganic constituents.	Water.	Not known.	H_2O.	Common Salt (chloride of sodium). Bone-earth (phosphate of lime) in milk, brcad, and meat. Alkaline Salts in meat and vegetables.

* What is understood by "force-value" the reader is referred to paragraph 7.

The *albuminous* constituents alone contain nitrogen; and as this element is found in every tissue of the body which manifests energy, the albuminates must be considered as the essential elements of the food. Nevertheless, taken alone, the albuminous constituents are highly uneconomical as foods: for it has been shown by experiment that a full-grown man requires about 4,000 grains of carbon and 300 grains of nitrogen daily to supply the wants of the body. Now the proportion of carbon to nitrogen in albumen is about 53 of the former to 15 of the latter. In order, therefore, to get 4,000 grains of carbon he must eat 7,500 grains of albumen; but 7,500 grains of albumen contain 1,100 grains of nitrogen, or four times more nitrogen than the body requires.

Thus, as Professor Huxley* well puts it, "A man confined to a purely albuminous diet must eat a prodigious quantity of it; this not only involves a great amount of physiological labour in comminuting the food, and a great expenditure of power and time in dissolving and absorbing it, but throws a great quantity of wholly profitless labour upon those organs (the kidneys), which have to get rid of the nitrogenous matter, of which three-fourths is superfluous." Moreover, the time occupied

* 'Lessons in Elementary Physiology.' By Thomas H. Huxley, F.R.S. Tenth edition. Macmillan & Co. 1876.

in the process of assimilation and digestion is much greater than with other articles of diet; so that the body, when fed on albuminous constituents, either entirely or out of due proportion, falls, as Professor Huxley well observes, " into the condition of the merchant who has abundant assets, but cannot get in his debts in time to meet his creditors."

The *fatty principles* of the food contain about 80 per cent. of carbon, comparing with 53 per cent. in albuminous matter, whilst starch contains 40 per cent. Now carbon is the essential element of fuel; it is therefore not surprising to find the oxidation of fat yields *double the force-value* of that given by the oxidation of an equal weight of either albumen or starch. Indeed, fat may be regarded as the storehouse of carbon, and one apparent advantage of its freedom from combination with other elements is that it is always ready for immediate service whenever the requirements of the system demand it. Fat also is essential to the growth and nutrition of the tissues; a larger proportion of fat being met with wherever cell-growth is going on rapidly. Men cannot live in good health without fat, and *when excessive bodily fatigue is undertaken a proportionate amount of fatty matter ought to be added to the dietary.*

The physiological action of the *starchy principles* of the food is less understood than in the two preceding groups.

In the body they are converted into sugar by a chemical change effected by the saliva in the mouth and the pancreatic juice in the intestine. A large proportion of the starchy and saccharine elements of food are undoubtedly converted into fat in the body; yet notwithstanding this, these elements do not seem capable of replacing fat as an article of food. Dr. Parkes * has well remarked, from a consideration of the diets used by all nations (except those, like the Esquimaux, who are under particular conditions of food), that in no case do we find, where it can be obtained, an admixture of starchy food with fat omitted. It is therefore probable, that besides the conversion of starchy and saccharine matter into fat in the body, these principles also play an important part, not yet understood, in promoting nutrition, and are, therefore, essential elements to every dietary.

The *Inorganic Constituents.*—Of the uses of water in the economy it is superfluous to speak. The physical properties of many tissues depend upon the water which is combined with them; whilst all the chemical processes going on in the body require the co-operation of water for their due performance, and the influence on nutrition and secretion is very marked. The mineral constituents of the food are most important—by imparting strength

* 'Manual of Hygiene,' p. 189.

and firmness to those textures which, like bone, cartilage and muscle, form the solid portion of the organism, and also in effecting chemical changes in the tissues and fluids. The most important of these are: (*a*) *chloride of sodium*, or common salt, which seems to exercise an important influence on the development and growth of the body; the instinctive craving for this article of diet shows how important it is to the economy, for animals deprived of the use of salt speedily fall into bad condition, and will travel miles to obtain it; and certain African tribes, in districts where salt is scarce, will even barter gold for an equal weight of this commodity. (*b*) *Phosphate of lime*, or bone-earth, is the chief constituent of our bones, but is absent from no tissue, and is always more abundant in young and growing tissues. (*c*) *Alkaline salts of soda and potash* are required to maintain the necessary degree of alkalinity of the blood; they are chiefly derived from our fresh vegetable food, and when this is withheld for a considerable time a disease known as scurvy is induced—a disease characterised by extreme muscular debility.

Accessory Articles of Diet.—These are tea, coffee, alcohol, &c.: these by their decomposition yield but little actual force; they have, however, considerable influence on nutrition, by preventing waste, &c.; physiologists therefore call them "force regulators." The part they play will be considered when we treat of the actual diet in training.

22. *Digestion of Food.*—Digestion is a process of *solution*, by which the insoluble materials of the food are broken up by the mechanical action of the teeth and muscles of the stomach and intestines, and rendered soluble by the action of the secretion of the glandular organs attached to the alimentary canal. Thus, the saliva of the mouth and the juice of the pancreas convert the starch of such food as potatoes, rice, sago, &c., into soluble sugar; the gastric juice attacks the meat, and converts its insoluble albumen into substances known as *peptones*, which have the power of passing (diffusing) through animal membranes. Fat, too, which we all know to be very insoluble in the presence of watery fluids, becomes readily soluble when acted on by the alkaline secretions of the liver (*bile*) and pancreas. In fact these alkaline secretions convert the fatty matter of the food into soap, just as the manufacturer, by boiling tallow with soda, forms that article.

During digestion a considerable expenditure of force takes place in the performance of the mechanical act of breaking down the food, and the furnishing the secretion concerned in the digestive process. It is important, therefore, to diminish the mechanical labour by having the food properly *cooked*, and to see that the bodily powers are not exhausted by *fatigue*, and that no other *work* be undertaken till the active labour of digestion is completed. Lastly, as different glandular organs are set apart for the digestion of each particular class of food, it is obvious that digestion will be best performed by giving each organ its proper share of work, by a *judicious admixture of the various principles* of diet, so as not to overburden any one particular organ.

23. *Construction of Dietaries.*—We have stated (4) that the amount of work daily performed by an adult weighing 150 lbs., under ordinary conditions, is about 3,400 foot-tons; and we have also stated (21) that experiment has proved that a full-grown man requires about 4,000 grains of carbon and 300 grains of nitrogen daily to supply the wants of the body. In Table III., page 62, is a calculation of the amount of water, nitrogen, and carbon, and the energy developed by the burning in the body of one ounce of the chief articles of diet; from a consideration of which we shall be better able to arrive at the best arrangement of the various articles of diet, and the quantity of each that ought to be supplied in order to furnish the required force (3,400 foot-tons), and the 300 grains of nitrogen and 4,000 grains of carbon.

Now, supposing the staple articles of a dietary to consist of 1 lb. of lean (uncooked) meat, 24 oz. of bread, 1 oz. of butter, 12 oz. of potatoes, 1 oz. of sugar, and 3 oz. of

TABLE III.*—SHOWING THE AMOUNT OF WATER, NITROGEN, CARBON, AND THE ENERGY DERIVED FROM AN OUNCE OF THE FOLLOWING SUBSTANCES:—

Name of Substance.	Water.	Nitrogen	Carbon.	Energy.
	Grains.	Grains.	Grains.	Foot-tons.
Lean Beef . .	328	10	64	55
Poultry . . .	324	14	62	51
Bread (crumb) .	175	5	119	83
Oatmeal . . .	65	8	127	152
Potatoes . . .	324	1	49	38
Dried Bacon. .	65	6	273	291
Butter . . .	26	0·2	315	280
Milk	380	3	30	24
Egg {white . . / yolk . .}	321	9	71	{ 22 / 127
Sugar . . .	13	..	187	275

TABLE IV.*

Substance.	Quantity.	Nitrogen.	Carbon.	Energy.
	Oz.	Grains.	Grains.	Foot-tons.
Meat	16	160	1,024	880
Bread . . .	24	120	1,676	1,342
Butter . . .	1	0·2	315	280
Potatoes . . .	12	12	588	456
Sugar . . .	1	..	187	275
Milk	9	9	90	72
Total	63	301·2	3,880	3,305

* Constructed from Tables in Parkes' 'Practical Hygiene.'

milk—in fact, a fair instance of what is daily consumed by a healthy man doing a moderate amount of work.

In Table IV. the amount of nitrogen is almost exactly supplied, whilst the carbon falls short of the requisite 4,000 grains by 120 grains, and the energy by about 100 foot-tons. It is obvious that, if half an ounce of butter or bacon were added to this dietary, the deficiency in carbon and energy would be made up without adding to the nitrogen.

24. *Diet for Laborious Work.*—The preceding table represents the diet necessary for a healthy man doing moderate work. When, however, the amount of exercise is greatly increased, more food is required in order to supply the requisite amount of force that the additional labour demands, as well as to repair the waste of the tissues consequent on increased action of respiration and circulation which additional muscular effort evokes.

In convict prisons, men on hard labour receive 255 grains of nitrogen and 5,289 grains of carbon; on this diet they lose weight, and have to be continuously shifted from heavy to lighter work. In the case of military prisoners at hard labour, 282 grains of nitrogen and 5,373 grains of carbon are not sufficient to prevent men losing weight; but with 300 grains of nitrogen, and about 5,300 grains of carbon, the weight is stationary. The old trainers increased the supply of food entirely in one direction, viz. the albuminous constituents: thus Dr. Lyon Playfair ('Food of Man in Relation to his Useful Work') gives the diet of the prize-fighter as containing 690 grains of nitrogen and 4,366 grains of carbon—a wasteful and, as we have seen (21), comparatively ineffective diet.

Talking of the work done on an average by University crews, and the lesser amount performed by crews of College eights, as fair instances of severe and moderate training respectively, we should say, in the former case, 450 grains of nitrogen and 5,300 grains of carbon, and in the latter, 380 grains of nitrogen and 4,600 grains of carbon would amply meet all the requirements of the body. As a rule, we may state that at present the dietaries of College crews are in excess of the work done, and a member of a "torpid," or a second or third division boat, thinks it his duty to copy—certainly in matters of diet—the University oarsman, who probably does twice the amount of work. Of course no single standard will meet all cases, as individual conditions, as size,* digestive powers, &c., have to be taken into consideration. The following tables, however, will form a useful guide to trainers as to the relative quantities of the staple articles of diet that should be given daily.

* Average weight of University crews may be taken as ranging between 11 and 12 stone; of College crews, from 10 to 11 stone.

TABLE V.—STAPLE ARTICLES OF DIET IN

Substance.	Severe Training. Quantity.	Nitrogen.	Carbon.	Moderate Training. Quantity.	Nitrogen.	Carbon.
	Oz.	Grains.	Grains.	Oz.	Grains.	Grains.
Meat and Poultry*	24	240	1,526	20	200	1,280
Bread . .	24	120	1,676	24	120	1,676
Butter . .	1½	0·3	450	1½	·3	450
Potatoes .	8	8	392	8	8	392
Sugar . .	1	..	187	1	..	187
Milk . .	4	12	120	3	9	90
Oatmeal .	2	6	250	2	6	250
Eggs . .	6	57	426	4	34	284
Total .	70½	443·3	5,027	63½	377·3	4,609

The *meat* should be of the best quality, and should be thoroughly cooked. Underdone or overdone meat is indigestible. It should be either broiled or roasted. When the latter, care should be taken to keep the juices of the meat from running out. This is effected as follows : Plunge the joint for ten minutes into boiling water. This hardens the outer surface of the joint, forming a slight outside core that keeps the gravy inside ; then place the joint

* Weighed raw and free from bone. About 1·8 oz. should be deducted from every 12 oz. of meat in deducting weight of bone in legs of mutton, sirloins of beef, and mutton chops.

opposite a good clear fire, not too near, and roast slowly for three hours and a half; then, for the last half-hour, bring the joint quite close, so as to brown the outside. This is known as the *slow* process of cooking, and few cooks will adopt it, because it deprives them of a large quantity of dripping, one of their perquisites. Meat done by the *slow* process is quite red when cut into, from the contained gravy, but is not raw, as is shown by the meat losing the red colour when cold, the gravy having drained out by the cut surfaces.

As the flesh of fowl contains nearly as much nitrogen and carbon as an equal weight of meat, and has nearly the same force-value, it is useful as a change of diet. Plain broiled chicken is a good breakfast dish, and roast fowl might replace beef and mutton for dinner at least twice in the week.

The weight of *bread* is taken as baker's weight, *i.e.* when new. It should, however, be a day old before it is used. The quantity given in the above tables is in excess of that usually allowed. It is strange how the prejudice which some trainers entertain for this article of diet, has arisen. It is eminently nutritious and digestible, and men do not tire of it.

Butter, too, is another article against which a prejudice exists. We have seen (21) how essential fatty principles of the food are to nutrition, and the enormous amount of force yielded by its combustion. Where fat is well digested, it may be *freely* given, even in excess of that stated in the above tables, which only represents the ordinary " commons," or " sizing " for butter at Oxford or Cambridge. In addition to this allowance of fatty matter, men who can digest it should be encouraged to eat the fat served with chops, steaks, and joints, and not to reject it, as is too commonly the case. When fat is not well digested, an additional quantity of *oatmeal* should be used, as porridge, made with *milk*.

Potatoes contain (Table IV.) a very large proportion of water, and consequently very little nutriment in a large bulk ; they cannot be omitted from a dietary, because they supply vegetable salts which are required to keep the body in health; and as the potato is particularly rich in these, they are most economically administered in this article of diet. The potato, too, is very rich in starch, which is converted into sugar by the saliva and the pancreatic juice. If, however, a large quantity of potato is taken, some of the starch may escape conversion, and then it will decompose in the intestines and cause flatulence, " internal fat." We have known trainers who would not allow a crew to touch bread, except in the form of toast or crust, permit an almost unrestricted use of potato !

Sugar is required for sweetening tea and jellies, and light puddings; it should not *per se* be used as an article of diet by adults, as it is liable to give rise to acidity, dyspepsia, heartburn, &c.

Eggs are very useful and convenient articles of diet. An egg weighs about two ounces. The best way of cooking is "poaching." One egg a day, at least, is to be used in making light farinaceous puddings.

Other *vegetable food* beside potatoes are not mentioned in the diet tables, as having little nutritive value. Their chief use is to "purify" the blood by the supplying the alkaline salts. The best are watercress, beetroot, tomatoes, spinach, broccoli, cauliflower, baked apples, and stewed pears.

As yet no consideration has been paid to the important question of the amount of fluid that should be taken in training. In ordinary conditions a healthy adult requires about 70 ounces ($3\frac{1}{2}$ pints) of water for nutrition, about 20 ounces (1 pint) of which is introduced into the body with the food combined in the meat, bread, &c. (Table III.). The remainder is taken as liquid. In training there is an increased elimination of water by the skin and lungs; consequently there is an increased demand for it in the system.

The amount, therefore, required in training may be placed at 100 ounces (5 pints) in winter, and 120 ounces (6 pints) in summer. Of this about $1\frac{3}{4}$ pint will be taken in combined with the food. In the old system of training, the amount of fluid was rigidly limited, and rarely exceeded three pints. The fallacy of such restriction has been thoroughly exposed by Mr. MacLaren,* and now more liberal views are held by trainers with respect to the amount of fluid drunk.

The two great points to remember are that fluid should not be drunk shortly before taking exercise, nor large quantities during or immediately after meals.

The following table gives the approximate quantity and best time for taking fluids:—

TABLE VI.

On rising	0½	pint of	cold water.
Breakfast	0¾	,,	weak tea.
Lunch or supper . .	1	,,	water or weak tea.
Dinner	1	,,	water or table ale.
Two hours after dinner	0½	,,	weak tea.
In porridge . . .	0½	,,	milk or water.
	4¼	pints.	

This, with the 1¾ pint contained in the articles of diet, meat, bread, &c., makes 6 pints, an ample allowance.

25. *Accessory articles of Diet.*—These are tea and

* 'Training in Theory and Practice.' By A. MacLaren. London: Macmillan, 1866.

alcohol. Their great duty is to prevent waste, and respectively to stimulate the nervous and circulatory systems.

Tea is a decided stimulator of the nervous system; perhaps, owing to the warmth of the infusion, there is increased action of the skin. Owing to its astringent qualities, it lessens the action of the bowels. Taken in large quantities, and in strong infusion, it is apt to cause dyspepsia and flatulence. In training it should be taken weak (two tea-spoonfuls of tea to a pint of boiling water). It should not be taken late at night, as it induces sleeplessness. A large breakfast cup of weak tea, taken fully two hours after a heavy meal, quickens digestion.

Alcohol.—Opinions are divided as to the dietetic value of alcohol. Certainly in the form of wine and spirits it is absolutely unnecessary for young *healthy* men. On this subject Dr. Parkes* says:—"A small quantity of alcohol does not seem to produce much effect, but more than two fluid ounces manifestly lessens the power of sustained and strong muscular work. In the case of a man on whom I experimented, four fluid ounces of brandy (= 1·8 fluid ounces of absolute alcohol) did not apparently affect labour, though I cannot affirm it did not do so; but 4 ounces more, given after four hours,

* 'Manual of Hygiene,' p. 381.

when there must have been some elimination, lessened muscular force; and a third 4 ounces, given four hours afterwards, entirely destroyed the power of work. The reason was twofold. There was, in the first place, *narcosis*, blunting of the nervous system. The will did not properly send its commands to the muscles, or the muscles did not respond to the will; and secondly, the action of the heart was too much increased, and induced palpitation and breathlessness, which put a stop to labour. The inferences were that *any amount* of alcohol, though it did not produce narcosis, would act injuriously by increasing unnecessarily the action of the heart, which labour alone had sufficiently augmented. I believe these experiments are in accord with common experience, which shows that men engaged in any hard labour, as iron-puddlers, glass-blowers, navvies on piece-work, and prize-fighters during training, do their work more easily without alcohol." We quite agree with these remarks, and we think the routine practice of giving two glasses of port wine or claret to men *in training after dinner* not only unnecessary, but in many cases positively injurious. This consideration does not apply to the use of light table ales, which contain only a very small quantity of alcohol (about three-quarters of an ounce to a pint). The men being accustomed to these would feel their withdrawal, whilst the quantity of alcohol in that diluted form is quite insignificant. The quantity of beer, however, should not exceed $1\frac{1}{2}$ pint daily, as, containing a considerable amount of sugar, it is apt to cause dyspepsia and flatulence if taken in large quantities. The use of wine should, in our opinion, be restricted to "training off," when men, from over-fatigue, lose their relish for food and begin to fall in weight. Then a glass of sherry, with an equal quantity of water, taken at the commencement of dinner, will have a wonderful restorative effect on the digestive powers.

2. Personal and General Hygiene.

26. *Rest.*—Our whole life, says Dr. Poore,* "consists in a series of vibrations, periods of tension alternating with periods of relaxation; and although the rapidity of these vibrations varies immensely, they are recognisable in all our acts, be they voluntary or involuntary." Thus, taking the heart, which is ceaselessly vibrating independently of our control, we find that each vibration (taking the rate of vibration at 72 to the minute), if divided into ten parts, gives four of these parts for *the systole,* vigorous contraction, hard labour; three are occupied by the

* 'Text-book of Electricity in Medicine and Surgery.' By G. Vivian Poore, M.D. London, F.R.C.P. London: Smith, Elder & Co. 1876.

diastole, the period of recoil, which, although hardly work, is an exercise of function; during the remaining three there is *absolute rest.*

Dr. Poore suggests that we may apply the lesson taught by the vibration of this organ, whose periods of active labour, functional exercise, and rest have been regulated for it, to the habits of our daily life. "If we divide," he says, "the day of twenty-four hours in ten equal parts, and give four of these to active work, three to functional exercises of other kinds, and three to sleep, we shall find that nine hours and a half work, seven and a quarter's relaxation, and seven and a quarter hours' sleep is what a normal man may, and as a rule does, perform without injury to himself."

This statement of what is the physiological requirement for sleep is in accordance with the practical experience of Mr. MacLaren,* who says:—"It must, I think, be viewed as one of the errors of training tactics that men are encouraged to take too much sleep; at any rate, to spend too much time in bed. What requirement can young men, in undergoing such bodily exertion as present training practice involves, have for ten or eleven hours' sleep? What need to spend nearly half their time in bed? In this, as in most things, some men will require more than others, but, speaking generally, seven

* 'Training in Theory and Practice,' p. 124.

hours will be found abundant at this time of life. To sustain the body in full vigour, if a man goes to bed at eleven o'clock he ought to be out of it at six."

In addition to the rest obtained during the period allotted for sleep, a measure of rest should be taken after exercise, so that fatigue induced by muscular exertion be fully recovered from before fresh work is undertaken by the body. A period of rest should certainly intervene between the strong exercise of the day and the principal meal. Yet how rarely is this allowed, and men hurry up from the boats or from a long walk and sit down at once to food, whilst the bodily powers are jaded and the digestive powers are depressed.

Every endeavour ought to be made to ensure perfect mental quietude whilst in a state of training. We know that horses in training are extremely susceptible of external influences; the change of stables, of water, or the absence of a stable companion, often causing a horse to train off. We can therefore understand the effect discouraging criticism has on a crew. Men who are anxious and worried will quickly fall out of condition, because these disturbing influences interfere with the processes by which the nutrition of the muscular and nervous systems are carried on. Under the old plan of training, every effort was made to keep the crew as quiet as possible, and in ignorance of the progress they were making, and the time of the trials was only known to the "captain" and the "coach," a little extra praise from the latter being the only encouragement received. The advantage of this plan is obvious; it kept a crew from becoming careless, from counting too much on fast trials, whilst it prevented the demoralization that bad performances always entail.

27. *Bathing.*—The habit of daily bathing in cold water is now so generally adopted that we need say nothing to recommend the practice to healthy men. The best time for the cold bath is undoubtedly on first rising, when its influence on the nervous and circulatory systems is most powerful. It is a question whether it may be repeated during the day—after exercise. Considering the powerful physiological action of the bath, we doubt whether a second complete immersion is advisable at a time when the bodily powers are depressed; and we think a rub down with a cold, wet sponge quite sufficient. The cold bath ought always to be followed by vigorous rubbing with a dry towel, to promote reaction, and to remove scales of dead skin and the products of its secretion, which by clogging the pores prevents its free action.

The occasional use of the warm bath, with plenty of soap, is advised, in order the more thoroughly to remove the accumulation of secretions at the mouth of the sweat ducts or pores. The best time for the warm bath is the last thing at night.

28. *Sweating.*—With the impression that accumulation of fat could be speedily removed by sweating, the old trainers used to promote vigorous action of the skin and induce profuse perspirations. Such unnatural excitement of the skin could not, however, last long, and the endeavour to force it only led to the function being gradually weakened. The practice was founded on physiological error; for accumulations of fat only occur in the body in health when the *gain* to the body is in excess of the *waste.* And it can only be removed by burning it off, by increasing the oxidizing action going on within the body. The products of this burning are carbonic acid and water; of which nine parts of the former pass off by the lungs, and one part only is eliminated by the skin, whilst the kidneys, in the form of urine, carry off three times as much water as is removed in the form of sweat.

Now, when increased natural exercise is taken, all three channels—the skin, the lungs, and the kidneys—are proportionately engaged in getting rid of this effete carbonic acid and water. But when the skin is unduly stimulated, it is generally at the expense of the other two functions. A man who is taking exercise swathed in thick flannels has his breathing power embarrassed, and consequently does not get rid of so much carbonic acid by the lungs as he otherwise would; and as the skin only eliminates a very small quantity of carbonic acid, the increased activity of its function does not compensate for the diminished exhalation by the lungs. Again, the kidneys are the chief channel for the elimination of water, and any great withdrawal of this substance from them impairs their functional activity.* It frequently happens, however, that a man who has been leading a sedentary life for some time, and is generally out of condition, finds on first going into training that the skin does not possess its healthy activity, and that with increased exercise the skin remains dry and harsh. Instead, however, of resorting to violent measures, he will find that the warm bath, with plenty of soap, followed by the cold douche and vigorous "towelling," will do more towards restoring a natural skin action than any amount of sweating under blankets in a hot room, or exercise on a hot day with the traditional great coat.

29. *Bowels.*—Constipation is often a serious difficulty with men in training. The increased quantity of food,

* In health the great object is to give each organ its proper and proportionate share of work. In disease, however, the physician often seeks to relieve and rest a weak and disordered organ by stimulating those that are sound to increased activity, and thus do the duty of the enfeebled member.

and consequently the larger amount of undigested residue left in the intestinal canal, together with the drier nature of the food on the one hand, and the increased withdrawal of water from the system by the skin and kidneys on the other, seem to be the chief factors concerned in producing this condition.

The bowels not only should be open once a day, but care should be taken to see that the evacuation is complete; that is, that the whole fæcal matter has been got rid of. For the detention of the intestinal contents leads to serious discomfort, and interferes materially with digestion.

In the first place, the result of their decomposition gives rise to flatulence, or distension of the bowels with wind; and these, by pressing upwards, prevent the proper expansion of the lungs, and thus diminishes the breathing power. The "internal fat," the bugbear of trainers, is, in the majority of cases, nothing but this flatulent distension, "wind in the wrong place," and would easily be put right by the administration of half a tumbler of Friedrichshall or Pulna water. Secondly, the putrid products arising from decomposition are absorbed into the blood, giving rise to a great disturbance of health, and often induce great irritation of the mucous membrane of the bowel, and set up diarrhœa.

30. *Tobacco.*—Most trainers rigidly prohibit the use of

this article, and, where smoking has not become an inveterate habit, they are quite right. It diminishes the elimination of carbonic acid, and thus interferes with the respiratory power. It also checks the natural waste of the body. It is therefore of use when great fatigue is undergone, and the amount of food is limited. When, however, the supply of food is abundant, there is no need for it. When smoking, however, has become an inveterate habit, the struggle to give it up often produces great depression, and thus interferes materially with the process of training, and the trainer may feel disposed to break a wholesome rule, and allow it in great moderation. In selecting a crew, however, unless the smoker is an exceptionally good man, and his services indispensable, such indulgence should not be permitted; for, when the habit has become inveterate, there is generally considerable impairment of muscular and nervous energy, and also dyspeptic trouble.

31. "*Training off.*"—When a man becomes "stale," it is obvious that he has departed from that condition of "healthy and vigorous living" which it is the great object of training to promote. The causes of "training off" are various. It may be from over-work, over-anxiety, some derangement of digestion, ill-health arising from some external cause difficult to ascertain—a not infrequent one being a dose of sewage gas, or sewer-polluted water, taken inadvertently at some river-side training quarter. Or it

may be the result of a break-down of the constitution, some hitherto latent taint manifesting itself under the strain of unwonted pressure. The symptoms are generally apparent. The man begins to lose weight; has a dis-relish for food; feels languid after exercise, and does not recover his spirits or elasticity; does his work carelessly, is inattentive, and is restless and sleepless at nights. These are the less serious symptoms, which perhaps a little proper management and care may soon put right. If, however, it is associated with much distress during the actual performance of the daily work, and there is also some degree (however slight) of breathlessness, and an intermittent action of the heart, "training off" assumes a serious aspect. The proper course to pursue, in all cases when a man becomes "stale," is to consult a physician in order to determine the exact nature of the break-down. There can be no object in patching up a man who will fail when the pinch comes in the race itself; whilst if the staleness be due to any organic mischief, a continuance of work in any form would be highly injurious. And lastly, it would be unjust to turn off a good man who was merely suffering from temporary indisposition, which a timely rest and a little judicious advice about diet might speedily put right. A physician alone can decide on these points, and indicate the proper course to be pursued under the circumstances.

32. *General Hygiene.*—Under this head is included questions of drainage, ventilation,* water-supply, &c.; but as one of the series of "Health Primers" is devoted to the consideration of this important subject, we refer the reader to its pages.

3. Amount of Exercise.

33. *The daily work* that ought to be performed during a course of training will depend materially on the conditions of the race for which preparation is being made. Thus men preparing for College races of little more than a mile will not undergo the severe preparation that is requisite for a crew intending to compete over the University course of rather more than four miles and a half. In judging of the amount of work necessary to be accomplished attention must be given to two important elements,

* We would remark here, however, that the condition of the bedrooms at our Universities, with respect to ventilation, are disgraceful, being mostly small cupboards, averaging barely 250 feet in cubic capacity, without chimneys! The occupants, however, may do something towards remedying this unwholesome arrangement. As long as the two Universities entrust the sanitary management of the colleges and lodgings to *clergymen*, utterly untrained for such duties, it is too much to expect the authorities to see the necessity for or undertake the much-needed reform at their own expense.

muscular power and *breathing* power. For it is quite possible, as Mr. MacLaren* has pointed out, that a "man of good physical capacity may be trained so that the voluntary muscles of his arms and chest would be powerfully developed, with a contractile force proportionate to their size; and yet his respiratory power shall be so disproportionate that he could not run a hundred yards without gasping; and another, or the same individual, if possessing ordinary locomotive capacity and fair development, may be trained to run ten times the distance without distress, but the voluntary muscles of whose arms and chest shall remain as they stood at the time that the training began."

The tendency of modern athleticism has certainly been towards throwing greater stress on the respiratory powers, without a corresponding increase of muscular exertion. Indeed, as far as rowing is concerned, all the improvements in racing boats, the outrigger and the sliding-seat, have tended to diminish muscular effort and increase the rapidity of the stroke.

On this point Mr. MacMichael,† a distinguished Cambridge oarsman, bears most important testimony:—

* 'Training in Theory and Practice,' p. 36.

† 'The Oxford and Cambridge Boat Races.' By W. F. MacMichael, B.A., late Secretary of the Cambridge University Boat Club. 1870.

"What strikes me most forcibly, in reading the accounts of what University crews used to do in former days, is the much greater amount of hard work they did than we do now." Mr. MacLaren's evidence on this point is also very decisive:—"The exercise in rowing a College race (a short mile) is barely sufficient to keep a healthy man well; it is not sufficient to keep up the condition of a strong one. The best men fall off when racing, or the exclusive training exercise for the racing, begins; under it powerful men dwindle: and this not from 'training down,' as the phrase goes, for the reduction is not in weight only, but in girth and tension and contractility of muscle, and in the stamina which gives endurance of fatigue."

Taking rowing, then, as the typical exercise on which our remarks on training have been founded, let us consider the amount of work, *muscular* and *respiratory*, that ought to be accomplished in order to develop both powers to the fullest extent.

34. *Muscular Work.*—We have seen (4) that, from calculations made by different observers, the amount of force daily expended by an adult weighing 150 lbs. in the performance of the internal, calorific, and external mechanical work of the body, has been estimated at about 3,400 foot-tons, or, in other words, in the expenditure of force requisite to lift 3,400 tons one foot high.

Of these 3,400 foot-tons, about 300 are expended in the ordinary external mechanical work of the body, *muscular work.* And we also saw that estimates had been made of the amount of work a man weighing 150 lbs. could accomplish in a given time with different kinds of exercise, thus:—

	Foot-tons.	Authority.
Rowing one mile at racing speed	= 18·56	MacLaren.
Walking one mile	= 17·67	Parkes.

From these data it is easy to arrive at an approximate idea of the amount of work actually performed by men in training on any given day. Mr. MacLaren tells us that at Oxford the training practice, allowing for the difference of some Colleges when a short run is preferred to the morning walk, is as follows:—

Walking.*—One mile, averaging four miles an hour	= 15 minutes.
Rowing.—Twice over the course and back, part of the distance at racing speed, part at two-thirds speed, and part at half speed. Whole distance, say five miles at one mile in nine minutes	= 45 ,,
	60 ,,

* Mr. MacLaren, 'Training in Theory and Practice,' p. 55.

The period of training lasts about three weeks; once or twice during this period the crew are taken for a long row (seven miles) to Nuneham.

At Cambridge the plan is very similar, only the course being further away from home than is the case at Oxford, the distance rowed each day is slightly longer—the distance being from Jesus Sluice (near the boat-houses) to Bait's-bite, 3 miles 3 furlongs 22 yards. As the boats do not start actually from Jesus Sluice, nor row quite to Bait's-bite lock, allowance must be made at each end; so that probably, allowing for the different turning-points adopted by the various Colleges, the average daily row at Cambridge may be considered as six miles. Their time per mile, however, is rather slower than it is at Oxford, owing to the narrowness of the river, causing repeated "easies" on the journey down to the locks. Of the six miles, one-fourth of the course is rowed at racing speed, the remainder at three-quarter speed and paddling.

In these calculations, no allowance has been made for the exertion taken in the ordinary business of the day—the walking to the boats, to and from College class-rooms, general "loafing," &c. This kind of work may be safely estimated as not likely to exceed four miles a day.

Thus we have, then, five miles' pedestrian exercise, and six miles' rowing, as the external mechanical work done on an average by men in training for College races.

		Foot-tons.
Five miles' walking (17·67 × 5)	=	88·35
Six miles' rowing (18·56 × 6)	=	111·36
		199·71

This amount of 199·71 foot-tons unfavourably compares with the 300 foot-tons, the average work of a strong healthy man, engaged in ordinary manual labour, and is little above the minimum allowance of 150 foot-tons which Professor Parkes considers that every healthy man ought to take in some way as exercise every day.*

* Professor du Chaumont, of Netley, has given some interesting particulars of the work done in India by natives. (1) Thus a hill coolie will go thirty miles, with an ascent of 5,500 feet, in three days, carrying 80 lb. weight, the weight carried on a frame supported on the loins and sacrum, and aided by a band passed round the forehead —*work per diem*, 500 *tons lifted* 1 *foot.* (2) Eight palanquin-bearers carried an officer weighing 180 lb., and the palanquin weighing 250 lb., twenty-five miles in Lower Bengal; assuming each man weighed 150 lb., the work was 600 foot-tons. Lastly, the work done by the sledge parties in the Arctic Expedition of 1875–6 has been calculated by Professor du Chaumont, as for the northern party (Markham's), at a daily mean of 574 foot-tons per man, with a maximum of 859! The western party (Aldrich's) did a mean of 443, and a maximum of over 600. Even this large amount was considered an under-estimate by the commander.

Certainly, as far as *muscular work* is concerned, members of College crews are not overtaxed.*

35. *Respiratory work, or Breathing Power.*—The act of breathing consists of the alternate expansion and contraction of the walls of the chest, by which air is alternately drawn into and expelled from its interior. This action is carried on by two forces: (*a*) the elasticity of the lungs themselves; (*b*) by the exercise of certain muscles, the *intercostals* and the *diaphragm.*† *Inspiration* is effected by enlarging the chest in all its diameters. Thus, the diaphragm by its contraction enlarges it in its vertical diameter, or depth, whilst the action of the *external intercostals*, by raising the ribs, enlarges it in width. In extraordinary or forced inspiration, as in violent exercise, other muscles are called into service, the chief of which are the serratus magnus, pectorales, and trapezius muscles, which we have seen (12) are also employed in drawing the arms forwards and backwards from the trunk. *Expiration.*—The enlargement produced by in-

* 'Manual of Hygiene,' pp. 420–422.

† The *intercostals* are the muscles between each rib—the external and internal. In the former the fibres run obliquely downwards and *forwards*, and draw the ribs up. In the latter the fibres are downwards and backwards, and draw the ribs down. The *diaphragm* is a large flat muscle, which serves as the partition between the chest and abdomen. When it contracts, it pushes down the abdominal viscera, and thus enlarges the chest cavity.

spiration is recovered from by the elastic recoil of the lungs, and little or no muscular power is required when the breathing is quiet; but when hurried and forced, the internal intercostals, by pulling down the ribs, aid the lungs by diminishing the cavity of the chest.*

The quantity of air changed in the lungs in each act of ordinary breathing is, in healthy adults, about 30 to 35 cubic inches. The number of respirations such a man would make in a minute ranges from 14 to 18. In health the proportion of breathing to the rapidity of the pulse is as 1 to 4; the respiration being 18, the pulse, under normal circumstances, will be 72 per minute. According to Dr. Haughton, the work done by the respiratory muscles, under ordinary circumstances, in the twenty-four hours amounts to 21 foot-tons.

* The following table, drawn up by Mr. Hutchinson, shows the relative power of the inspiratory and expiratory muscles in ordinary and extraordinary respiration :—

Power of Inspiratory Muscles.		Power of Expiratory Muscles.
1·5	Weak breathing	2·0
2·0	Ordinary	2·5
2·5	Strong	3·5
3·5	Very strong	4·5
4·5	Remarkable	5·8
5·5	Very remarkable	7·0
6·0	Extraordinary	8·5
7·0	Very extraordinary	10·0

(Kirke's 'Physiology,' by Morrant Baker.)

With vigorous exercise there is increased activity of the respiratory process. The number of respirations is greatly increased, at the same time the heart's action becomes more frequent. In rowing, for instance, at a stroke of 37 per minute, the respirations will be increased from 18 to 35 or 40, and the pulse from 72 to 110 or 120 a minute. At the same time the quantity of carbonic acid discharged from the lungs is greatly augmented (14).

Now, it is very evident that such important organs cannot pass from a condition of comparative quietude to such intense rapidity of action without having an immense strain thrown on them. And this is what really does occur in training. Nearly all the distress experienced by men after a severe race, or in the earlier periods of training, when undertaking quick work before the concordant action between the heart and the blood-vessels, is due to the embarrassment of the lungs, and not to muscular fatigue. As we have seen (34), the work done by the muscles during an ordinary race is anything but severe; while the effect on the circulation and respiration, as evidenced by the gasping, shallow respiration, and rapid, irregular pulse that follows violent and injudicious exertions before the body is properly accustomed, is enormous. These facts lead us to the following conclusions, which may be thus briefly summarised :—

(*a*) That the chief object of the work in training is to establish a *reciprocal action* between the heart and lungs, so that the increased supply of blood sent to the lungs by the heart may pass through them freely; that there should be no blockage, and consequently no strain.*

(*b*) This *reciprocal action* will be best attained by *gradually* increasing the respiratory work, otherwise the immediate effect of fast exercise being to cause augmented action of the heart, the increased amount of blood sent to the lungs will cause embarrassment to the respiration, a checking of the flow of blood through them. This causes more violent breathing efforts, which may lead to expansion of the air-vesicles of the lungs (emphysema), or dilatation of the heart.

(*c*) The action of the lungs and circulation should be carefully watched during training. If the breathing becomes laborious, especially sighing, and the pulse exceeds 120–130 and becomes irregular, the training should not be persisted in. If trainers paid a little more attention to these points, failures at a late period of training would not be so frequent, inefficient men being eliminated at an early period.

36. *Fatigue.* Our observations on *muscular* and *respiratory* work would not be complete without some reference to the condition known as fatigue; the more

* All races, such as "scratch pairs," rowed by untrained persons, are for this reason positively dangerous, and ought to be discouraged.

so as this condition has recently received considerable attention from physicians, and the existence of a number of distinct affections known as "fatigue diseases" are now recognised. For this purpose we cannot do better than summarise the excellent description given by Dr. Poore,* who has thoroughly studied this subject. Work, he says, results in fatigue, and fatigue is a regular and constantly recurring symptom experienced by us all. As our life consists of a series of vibrations—periods of tension alternating with periods of relaxation—therefore periods of functional activity invariably alternate with periods of repose, during which the waste caused by the exercise of function is repaired. Fatigue occurs directly we attempt to alter the rhythm of our vital vibrations by prolonging the periods of tension at the expense of the period of relaxation. Fatigue may be local or general, and both forms may be either acute or chronic.

Local fatigue is caused sooner by prolonged and sustained muscular effort than by repetitions of short muscular contraction having due intervals of relaxation between them. Thus we find it difficult to hold a weight at arm's length, or standing in one position more tiring than moving the same weight frequently, or by the alter-

* 'A Text-book of Electricity in Medicine and Surgery.' By G. Vivian Poore, M.D. London, Assistant Physician University College. London, 1878.

nate action of the limbs in walking. The symptoms of local fatigue are a *loss of power*, the irritability of the muscular tissue becomes exhausted, the force of its contraction is lessened.

Tremor is another symptom of muscular exhaustion, and is generally noticeable after an unwonted muscular effort. It is characterised by a peculiar jerking of the muscles throughout the body, which gives uncertainty to all muscular movements. The effect of *cramp* as the result of fatigue is familiar to most of us. It may come on during actual exercise, or some hours after.

The symptoms of general fatigue are mostly those of nervous exhaustion, and consequently we find there is a disability for performing either mental or physical work, especially that requiring sustained effort or attention.

The acute forms of local or general fatigue are usually recovered from without leaving traces of injurious effect behind them. When, however, fatigue is frequently induced, it is a common cause of many of those chronic maladies which are characterised by irregular muscular action. But it must not be forgotten that fatigue, in all its forms, is *preceded by impaired nutrition*, and this impairment of nutrition has to be recovered from before functional activity can be restored to its pristine vigour. Trainers should therefore be careful to avoid *fatiguing* the men under their care, for one day of overwork has probably to be followed by days of rest or of inefficient work. Recognising also the fact that monotonous repetition of the same act is one of the most potent causes of fatigue, trainers should endeavour to get the greatest amount of work out of their men by a constant variety of exercise.

37. *General Conclusions.*—We have now passed in review the means by which the trainer brings the body into the most perfect condition of health, making muscular action more vigorous and enduring, increasing at the same time the breathing power. We will now endeavour to systematize our remarks by drawing a plan on which a day's training should be conducted.

Rise about 6·30 A.M. in summer, and at 7 A.M. in winter.

The Bath.—Immediately on rising use the cold bath. This in summer is best in the form of a douche or shower. In the winter the sponge is sufficient. When the weather is very cold, the water should be placed in the bath overnight, so that the temperature is not exactly ice cold.

Morning Exercise.—At 7 A.M. in summer, and 7·30 in winter, start for a brisk walk of two miles, with occasional quick runs, which may be lengthened as the "breathing power" becomes developed.

Breakfast.—At 8 o'clock breakfast, which should consist of a chop or steak ($\frac{1}{2}$ lb.) broiled, a poached egg, a couple of cups of weak tea, or, if preferred, cocoa made from nibs, with plenty of milk; stale bread (brown recommended, if troubled with constipation) and watercresses. Broiled fish or chicken may occasionally be substituted for meat as a change, when men are beginning to weary of an exclusively flesh diet.

After Breakfast.—Generally, from 9 to 12, men are engaged in their ordinary pursuits. From 12 to 1, however, if the time can be spared, may be profitably spent in the gymnasium. We have already seen (34) that certainly, as far as *muscular work* is concerned, members of College crews are not overtaxed. Besides, as the chief work they do is thrown on the trunk and lower limbs, it is advisable to bring into play other groups of muscles; for by so doing one of the most potent causes of fatigue, the monotonous repetition of the same act, is avoided, and the trainer is able to get a greater amount of work from his men by thus varying the exercise. Nor should Dr. Parkes' statement—(14), that when a single muscle, or *group of muscles*, is exercised to too great extent, these, after growing to a great size, commence to waste; this does not seem to be the case *when all the muscles are exercised*—be forgotten. The exercises of the gymnasium bring into action muscles that are little used in rowing and walking, and thus fulfil the condition indicated by

Dr. Parkes, for maintaining a healthy state of the muscles that are called into severe action. Where the use of the gymnasium is not possible, boxing and fencing will be found useful substitutes.

Lunch.—This meal should be taken quite an hour and a half before going to the boat, and should be as light as possible. Bread and butter, with cold chicken, or cold roast meat; a glass of light bitter ale, or, better still, cold spring water.

Afternoon Exercise.—At 2·30 say the active exercise of the day is commenced. This for College races usually consists in rowing about one mile at full speed, three miles at three-quarter speed, and one and a half mile at half-speed. Long distance rows at three-quarter speed should be adopted twice a week; on those days the course would not be rowed at full speed. The time spent on the river should not exceed, when the course is rowed, more than one hour and twenty minutes; when the long journey is made, about two hours and a quarter should be allowed. If more time is required, the crew should start earlier, so as to return at least an hour and a half before dinner. After the row the men should have a rub down with a wet sponge, followed by a good "towelling," and walk *quietly* back to their rooms and rest till the dinner hour.

Dinner.—Usually at six o'clock. Meat, slowly roasted and full of gravy, either beef or mutton. Roast fowls twice in the week advisable, as a change; and boiled fish (soles, cod, haddock, turbot, whiting) may be added, if any of the men fall off in appetite, or suffer from constipation and boils. Plenty of green food, in the shape of spinach, turnip-tops, asparagus, broccoli, young green cabbage, French beans; beet-root or tomato excellent. Potatoes limited to one of fair size, mealy, and thoroughly cooked. Stale bread. Light farinaceous puddings, tapioca, sago, &c. Baked apples, stewed pears, rhubarb, prunes. Light table ale, one pint. No wine recommended; a glass of light claret, if desired, permitted.

Supper.—At 10 o'clock, one pint of oatmeal gruel.

Bed.—By 11 o'clock during the first period of training, and at 10·30 P.M., during the last week, all members of the crew should be actually in bed.*

C. H. R.

* These rules are subject to some modification, according as the training is carried out in the winter or summer months. In the former case the exercise is done in the afternoon before dinner; in the latter, in the evening and after dinner. In this case dinner is at half-past one and supper is taken at nine P.M., after the evening row, and should consist of cold meat, chicken, stale bread, water-cress, one pint of cold spring water or of weak tea, or a basin of oatmeal porridge.

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