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Lecture Notes
of Lectures on Organic
Chemistry by
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precede 13

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Inorganic

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Organic Chemistry

Table of the most important bodies capable of being formed from their elements without vital agency.

Cyanogen	$(C_2N) = Cy$.
Hydrocyanic acid	$Cy H$.
Ferrocyanide of	$Fe_2 Cy_6$
Potassium	$4K + 6HO$.
Ferricyanide of K.	$Fe_2 Cy_6 3K$.
Urea	$\left.\begin{matrix} NH_3 Cy O \\ HO \end{matrix}\right\}$
Marsh gas	$C_2 H_4$
Oxalic acid	$\left.\begin{matrix} C_2 O_3 HO \\ C_2 O_3 HO \end{matrix}\right\}$
Formic acid	$\left.\begin{matrix} C_2 HO_3 \\ HO \end{matrix}\right\}$
Chloroform	$C_2 HCl_3$
Acetic acid	$\left.\begin{matrix} C_4 H_3 O_3 \\ HO \end{matrix}\right\}$
Alcohol	$\left.\begin{matrix} C_4 H_5 O \\ HO \end{matrix}\right\}$

Ether	$\left.\begin{matrix} C_4H_5O \\ C_4H_5O \end{matrix}\right\}$
Olefiant gas	C_4H_4
Acetic ether	$\left.\begin{matrix} C_4H_5O \\ C_4H_3O_3 \end{matrix}\right\}$
Oil of garlic	$\left.\begin{matrix} C_6H_5S \\ C_6H_5S \end{matrix}\right\}$
Oil of mustard	$\left.\begin{matrix} C_6H_5S \\ Cy\,S \end{matrix}\right\}$
Glycerine	$C_6H_8O_6$
Butyric acid	$\left.\begin{matrix} C_8H_7O_3 \\ HO \end{matrix}\right\}$
Oil of pine apples	$\left.\begin{matrix} C_4H_5O \\ C_8H_7O_3 \end{matrix}\right\}$
Oil of pears	$\left.\begin{matrix} C_{10}H_{11}O \\ C_4H_3O \end{matrix}\right\}$
Oil of apples	$\left.\begin{matrix} C_{10}H_{11}O \\ C_{10}H_9O_3 \end{matrix}\right\}$
Valerianic acid	$\left.\begin{matrix} C_{10}H_9O_3 \\ HO \end{matrix}\right\}$
Grape sugar	$C_{12}H_{12}O_{12}$
Lactic acid	$C_{12}H_{12}O_{12}$

Caproic acid	$C_{12}H_{11}O_3$ HO
Benzole	$C_{12}H_6$
Nitrobenzol	$C_{12}H_5\text{-}NO_4$
	$C_{12}H_5O$ HO
Picric acid	$C_{12}H_2(NO_4)_3O$ HO
Salicylate of Methyl	$C_{14}H_5\text{-}O_5$
Oil of Wintergreen	C_2H_3O
Naphth	$C_{20}H_8$.

Organic chemistry is that part of the science wh. relates to living bodies.

Organic substances are either those wh. build up living bodies or are produced by living bodies or by submitting these products to different processes in the laboratory.

If you compare alcohol an organic base with KO an inorganic base you perceive a great difference between them.

Place alcohol in contact with an acid & it does not combine with it while KO does forming a salt.

If you add chloroform an organic substance rich in Cl. to acetate of Pb you get no precipitate of Pb,Cl. while if you add $NaCl$ an inorganic substance containing Cl. you get a precipitate

If you take a solution of a salt & try reactions with it to-day & then try the same reactions with it to-morrow you will get the same result.

If you do this with an organic compound you may very probably get a different result.

If you break up an organic compound you get C, O. H, & N but if you put these together in a flask you cannot make them combine.

If you place Na, O & P together you will get $NaO\,PO_5$

Place C, H. & O together & you will not get an organic body.

It was supposed at the beginning of the century that there were two different sciences

It was sought to give a definition, & in order to do this it was sought whether there was not some element common to organic chemistry & peculiar to it.
It was proposed to call it the chemistry of carbon.
But CO_2, cyanogen & cyanide of K can be made without vital agency.
There are bodies not organic wh contain carbon.

Liebig defined it as the chemistry of compound radicals, you deal in it, not with elements but with little systems.
We have however as much right to consider SO_2 as a com-

pound radical as many of the organic

The last definition was.,

In organic chemistry combination is ternary or quaternary in inorganic chemistry it is binary.

A chemical definition could not be got.

It was shown that many products of vital action could be obtained in the laboratory Wöhler made urea & acetic acid artificially

Any alcohol, can be made from a lower one by making a cyanide of an alcohol radical & from this a compound ammonium by acting on it by nascent H. The alcohol can be made from this.

We see then that the laws of transformation are the same & why then is it necessary to break up the science?
The division is empirical.
The compounds of C have been farther investigated than the compounds of any other element.
These compounds of C occur in living beings & for this reason we call it organic chemistry.
The compounds of C are particularly complex.
It is important to distinguish between empirical & rational formulae.
The empirical formula is merely the translation of the analysis. Some chemists believe that the rational formula expresses the mode in wh the atoms

are arranged.

The chemists who hold this doctrine seldom come to an agreement regarding the rational formula of a body.

The empirical formula is a fact, the rational is a conjecture.

When two chemists were arguing about the formula, it resolved itself into an enumeration of what could be got from the body; & when one chemist was hard pressed he said "although you show that a certain body* can be taken from this body you cannot show that it exists in the body.

Gerhardt proposed that you should make the formula indicate the transformations wh a body could undergo.

Thus alcohol

$$\left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2$$

Meaning that H & O could be replaced by other substances & that ethers could be got from it in wh. C_4H_5 exists.

The importance of rational formulae is apparent when we consider isomeric bodies.

Acetate of methyl $\left.\begin{matrix} C_4H_3O_2 \\ C_2H_3 \end{matrix}\right\} O_2 = C_6H_6O_4$

Formiate of ethyl $\left.\begin{matrix} C_2HO_2 \\ C_4H_5 \end{matrix}\right\} O_2 = C_6H_6O_4$

These bodies have the same empirical formula but different properties.

In organic chemistry the notion of homologous series is important.

A homologous series is a series of bodies differing from one

another by n times C_2H_2.
The members represent one another in function, if you apply the same reagents you get the same result.

$C_4H_6O_2$ act on it by	C_4H_5I
$C_6H_8O_2$	C_6H_7I
$C_{10}H_{12}O_2$	$C_{10}H_{11}I$

Heterologous Class.

If you compare the bodies you derive from common alcohol you get bodies said to be heterologous.

Alcohol	Ether	Aldehyd
$C_4H_6O_2$	C_4H_5O	$C_4H_4O_2$
$C_6H_8O_2$	C_6H_7O	$C_6H_6O_2$

In the horizontal line the bodies are heterologous & in the vertical lines homologous

The boiling pt. of alcohol rises 19 degrees Centigrade for every addition of C_2H_2.

The qualitative examination of organic bodies is peculiar.

Examination of bodies for C.

When you heat a body rich in C decomposition takes place CO_2 being given off & some residual C deposited

Organic bodies when heated, as a rule deposit C.

Heat sugar in a tube

Organic matter when heated either deposits carbonaceous matter or gives off a peculiar smell due to empyreumatic oils.

This is the test for C.

We seldom test for H.

Organic bodies frequently contain N, the testing for which is very important.

When a body containing N is burned, a peculiar smell is given off. Burns a feather.

When a body containing N is heated to redness with a mixture of soda & lime called soda-lime NH_3 or a compound NH_4 is given off.

Another method.

When you heat an organic body to redness with Na. you get the N transformed into Cy or Na Cy. Dissolve the residue in HO & add a mixture of per & proto salts of Fe. & HCl, if N be present you get prussian blue.

The detection of Br, S, &c in organic bodies is attended with difficulty.

When organic bodies contain Cl, & the like. the properties of the Cl are masked & you must heat to redness or with some strongly oxidizing body.

Cause the organic body to come

into contact with red hot $NaOCO_2$ the Cl combines with the Na & you get Na Cl from which you may calculate the Cl.

In place of heating to redness you may heat to 150° C. with strong NO_5.

If you seal up an organic body containing Cl with NO_5 & $AgO\,NO_5$, you get the Cl as Ag Cl.

Detection of S.

Not to miss the S you must effect complete destruction of the body.

Quantitative Analysis.

When organic bodies are heated to redness with great excess of O all the C becomes CO_2 & all the H becomes HO.

This is universally true.

Organic analysis is founded on this fact

Ascertain how much CO_2 & HO a given weight of the substance will yield.

Several methods may be employed.

Bring the body into contact with red hot CuO.

The apparatus, consists of 2 parts the, combustion & absorption parts.

Previously to using the CuO must be heated red hot since anything exposed to the air takes up dust wh is often organic.

You may conveniently heat the CuO in a Cu crucible. 

The absorption part consists of a

Ca Cl tube & KO bulbs.

The solution of KO is made by dissolving 1 part of stick caustic KO in $2\frac{1}{2}$ parts HO.

The connections must be tight. To test this warm the bulbs so as to expel some air & if the liquid keeps its level afterwards for 2 or 3 minutes the joints are tight.

In place of Cu O. Pb O CrO_3 is often used. it fuses at a red heat & buries the substance to be burned.

Oils are burned by Pb O CrO_3

O must be passed thro' the tube at the end of the operation, either from a gas-holder or from some KO ClO_5 in the tube.

When a substance contains N a little alteration is necessary in this arrangement.

When a body containing N is heated to redness with Cu O, the

C becomes CO_2 & the H; HO, the N appears partly as N & partly as NO_2.

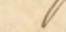
The NO_2 would interfere with the CO_2. To remedy this you introduce clean Cu turnings.

NO_2 when slowly passed over Cu turnings is decomposed.

Cu turnings prevent NO_2 from becoming NO.

When a substance contains Cl it is essential to make the combustion with $PbOCrO_3$.

If it contains I. you must place a long layer of Cu turnings in the front of the tube, these at a red heat absorb the I.

To make combustion of liquids make a small glass bulb & seal one end , weigh it, fill it with liquid by warming it, seal it & weigh again.

The difference of the wts is the wt of the liquid taken up.

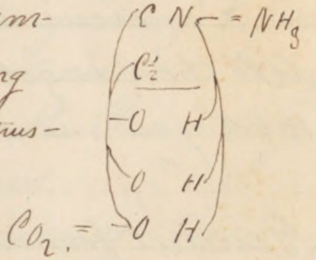
You allow the liquid to distil very slowly over the CuO.

When gas ceases to escape the operation is finished.

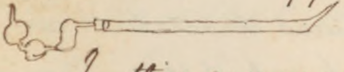
Then pass O over it.

Determination of N.

Most organic bodies when heated to redness with a caustic alkali yield NH_3, the HO of the caustic alkali being decomposed, the C taking the O & forming CO_2 & the N taking H & forming NH_3. thus –



Will & Varrentrapp's method.



In this case you use a mixture of NaO & CaO for combustion

The N is converted into NH_3 & absorbed

by the HCl with wh. the bulbs are filled
If you were to operate on $KO\,NO_5$ you would get no NH_3

You would only get traces if you were working with indigo.

Where the N is present in the oxidized or nitrous state you get no NH_3.

Mix a body with CuO, heat to redness, cause the products to pass over Cu turnings & collect the gas in a mercurial trough

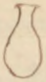
All the C is got as CO_2 the H as HO & you measure the N.

General formula of Olefines
$C_{2n}H_{2n}$

Olefiant gas was described in the inorganic part of the course

Olefiant gas or Ethylene. C_4H_4
atomic wt 28 S.G. ·9784

When $HOSO_3$ is heated with alcohol C_4H_4 is produced.



Alcohol $C_4H_6O_2$

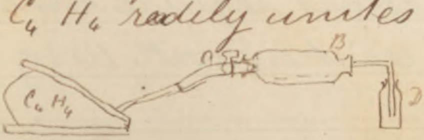
$C_4H_6O_2 = C_4H_4 + H_2O_2$ taken by $HOSO_3$.

C_4H_4 is a colourless gas, has a faint smell, is poisonous, produces headache if much gets into the atmosphere, burns with a very luminous flame. It is contained in small quantity in common illuminating gas.

The name of the gas is got from the fact that when it is brought into contact with Cl an oily liquid is formed.

B is a gas holder containing C_4H_4 & C a bottle containing Cl. Pass the C_4H_4 into C & an oily liquid is seen on the sides.

C_4H_4 readily unites with Br



C is a glass stopcock fitting tightly into the mouth of the vessel B, into wh some Br is put, C_4H_4 is then passed thro' it & B is gently heated, & afterwards the liquid formed is poured out of B.

The Brome liquid is not miscible with HO.

C_4H_4 takes up 2 equivalents of Cl, Br or I forming

Dutch liquid $C_4H_4Cl_2$
$C_4H_4Br_2$
$C_4H_4I_2$

C_4H_4 unites with hydracids

$C_4H_4 + HCl = C_4H_4$ Chloride of ethyl
$C_4H_4 + HBr =$ Bromide ——
$C_4H_4 + HI =$ Iodide ——

C_4H_4 unites with $HOSO_3$

$C_4H_4 \; HOSO_3$ sulphovinic acid.
$HOSO_3$

These reactions require time

To get the reaction with $HOSO_3$

seal up C_4H_4 with $HOSO_3$ & Hg & shake up. Berthelot the discoverer of the process shook it 5000 times.
If Cl be made to act on $C_4H_6Cl_2$ substitution products are obtained. Act in the sunshine on $C_4H_6Cl_2$ by Cl & you may get $C_4Cl_4Cl_2$.
Dutch liquid is not attacked by aqueous caustic KO but when digested for some time with an alcoholic solution of KO it yields $C_4H_3Cl + HCl$ wh the alcohol takes away.
Monochloride of ethylene is acted on by Cl yielding C_4H_3Cl, Cl_2.
If you act on this by a solution of caustic KO in alcohol you get $C_4H_3Cl_2 + HCl$.

Ethylene C_4H_4 $C_4H_4Cl_2$
$C_4H_3Cl_2$ $C_4H_3ClCl_2$
$C_4H_2Cl_2$ $C_4H_2Cl_2Cl_2$
C_4HCl_3 $C_4HCl_3Cl_2$
C_4Cl_4 $C_4Cl_4Cl_2$.

A similar set of reactions can be got with every olifine

Propylene. C_6H_6

A gas having a very disagreeable smell, very noxious

$C_6H_5I + 2Hg + HCl = C_6H_6 + HgI + HgCl$.

C_6H_6 exists in many mixtures it represents C_4H_4 exactly.

It combines with Br I & hydracids

With HCl it forms chloride of propyl.
HI ——— iodide ———
$HOSO_3$

Butylene C_8H_8.

$C_8 H_8$ occurs in small quantity in coal gas, it is colourless. slightly soluble in HO, soluble in alcohol, combines with Br & I.

Amylene $C_{10}H_{10}$. A

A colourless liquid, boils at a temp. very little above the ordinary one of the atmosphere has a disagreeable smell, very volatile.

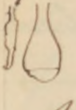
Distil potato spirit with ZnCl

Potato spirit = $C_{10}H_{12}O_2$

$C_{10}H_{12}O_2 + ZnCl = C_{10}H_{10}$

It is a liquid heavier than HO.

Readily combines with Cl & Br producing much heat.



Pours some Br from a pipette into some $C_{10}H_{10}$ in a flask. Violent action takes place.

Combines with hydracids.

With HCl it forms chloride of amyl.

Unites with NO_4 forming a beautiful crystalline compound.
$C_{10}H_{10}(NO_4)_2$

The higher olifines are very little known

Hexylene $C_{12}H_{12}$
Distil oleic acid.
May be got pure from mannite
It is a colourless liquid boils at 60°C, resembles amylene.
Unites with Cl violently with Br.

$C_{14}H_{14}$
Caprylene $C_{16}H_{16}$
Elaene $C_{18}H_{18}$
Paramylene $C_{20}H_{20}$
Cetylene $C_{32}H_{32}$ got from spermaceti.

The composition of olifines above $C_{12}H_{12}$ is little known.

Marsh gas. $C_2H_4 = 16$. S.G. ·5596
Marsh gas is derived from C_2H_2 by adding 2 equivalents.
Add H_2 to any olifine & you get the corresponding member of the marsh gas family.
C_2H_4 occurs occurs native, bubbles up in marshy places, exists in considerable quantity in coal mines, & in common gas

Prep. Heat Acetate of KO with HOKO

Acetate of KO = $C_2O_2C_2\begin{matrix}H_3\\K\end{matrix}\Big|O_2$ HOKO = $\begin{matrix}H\\K\end{matrix}\Big|O_2$

$$C_2O_2C_2\begin{matrix}H_3\\K\end{matrix}\Big|O_2 + \begin{matrix}H\\K\end{matrix}\Big|O_2 = C_2O_2\begin{matrix}K\\K\end{matrix}\Big|O_4 + \begin{matrix}H\\C_2H_3\end{matrix}$$

Marsh gas = hydride of ethyl
Zinc ethyl is a colourless liquid of immense energy, as great as that of K. It unites with great f energy with HO. $ZnC_2H_3 + HO = ZnO + C_2H_3H$.

Break the end off a small bulb of Zn methyl under HO. You may collect & measure the gas produced. Break the end of a glass bulb & the liquid will take fire depositing ZnO & metallic Zn

C_2H_4 burns without much smoke, it is inert, Br does not act on it

Expose C_2H_4 & Cl to sunlight & you get action

Members of the olifine family may be absorbed by fuming $HOSO_3$. You may make this by adding anhydrous SO_3 to $HOSO_3$

There are not many members of the marsh gas family well known.

C_2H_4 Marsh gas
C_4H_6 hydride of Ethyl.
C_6H_8 } exist but not
C_8H_{10} } well examined

$C_{10}H_{12}$ hydride of amyl
$C_{12}H_{16}$ ———— hexyl.

Hydride of Ethyl atomic wt 30
S. G.

Place Zn Ethyl in HO.
Take propionate of KO & $HOKO$ heat together & you get hydride of ethyl.

It is a colourless gas.
It closely resembles hydride of methyl in its properties

Hydride of Amyl.
Boils at about 30°C, has a smell like chloroform

Iodide of amyl Zn & HO are sealed up in a tube & heated in the water bath for some time

Zn amyl forms first & then acts on the HO.

It is very light; the lightest liquid known, has a pleasant smell.

Hydride of Hexyl C_6H_{14}
May be got from mannite
Colourless, very light. boils at 60°C.
It is very probable that it is
the H representative of the
sugar family.
Very little certain is known
of the higher families

Family of alcohol radicals.

Methyl C_2H_3
C_2H_3
Ethyl C_4H_5

Propyl

Butyl

Amyl $C_{10}H_{11}$
$C_{10}H_{11}$

Amyl boils at a very high temp. is a
colourless mobile liquid with
a peculiar smell

When an iodide of an alcohol radical is heated strongly with Zn you get Zn I & the radical.

$$\left.\begin{matrix}C_4H_5\\I\\C_4H_5\\I\end{matrix}\right\} + Zn_2 = \left.\begin{matrix}Zn\\I\\Zn\\I\end{matrix}\right\} + \begin{matrix}C_4H_5\\C_4H_5\end{matrix}$$

Alcohol radicals may be got from fatty acids

If you electrolyse acetic acid you get CO_2 & methyl.

Acetic acid = $C_2O_2\,C_2\left.\begin{matrix}H_3\\H\end{matrix}\right\}O_2$

$$C_2O_2\,C_2\left.\begin{matrix}H_3\\H\end{matrix}\right\}O_2 + O = C_2O_2O_2 + HO + C_2H_3$$

Take any other fatty acid of the series & you get an alcohol radical having C_2 less than the acid

is an extremely indifferent body

The alcohols have not yet been

got from alcohol radicals

Example of organic analysis

Analysis of Mannite.

·3552 grams mannite gave
·5069 —— CO_2 diff. of wt. of KO bulb
·2505 —— HO —— of $CaCl$ tube.

Since 22 grains of CO_2 contain 6 C you multiply the CO_2 by 3 & divide by 11.

·5069 × 3 = 1·5207 ÷ 11 = ·1382 C

To find the H divide the HO by 9

·2505 ÷ 9 = ·0277

·3512 : ·1382 :: 100 : 39·13 Percentage of C.
·3512 : ·0277 :: 100 : 7·8 —— - H

The diff between the wts of C & H & of the mannite is O.

39·1 C ÷ 6 = 6·5 C = 65
7·8 H ÷ 1 = 7·8 H = 78
53·1 O ÷ 8 = 6·60 = 66
100.

To find the formula divide the percentage by the equivalents of the bodies.

The percentage of C should not be $\frac{2}{10}$° below the theoretical quantity of the percentage of H $\frac{1}{10}$ above it.

Transformation of organic compounds by different ferments.

1

Diastase

$$\overbrace{C_{12}H_{10}O_{10}}^{\text{Starch}} + 4HO = \overbrace{C_{12}H_{14}O_{14}}^{\text{Grape sugar}}$$

2

Yeast

$$\overbrace{C_{12}H_{14}O_{14}}^{\text{Grape sugar}} = \overbrace{2C_4H_6O_2}^{\text{alcohol}} + 4CO_2 + 2HO$$

3.

Casein

$$\overbrace{C_{24}H_{24}O_{24}}^{\text{Milk sugar}} = \overbrace{2(C_{12}H_{10}O_{10}, 2HO)}^{\text{Lactic acid}}$$

$$\overbrace{C_{12}H_{12}O_{12}}^{\text{Lactic acid}} = \overbrace{C_8H_8O_4}^{\text{Butyric acid}} + 4CO_2 + 4H$$

Synaptase

Amygdalin Hydrocyanic acid Oil of bitter almonds

$\overbrace{C_{40}H_{27}NO_{22}} = \overbrace{HC_2N} + \overbrace{2C_{14}H_6O_2} +$

Formic acid Grape sugar

$2C_2H_4O_4 + 3HO + \overbrace{\underset{2}{\underline{C_{12}H_{14}}}\,O_{14}}$

Salicin Salicenin Grape sugar

$C_{26}H_{18}O_{14} + 4HO = \overbrace{C_{14}HO} +$

We have considered the olifines the homologues of marsh gas & the alcohol radicals.

We can reduce nearly all the others to the olifines

Methyline C_2H_2 supposed to exist in wood spirit, not known in a separate state?

Ethylene C_4H_4

Propylene C_6H_6

Butylene C_8H_8

Amylene $C_{10}H_{10}$

These are distinctly radicals in themselves, they unite

with Cl.
They are biatomic. This is expressed by two dots thus $C_4 \overset{''}{H}_4$
They unite with 2 atoms Cl, Br &c.
Homologues of marsh gas.
These are olefines having their biatomicity gratified by 2 atoms H.

$C_2 H_4$
$C_4 H_6$ &c

There are some instances where the biatomicity is not fully gratified, having only 1 atom of H & 1 atom to be filled up by something else.
These are the alcohol radicals.

$C_2 H_2, H = C_2 H_3$ methyl
$C_4 H_4, H = C_4 H_5$ ethyl
$C_6 H_6, H = C_6 H_7$ propyl
$C_8 H_8, H = C_8 H_9$ butyl
$C_{10} H_{10}, H = C_{10} H_{11}$ amyl.

These are olefines stepping towards

the gratification of their biatomicity

Suppose you add 1 atom Cl to C_2H_3 you get chloride of methyl. C_2H_3Cl or to C_4H_5 you get chloride of ethyl $C_4H_4\,HCl = C_4H_5Cl$

Suppose instead of Cl you substitute O. thus. C_4H_4HO

You get ethers, of wh common ether is the type.

General formula of ethers $C_nH_n''HO$ corresponding to marsh gas C_nH_nHH.

A radical is merely a body wh moves about

Act on PbO by HCl. $Pb\underbrace{O+H}Cl = PbCl + HO$.

What is the radical? The body you can move about viz., Pb. In the same way $\boxed{C_4H_4''H}\underbrace{O+H}Cl = C_4H_5Cl + HO.$

Instead of C_4H_4H you write

C_4H_5. the radical because you move it about.

What are the ethers

wood spirit or methylic

common

propylic

butylic

amylic

Methylic ether $C_2H_3O = 23$.

Or when free it is doubled, as instead of C_4H_5 to get a four volume formula you have C_8H_{10}

$(C_4H_4)H$ This is lob sided having H on one pole & not on the other.

$$H\begin{pmatrix}C_4H_4\\C_4H_4\end{pmatrix}H$$ When doubled it is symmetrical.

Why does ether double itself.

$O(C_4H_4)H$. The symmetry is not quite complete, tho' it is thus when in combination

$$\begin{matrix}H\\O\end{matrix}\begin{pmatrix}C_4\overset{H}{H_4}\\C_4\underset{H}{H_4}\end{pmatrix}\begin{matrix}H\\O\end{matrix}$$ When free it doubles its combining vol.

w^t is 2
Methylic ether vap. density

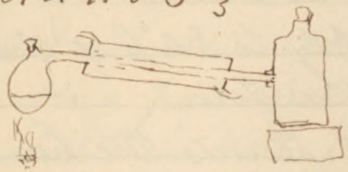
Prep. Heat wood spirit with 4 parts $HOSO_3$ & pass thro $HOKO$. It is a colourless etherial gas not condensible at 60°C, burns with a pale blue flame, very soluble in HO to the extent of
soluble in alcohol.
Combines readily with $HOSO_3$ & HCl.
Act on KO by HCl. $KO + HCl = KCl + HO$.
—— C_2H_3O ——. $C_2H_3O + HCl = C_2H_3Cl + HO$.
You may get chloride, iodide or bromide of methyl.
Substitution products of Chloride of methyl, C_2H_3Cl.
Chloroform. Two equivalents of H are substituted by Cl. $(C_2HCl_2)Cl$. The arbitrary formula is C_2HCl_3.

S. G of liquid chloroform 1.48
boils at 60.8°C

Put 20 lbs $Ca\,Cl$ in 120 lbs HO
place in a Cu retort $\frac{1}{3}$ full
add 4 lbs alcohol.
Heat quickly to 80°C & then
withdraw the fire.
You get 2 fluids the heavier
is chloroform, wash with

It is a colourless liquid, of an
ethereal sweet odour, sharp
& sweetish taste.
It is inflamed with difficulty. Place some on cotton
wool, it burns & gives off HCl.
It falls thro' HO without dissolving. It is a good solvent
of india rubber, P.
Vinic ether. C_4H_5O combining
formula. & $C_8H_{10}O_2$ its free form-

ula.
S. G of liquid .03736 at 0°C & .0724 at 16°C or 257. Boils at 35.5°C or 957. Vap. den. 2.586
Prep. Act on common alcohol with $HOSO_3$



$C_4H_6O_2$ common alcohol
$\underline{\quad HO \quad}$
C_4H_5O = ether.

You may suppose alcohol to be the hydrate of ether.

There have been many treatises on this reaction.

The $HOSO_3$ has an affinity for HO & takes it away.

Seal up anhydrous $MgO.SO_3$ & alcohol in a tube, the $MgOSO_3$ takes away the HO & you get ether. There is no difficulty

in this case.
But in distilling alcohol & $HOSO_3$, the $HOSO_3$ does not combine with the HO.
In the receiver you get HO & ether equal in bulk to the alcohol.
There are many like instances in catalyses.
The $HOSO_3$ takes the HO but the heat drives it off.
There are other theories.
One is that a body called sulphovinic acid is formed. first.
There is reason to suppose that $HOSO_3$ is S_2O_6. = $\left.\begin{matrix}HO\\HO\end{matrix}\right| S_2O_6$

$\left.\begin{matrix}HO\\C_4H_5O\end{matrix}\right| S_2O_6$ sulphovinic acid.

$\left.\begin{matrix}KO\\C_4H_5O\end{matrix}\right| S2O_6$ sulphovinate of Ko.

They say that the sulphovinic acid is decomposed.

Haloid compounds of ether.

Hydrochloric ether. C_4H_5Cl

Pass HCl thro' ether or better thro' alcohol, you get C_4H_5Cl, Chloride of ethyl.

S.G of liquid 0.874 boils at 11°C

A colourless, very volatile liquid & has a penetrating etherial odour. Slightly soluble in HO, soluble in alcohol.

Analogous to an oxide

$KO + HCl = KCl + HO$

$C_4H_5O + HCl = C_4H_5Cl + HO.$

Iodide of ethyl. C_4H_5I.

S.G boils at 72°C

Colourless of an etherial smell.

Much used to get radicals

Act on hydrochloric ether by Cl & you get Chlorinated ether.

Act on it with Cl in sunlight & you get Dichlorinated ether.

Act with Cl by sunlight & heat & you get trichlorinated ether.

Ethers as a class.

They represent the protoxides of metals

KO when free is probably not KO but KKO_2 or K_2O_2.

Ether when separate is not 5 C_4H_4O but $\boxed{C_8H_{10}}O_2$. Two atoms of radical united with $2O$.

What happens to KO when it is hydrated? $\left.\begin{matrix}K\\H\end{matrix}\right|O_2 = KO, HO$. one atom K going out & one of H going in.

Take 1 atom of radical from ether & add 1 of H.

$\begin{matrix}(C_4H_5)\\H\end{matrix}O_2$ alcohol is one of the radicals of the double ether taken out & 1 atom H put in its place.

That the ethers are really duplicated in their separate state follows from the fact that you are able to substitute one radical by another.

$$\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2 \qquad \left.\begin{matrix}C_4H_5\\C_2H_3\end{matrix}\right\}O_2$$

$$\left.\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right\}O_2 \qquad \left.\begin{matrix}C_2H_3\\C_4H_5\end{matrix}\right\}O_2$$

When not in a free state they halve themselves & unite with a base.

$KO + NO_5 = KONO_5$

$C_4H_5O + NO_5 = C_4H_5ONO_5$

You can form a whole set of ethers.

The ethers are to be considered as the protoxides of the metals & the alcohols as the hydrates of the protoxides

KO HOKO.

$(C_4 H_5 O)$ $(C_4 H_5 O) HO$.

alcohols = 4 vols.

		S. G		Boiling
		liquid	vap.	point
Wood spirit	$C_2 H_4 O_2$	0·798	1.12	150°
Spirit of wine	$C_4 H_6 O_2$	0·796	1.61	173
Propylic alcohol	$C_6 H_8 O_2$		2.02	206
Butylic - - -	$C_8 H_{10} O_2$	0·803	2·59	233
Amylic	$C_{10} H_{12} O_2$	0·818	3·14	270
Caproic	$C_{12} H_{14} O_2$	0·830	3·53	304
Caprylic	$C_{16} H_{18} O_2$	0·820	4·5	356
Lauric	$C_{24} H_{26} O_2$			
Cetylic	$C_{32} H_{34} O_2$			
Cerylic	$C_{54} H_{56} O_2$			
Melissic	$C_{60} H_{62} O_2$			

aldehydes.

Formic aldehyd
Acetic
Propionic
Butyric

Valerianic aldehyd
Caproic
Oenanthylic
Capric
Euodic.

Ethers form a homologous series corresponding to the alcohols.

The general formula of an alcohol is that of an ether $+ 1HO$

Ether. $= C_n H_n'' HO. + HO = C_n H_n$ an alcohol.

The alcohols belong to a different class from the ethers, as a hydrate does not represent a protoxide but a peroxide.

$$\left.\begin{array}{c}O\\O\end{array}\right| K_2 \quad \Bigg| \quad \left.\begin{array}{c}O\\O\end{array}\right| K \quad \left.\begin{array}{c}O\\HO\end{array}\right| K \quad \left.\begin{array}{c}O\\NO_5\end{array}\right| K$$

$$\left.\begin{array}{c}O\\O\end{array}\right| (C_n H_n)_2 \quad \Bigg| \quad \left.\begin{array}{c}O\\HO\end{array}\right| C_4H_5 \quad \left.\begin{array}{c}O\\NO_5\end{array}\right| C_4H_5$$

Alcohol is a hydrate of ether ?. is a salt.

Wood spirit or methylic alcohol $C_2H_4O_2 = \overset{O}{H}O | C_2H_3$. equivt 32. S.G of liquid 0.818 at 32°, at 65° 0.798. vap. density 1.12. boils at 150° F.

Prep. Distil wood, acetic acid & wood spirit are given off. it is purified by lime & distilled from $CaCl$,

When pure, it is colourless has the odour of acetic ether is a good solvent for resins when oxidized it forms formic acid.

Vinic alcohol or spirit of wine. $C_4H_6O_2$. $\overset{O}{H}O | C_4H_5 = 46$. S.G when free at 60° is 0.794 vap. den. 1.613 boils at 173° F or 78° C.

Alcohol has been made synthetically.

We believe it contains C_4H_4

add 2 atoms HO & you C_4H_4 alcohol.

$$\begin{array}{l} C_4H_4 \\ \underline{H_2O_2} \\ C_4H_6O_2 \end{array}$$

Pass C_4H_4 into $HOSO_3$ add HO & distil, alcohol comes over.

Prep. Distil from fermented  add $KOCO_2$ wh has been heated & the $KOCO_2$ takes the HO & falls to the bottom, you distil again from CaCl or dried CuO.

It is a colourless, volatile mobile liquid of an aromatic smell & burning taste

It has a strong affinity for HO, & the mixture contracts.

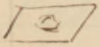
burns without smoke.

It has never been solidified by cold, at -166° F it becomes viscid. is a good solvent for Br, I, S, Na & bodies containing H.

In using it as a fuel it is

completely burnt.
$C_4H_6O_2 + 12O = 4CO_2 + 6HO$.
It unites with salts as HO does & forms alcoates instead of hydrates.

Wines & spirits.
Proof spirit 50.76 P.C. alcohol & 49.74 HO


. Proof used to be — set some gunpowder on a tile pour spirit over it & set the spirit on fire. If the spirit be above proof the gunpowder should go off when the spirit is burned. if under proof the HO it contains wets the powder so that it does not go off.

Distilled spirits. Brandy contains 55 P.C. alcohol. in its ordinary state it is coloured with burnt sugar

& peach kernels are added during distillation to flavour it.
Gin. is got from fermented grain & flavoured by juniper berries.
Whisky is distilled from grain & has a slightly smoky taste.
Rum is got from sugar

Arrack from fermented rice betel nuts or palm juice
Potato brandy is got by converting potato starch into glucose & distilling it.
Wines are the fermented fluid without distilling.
When all the sugar is converted into alcohol they are called dry, when much sugar remains they are called fruity.
The bouquet is due
1st To the completion or

non completion of these actions
2nd To the deposition of cream of tartar
3d To the formation of fragrant ethers by the action of vegetable acids on the

Strength of wines

Port or Madeira	15–20 P. C alcohol
Sherry	16–17
Lisbon	16
Malmsey	13
Champagne	12
French clarets	9–10
Rhenish wines	10-12
Cider	4–8
Perry	6–8
Ale	6–8
Porter	5
Small beer	1½

The market value of wines depends on their flavour

One imperial pint of the following wines contains

	HO oz	alcohol oz	sugar grs	Tartaric acid grs.
Port	16	4	1-2	80
Brown sherry		4½	360	90
Claret		2	none	161
Burgundy	12½		2½	160

Fermentation

It is the process by wh sugar is converted into alcohol.

Grape sugar in honey $C_{12}H_{12}O_{12}$
Act by yeast $= 4CO_2 + 2(C_4H_6O_2)$
Yeast does not appear in the final product

Conditions for fermentation
The temperature must be 50°–60°F. HO must be present to keep the sugar in solution
Air must be present to make the yeast live & effect the transformation
Nitrogenized substances

must be present & a body capable of fermenting.
There is spontaneous fermentation as in crushed grapes, the air acts on the nitrogenous matter in the cells.
When we add a ferment to sugar, & the ferment disappears or forms a heavy substance wh. falls to the bottom.
The yeast is a vegetable growing body, & consists of cells wh. when placed in a warm saccharine fluid increase, one cell giving off many others, about $\frac{1}{250}$th of an inch in diameter.

They finally cease to produce gas.

Composition

	Before fermentation	after
C	47·71 P.C	48·31.
H	6·7	7·33
N	10·15	5·07
O	35·44	39·29
S & P	Traces	Traces.

The N is only one half of what it was when the operation commenced.

When yeast is active it is acid if you add an alkali to it, it stops its action & the fermentation. Weak acids favour fermentation, strong acids destroy it. Some poisons destroy it others do not.

Theory of action of ferments.

Liebigs view is that the ferment is in a state of internal change & that it communicates this change to the other body wh. is in a state of statical equilibrium.

Pasteur considers that it is an action not correlative with the death of the plant but with its life.

He burnt yeast & added the ashes & an ammonia salt to sugar.

The NH_3 disappeared from the solution.

The result of fermentation is complex.

Glycerin & butylic acid are produced as well as alcohol & CO_2.

Suppose you put a piece of putrid cheese or casein into sugar, you get a different action & lactic acid is produced. If the cheese is very putrid the lactic acid becomes butyric acid.

$C_{12}H_{12}O_{12}$

The brewing of beer is a reproductive fermentation

A certain quantity of yeast is added to the fermenting liquid & grows so much that much more yeast is obtained.

Malting is the germination of barley. When the young sprout is about $\frac{1}{2}$ inch in length & begins to bifurcate, its life is destroyed by roasting.

The barley in malting contains diastase. Diastase can convert starch into dextrin, it then changes the dextrin into grape sugar.

One part diastase can convert 4000 parts of starch into sugar. Malt contains $\frac{1}{500}$th of its weight of diastase, so there is enough diastase left to

An infusion of the malt is made & 4 or 5 parts of fresh barley added It converts the barley into sugar You then add say 1 part yeast wh produces 2 parts of alcohol 4 CO_2 & 2 HO.

In the barley there is gluten a body of the same composition as the muscle of our bodies. The yeast acts on the gluten & it receives so much food from the gluten that it grows with great rapidity & produces much new yeast.

Composition of 1 imperial pint

	HO	alc	sugar	acetic acid
	oz.	oz	grs	grs
London stout	18½	1½	281	54
— — porter	19¼	¾	267	45
pale ale	17½	2½	240	40
mild —	18¾	1¼	280	38
strong —	18	2	$\overset{oz}{2}$..136	54

Homologous of the alcohols.

Propylic alcohol. $C_6H_8O_2$.

Found in the product of the fermentation of grape skins.

It is a colourless liquid with an agreeable fruity smell, lighter than HO.

Prepared by synthesis from propylene.

Propylene is passed into $HOSO_3$ HO is added & it is distilled.

Butylic alcohol $C_8H_{10}O_2$

Found in small quantity in fusel oil.

It is a colourless liquid, smelling like fusel oil & wine, soluble in HO but separates on the addition of salt

Amylic alcohol. $C_{10}H_{12}O_2$

S.G of the liquid 0.818 vap. density 3.147 boils at

Has a higher boiling pt. than the previous ones.

Brandy contains a little fusel oil & whisky a good deal.

Test. Pour some of the spirit thought to contain it on your hand & allow it to evaporate you can then smell the fusel oil.

It is ~~though~~ a colourless, mobile liquid, of a disagreeable odour burning taste, slightly soluble in H_2O, soluble in alcohol & ether, when strong it is poisonous & produces a cough & spasm of the glottis

Caproic alcohol.

Formed in the fermentation of grape skins. Refracts light strongly; insoluble in H_2O

General properties of alcohols.

The chemical reactions of alcohols are nearly all the same. If we act on them by acids you get ethers.

$C_4H_5O\,HO + NO_5 = C_4H_5O\,NO_5 + HO$

$KO\,HO + NO_5 = KONO_5 + HO.$

The compound ethers are on the same type as alcohols, but acids replacing the HO.

Boiling pts.

Vinic alcohol	78°C	difference
Propylic	96°C	18°C
Butylic	112°	16°C
Amylic	132	20°C
Caproic	150	18°C

Compound ethers are derived from the alcohols, & are salts of the ethers, the HO of the alcohol being replaced by acid.

Sulphuric æther, not that of shops wh is common ether but that of Chemists. $C_4H_5OSO_3$

Prep. Act on ether by anhy-

drous SO_3 in the cold,
Colourless, aromatic liquid not miscible with HO.

Nitric ether. C_4H_5O,NO_5.
Used in pharmacy. S·G of liquid 1·11. boils at 85°C.
Distil $HONO_5$ with alcohol & a little urea.
When pure it is a colourless aromatic liquid, with a faint smell of apples, explodes when quickly heated.

Nitrous ether. $C_4H_5ONO_3$
S·G of liq . boils at 16·4°C
Distil spirit of wine with $HONO_5$.
It is yellow, inflammable insoluble in HO soluble in alcohol.
Decomposed in heating with the evolution of N.
Even the feeble acids have

been made to unite with ether.

$C_4H_5O\,CO_2$

$C_4H_5O\,SiO_2$.

A proposition was made for covering the houses of Parliament with a coating of silica by means of $C_4H_5O\,SiO_2$.

Sulphovinates, are salts of ether in wh one of the eqivlts of HO in $HO\,SO_3$ viewed as a bibasic acid is replaced by ether. $\left.\begin{matrix}HO\\HO\end{matrix}\right|S_2O_6 \quad \left.\begin{matrix}HO\\C_4H_5O\end{matrix}\right|S_2O_6$

add KO $\left.\begin{matrix}KO\\C_4H_5O\end{matrix}\right|S_2O_6$ sulphovinate of KO

It is not $HO\,SO_3$ alone wh acts in this way, PO_5''' does it also

$\left.\begin{matrix}HO\\HO\\HO\end{matrix}\right|PO_5 \quad \left.\begin{matrix}HO\\HO\\C_4H_5O\end{matrix}\right|PO_5$ Phosphovinic acid

As every ether has its alcohol & every alcohol can form a compound ether you might.

go on in the series but when you know the properties of one in a series the others much resemble it.

Nitrite of amyl.

It is amylic alcohol with HO displaced & NO_3 added

$C_{10}H_{11}O\,HO$.

$C_{10}H_{11}O\,NO_3$.

It has properties the very reverse of chloroform.

It increases the action of the heart, & produces acute headache.

In cases of long suspended syncope it might be useful.

Biatomic ethers & alcohols.

An ether is monoatomic when it unites with 1 atom acid or with of HO to form alcohol.

$C_4H_4''\,HH$. marsh gas.

$C_4H_4\,ClCl$

$C_4H_4\,HO$ ether.

C_4H_4OO

$C_nH_n''OO$ biatomic ether

$C_nH_nOO+2HO$ — alcohol

Why should those be biatomic?

$KOHO$ it has one of O in the base

$KONO_5$

$SnO_2 . 2HO$ it has 2 of O in the base

$SnO_2 . 2NO_5$

The same with biatomic alcohol.

Ethylene ether $C_4H_4O_2$ corresponding to dutch liquid Has been imperfectly studied. Its hydrate or ethylene alcohol $C_4H_4O_2+2HO$ generally called Glycol is better known. Empirical formula $C_4H_6O_4$

Obtained by the action of HOKO on acetate of ethylene.

$C_4H_4O_2, 2C_4H_3O_3+2KOHO=2(KOC_4H_3O_3)$
$+C_4H_4O_2+2HO$.

A clear thick sweet liquid

soluble in HO & alcohol; the vapour burns & is converted into acid by oxidation.

Acetate of ethylene.

Act on Bromide of ethylene, a dutch liquid by acetate of KO.

$C_4 H_4 I_2 + 2 KO C_4 H_3 O_3 = 2 KI +$
$C_4 H_4 O_2, 2 C_4 H_3 O_3$

Acetic ether is a colourless liquid, at a high temp. it smells feebly of acetic acid.

We can produce the homologues of glycol thro' the whole series.

$C_4 H_4 HO$ common ether
$C_4 H_4 OO$ biatomic — .
$C_4 H_4 HO + HO$ common alcohol.
$C_4 H_4 OO + 2 HO$ biatomic —
$C_n H_n HO + HO$ common
$C_n H_n OO + 2HO$ biatomic
$C_n H_n OO, 2HO$
$C_n H_n OO, 2A$
$C_4 H_4 OO, 2 (C_4 H_3 O_3)$ binacetate of ether of olefine.

Every homologous olifine has an ether & alcohol belonging to it. We now consider a stepping stone between the alcohols & acids, the aldehydes.

Alcohol

Aldehyde

Acids of alcohols.

C_nH_{n+1}. +1 means that there is 1 atom of H more than the number of C.

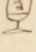
alcohol.

$C_nH_n^{+1}O, HO = HO +$ ether

General way of forming aldehydes from alcohols.

$C_nH_n^{+1}HO - 2H =$ aldehyde.

It is simply by oxidation that you do this.


Put a heated Pt wire into a glass in wh is a little ether.

Aldehyde vapours form round the Pt. You are forcing the H to combine with the O by the action of the Pt.

Distil alcohol, $HOSO_3$ & MnO_2 in a capacious retort & aldehyde is produced.

Add 2 atoms of H to an aldehyde & you get an alcohol.

Vinic or acetic aldehyde. $C_4H_4O_2$.
S.G of liq 0.79. vapour density 1.53
4 volume formula boils at 21°C.
Distil in a capacious retort 6 parts $HOSO_3$, 4 alcohol of 85 P.C.. 4 HO & 6 MnO_2.
The loss is considerable. You get a colourless liquid of an irritating pungent odour, burns with a white flame, with alkaline bisulphides it forms a white solid compounds. It is singularly unstable. if you seal it up in a tube it changes after a time to a porcelain

like substance, it is then probably $C_{12}H_{12}O_6$

There are seberal of these varieties.

General process to get aldehydes.

Suppose you wish acetic aldehyde.

Distil acetate of lime with one equivalent of formiate of lime

$$CaO\,C_4H_3O_3 + CaO\,C_2HO_3 = 2\,CaOCO_2 + \overset{\text{acetic aldehyde.}}{C_6H_4O_2}$$

General view of the constitution of aldehydes

There are several views.

Gerhardt thinks they are constituted on the type of H.

$$H = \left.\begin{matrix}H\\H\end{matrix}\right\} \quad \left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\} = \text{acetic aldehyde.}$$

That one H is replaced by $C_4H_3O_2$ a radical he calls acetyle.

Liebig thinks that they are alcohols of unknown radicals

& that the radicals are negative or are C_nH_{n-1} having 1 atom less H than C.

$C_4H_3O\ HO$ = aldehyde = hydrate of oxide of acetyle.

He calls C_4H_3O acetyle.

In our view we view aldehyde as the alcohols of oxidized olefines $C_4H_4''HO$ common ether

$C_4H_3O,''HO$ aldehyde

1H being replaced by O.

Every alcohol has its ether

——— aldehyde

——— ketone.

If you take the acid salt of any as Acetate of Pb & distil you get a tarry liquid wh when purified is acetone the ketone of the

Ketone the aldehyd in wh 1 H is substituted by the alcohol radical below it in the series.

C_2H_3 methyl is the radical below
C_4H_5 ethyl in the series.
C_4H_5O, HO substitute the H by methyl
$C_4H_5O(C_2H_3)O$. Ketone of the series.
Acetone: $C_6H_8O_2$ =

$$\begin{array}{l} C_4H_5O_2 \\ \underline{C_2H_3} \\ C_6H_8O_2 \end{array}$$

Heat chloride of acetyle with Zn methyl.
It is a clear colourless liquid of an etherial smell, soluble in HO but separates readily on the addition of salt, readily soluble in alcohol & ether.
Absorbs HCl readily & polymerizes

Anhydrides or acids.

When monoatomic alcohols homologous with methylic are fully oxidized they are changed into aldehydes & then into acids.

All the acids are derived from corresponding alcohols by oxidation

It was long supposed that there was no anhydrous acid in the organic series.

$KOSO_3 = KSO_4$ There is a great disposition among chemists to reduce to the binary type.

They have got anhydrous acids

Mode. General reaction.

By acting on a salt such as an acetate with a body wh is oxichloride of P, PCl_3O_2.

Example. To get anhydrous acetic acid. Take acetate of KO. $C_4H_3O_3,KO$, From chloride of P you can get chloride of acetyle $C_4H_3O_2Cl$, = anhydrous acetic acid in wh 1 of O is replaced by Cl.

$C_4H_3O_3\underbrace{KO+C_4H_3O_2Cl}=2(C_4H_3O_3)+KCl.$

Anhydrous acetic acid. Its formula is doubled $C_8H_6O_6$ liquid S.G 1.073 vapour density 3.47 boils at 140°C.

It is a colourless mobile, highly refracting liquid

It sinks thro' HO like oil but gradually unites with it & forms vinegar

All other anhydrous acids could be prepared.

Hydrated acids

Relation of these acids to alcohol & ether.

	Oxydized series
Ether $C_4H_4''HO$	Aldehyd $C_4H_3\overset{\circ}{O}\,HO$
Ethylene ether $C_4H_4''OO$	Anhydride $C_4H_3\overset{''}{O}\,OO$
— alcohol or glycol C_4H_4OO	$\boxed{\overset{HO}{HO}}$ $\overset{\text{acetic acid}}{C_4H_3OOO}\mid HO$

Formic acid. empirical formula
$C_2H_2O_4$. S.G of liquid 1.235
vapour density 1.554.
Occurrence. Called formic acid
because it occurs in the red ant
Formica rufa; occurs in the
stinging nettle urtica urens.
& in various animal secretions.
Obtained by synthesis.
By passing CO over HO KO
$KOHO + 2CO = KOC_2HO_3$.
Distil starch with $HOSO_3$ & MnO_2
This is not the best way.
Mix syrupy glycerine with
oxalic acid & heat.
It was formerly got by crushing
& distilling ants.
It forms many salts wh. crystallize readily & form definite
& permanent compounds.
Acetic acid. $HO\,C_4H_3O_3$ or $C_4H_4O_4$
S.G of liquid 1.063 vapour density

2.08 boils at 119°C.

Occurs as acetates in various vegetable juices in the perspiation of animals, in the juice of flesh

Prepared by synthesis.

By the action of CO_2 on Zn methyl.

$C_2H_3Na + \overset{2CO_2}{C_2O_4} = NaC_4H_3O_3$.

You get acetate of Na

Commercially. Distil wood & you get pyroligneous acid & pyroxylic spirit.

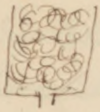
The ash, oak & beech are preferred.

Add lime & you get acetate of lime, distil over & you get glacial acetic acid; it is so called because it becomes solid when exposed to cold.

If you pass alcohol over spongy Pt in presence of air you get acetic acid.

Oxidize alcohol. A large cask is

taken, wh allows air to pass thro' it, & filled with beech wood shavings & alcohol



poured over it; it is done two or three times & in its passage is oxidized to acetic acid. 1 part alcohol & 6 HO & $\frac{1}{1000}$th part of honey are taken.

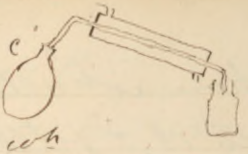
Relation between the alcohols aldehydes, & ketones.

alcohol	$C_4\,H_4''\,H.O.HO$
double ether	$C_4\,H_4''\,H.O.(C_2H_3)O$
aldehyd	$C_4\,H_3\,O''\,H.O.$
Acetone	$C_4\,H_3\,O''\,(C_2H_3)\,O.$

is not a common alcohol in wh the H is replaced by the radical next lower in the series it is the aldehyd in wh the H is replaced by the radical 1 below it in the series. Thus,

Butyrone, $C_8\,H_7\,O''(C_6H_7)O.$

Prep of acetone



C is a Cu retort in wh

Acetic acid. $C_4H_4O_2$

At 55° it is solid & crystalline melts at 62°, has a pungent peculiar smell, burning taste acid taste, miscible with HO, ether & alcohol, it dissolves camphor & essential oils, the strongest acetic acid forms aromatic vinegar & is generally flavoured with essence of camphor or bergamot.

It is used in medicine as a rubefacient, when too strong it blisters the skin.

Most acetates are soluble.

Vinegar is dilute acetic acid is is made from bad wine.

The temp. necessary to produce oxidation is 70-80°F.

Malt vinegar is now largely

used, it contains about 5 P. C of acetic acid.

Acetic acid may be acted on by Cl & forms a very complete substitution acid.

$KO\,C_4H_3O_3$ acetate of KO.

$KO\,C_4Cl_3O_3$ Chloracetate of KO.

Acetates.

Acetate of KO. $KO\,C_4H_3O_3$

Prep. Dissolve $KO\,CO_2$ in acetic acid.

Prop. Anhydrous. foliated, deliquescent.

Acetate of NaO. $NaO\,C_4H_3O_3+6HO$.

Colourless transparent efflorescent cooling taste.

Acetate of ammonia. $NH_4O\,C_4H_3O_3$.

White crystalline easily solube decomposes when heated. distilled.

$NH_4O\,C_4H_3O_3=4HO+C_4H_3N=$ $C_2H_3C_2N$ or cyanide of methyl.

The cyanide of the radical below that from wh the acid is derived.

another example propionate of ammonia. $NH_4O\,C_6H_5O_3 = 4HO + C_6H_5N$ $= C_4H_5\,C_2N$

$NH_4O\,C_4H_3O_3$ is used in medicine as a refrigerent & to act on the kidneys

Acetate of Pb. $PbO\,C_4H_3O_3 + 3HO$ this is neutral acetate.

Prep. Dissolve PbO in acetic acid & crystallize.

It is often called sugar of Pb. It crystallizes in transparent rhombic prisms, has a sweet taste, soluble in twice its wt. of HO & alcohol, it is used as a lotion, is poisonous.

There are some subacetates.

$3PbO, 1C_4H_3O_3$

$6PbO, 1C_4H_3O_3$.

Acetates of Cu. There are several.

Neutral acetate 1 CuO 5 acetic acid

& 5 HO.

There are various insoluble sub-acetates.

Verdigris. Expose sheets of Cu in alternate layers with fermenting grape skins.

The crust is scraped off & made into a paste with vinegar & made into moulds.

Glycocol is connected with acetic acid.

Occurs in the transformation of many animal substances in the decomposition of hippuric acid &c.

It is crystalline sweet, fusible at 78 °C soluble in HO & hydrated alcohol, insoluble in ether & absolute alcohol.

It is a very weak acid acting partly as an acid & partly as a base.

It is acetic acid in wh 1 atom H in rad-ical is substituted by amidogen. NH_2.

Acetic acid $(C_4H_2HO)''OO$

Glycolic —. $(C_4H_2OO)''OO$

Glycocol $C_4H_2(NH_2)O)OO$

NH_3 thought to be $(NH_2)H$ hydride of amidogen

Acids homologous to acetic acid

Propionic acid. $HOC_6H_5O_3$.

liquid S.G 0.991 boils at 140°C.

Its synthesis has been effected by Na ethyl.

$C_4H_5Na + \overset{\text{rat}\,CO_2}{C_2O_4} = NaOC_6H_5O_3$ propionate of NaO.

Butyric acid $C_8H_8O_4 = HOC_8H_7O_3$

liquid S.G 0.978

Occurs ready formed in certain fruits, in sourkrout.

In the animal organism it is found sometimes in sweat, in gastric juice, in

certain diseases in wh. the expectorations have a bad smell.
In the bad smelling juices of certain animals.
In the oxidation of casein & fibrin
By fermenting sugar by poor cheese or curd in presence of chalk. You get butyrate of lime, lactate of lime is first formed. Add HCl & distil & you get butyric acid.
It is a colourless liquid, with a very disgusting odour.

Crystallized by intense cold.
Slightly soluble in HO.
Butyrates crystallize, & have no disagreeable smell when dry, tho' when wet the CO_2 of the air liberates some

butyric acid & causes a smell.
They have more the character of soaps than any salts we have yet dealt with.

Butyrate of lime.
It is much more soluble in · than

Butyric ether $C_4H_5O.C_8H_7O_3$.
liquid S.G ·901 boils at 119°C, a clear, mobile, liquid, & fragrant ether
It occurs in the pineapple, melon strawberry & other fruits
Some fragrant ethers are got from acids having an abominable smell.
A strong alcoholic solution of butyric ether is sold under the name of essence of pineapples, & more diluted as essence of strawberries.

Amylic or valeric acid. $C_{10}H_{10}O_4$
$= HO,C_{10}H_9O_3$

liquid S. G 0·937 vapour density 3·66 boiling point 347°

Occurs in valerian & angelica root, in putrid cheese in train & sperm oil

Prep. Distil valerian root with HO.

Or Distil fusel oil with $HOSO_3$ & $KO\,2CrO_3$

It is limpid, has an odour like cheese floats on HO.

Forms valeriates wh: are soapy substances.

Fatty acids

Rutic is the first true fatty acid or oil when melted. It occurs in the fat of goats.

Palmitic acid. $C_{32}H_{32}O_4$ or $HO\,C_{32}H_{31}O_3$

Melts at 62°C.

All the fats vegetable & animal are compound ethers, the ether they contain is that of Glycerin united with a fatty acid

Palmitic acid in combination

with glycerin is in almost all fats especially human & pig's
It is obtained by saponification

$$\text{Fat} = \left.\begin{matrix}\text{Glycerin} \\ \text{Fatty acid}\end{matrix}\right\} + KO = \left.\begin{matrix}KO \\ \text{Fatty acid}\end{matrix}\right\} = \text{soap.}$$

Act on soap by alcohol & you get the acid in a free state.

Prop. Tasteless white fat. crystallizes in tufts. insoluble in HO soluble in alcohol & ether.

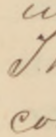
Palmitates are soaps insoluble when the bases are earths, soluble when they are fats.

Stearic acid $C_{36}H_{36}O_4$
melts at 69·2°C, occurs in combination with glycerine in most fats, in all animal fats, the richer the fat is in stearic acid the harder it is.
It is got from stearate of KO by HCl
Insoluble in HO.

When distilled it is converted into palmitic acid.
Stearates of alkalis are soluble

Neutral stearates are decomposed by HO into alkalis &

Lamps were used before candles were introduced. Torches were the first candles & were probably used with lanterns.
Pliny alludes to candles wh. were probably of wax.
The only cheap candles in this country were the fats themselves. They had a low fusing point & ran, & the wick did not burn away and required snuffing.



Palmers candlestick was meant to remedy this. The cande was kept at the level of the candlestick by a spiral spring, & the wick wh was double turned outwards so that the end was always exposed to the air & thus burned away.

Improvements in candles.

It was discovered that tallow consisted of stearine & oleine, & that by heating tallow to the fusing pt. of oleine but not to that of stearine the oleine might be pressed out & stearine left.

Tallow melts at	102°
Stearine	144
Stearic acid	15°

Candles of stearic acid would thus be better than those of stearine. The stearine was saponified & the soap acted on by HCl. There were many objections to the use of the stearic acid candles. The wick got clogged up. This was found to be owing to the wick leaving alkaline ashes & forming a soap with the stearic acid. This was remedied by dipping the wick in $HO SO_3$.

$C_6 H_5 - O_3'''$ Glycerine ether

$(C_6 H_5 - O_3''') 3HO$ Glycerine

$(C_6 H_5 - O_3''') 3 \bar{A}$ A fat.

Tallow is a mixture of fats, as, oleine, palmitine & stearine

Glycerine itself is not combustible.

In the stearic acid candles, the oleine & glycerine are both removed.

Stearic acid candles so called, are generally palmitic acid. & are got from palm oil.

The improvements in candle making depend chiefly on Chevreuls researches on fats.

Saponification. The fat is boiled with lime, & $HO SO_3$ added to the lime salt of the fatty acid thus obtained. the acid is then got in a free state.

$(C_6H_5O_3)^{'''}\,3\overrightarrow{A} + CaO$ = lime salt
$3HO$ = glycerine $3SO_3$

Another difficulty in the use of stearic acid candles is that it has a tendency to crystallize.

The crystalline flakes often broke off the candles.

By putting a little arsenic into the acid the crystallization was stopped, but fumes of As were given off while the candle was burning & hurt the health of those who used it.

This nearly put a stop to the manufacture, but after some time it was found that a small percentage of wax served the same purpose as the As.

The saponification was next

effected by $HO\,SO_3$ instead of lime.
Mix the fat with $HO\,SO_3$ & heat by blowing steam thro' them

$C_6H_5{-}O_3''' \; 3A + 6HOSO_3 = C_6H_5{-}O_3''' ; 3SO_3$
$+ 3A, 3SO_3$.

Pass superheated steam at about 600° thro the fat, it splits it up into the acid & the ether.

$C_6H_5{-}O_3''' \mid 3A$.

The glycerin & acid both distil. separately.

Candles from Coal.

Coal when distilled produces various gases, amongst others olefiant gas C_4H_4 & other higher homologues.

$C_8\;H_8$

$C_{10}\;H_{10}$

$C_n\,H_n$

If you distil at a low temperature $C_n H_n$ comes over chiefly in a solid state; if at a higer temp. you get liquid products; & higer still gaseous products.

Boghead coal is distilled at as low a temp. as possible & an oil comes over, wh. is called paraffin because it possesses almost no affinities This when cooled from 40° to 32° deposits solid paraffine.

In 1852 L. Playfair thought that paraffine could be got from the oil, but the maker of the oil would not try it, so Playfair obtained a quantity from him & by experimenting succeeded in getting it.

Paraffine contains the conditions of illumination in the highest degree. The illuminant in coal gas is $C_4 H_4$ & its homologues

Paraffine is $C_4 H_4$ in a condensed state.

All the paraffine is burned.

It is not fat wh burns in a candle it is gas. The pores of the carbonized part of the wick act as so many retorts.

Acids heterologous

Melissic	$HOC_{60}H_{59}O_3$
Cerotic	$HOC_{54}H_{53}O_3$
Arachidic	
Stearic	
Palmitic	
Myristic	
Lauric	
Rutic	
Pelargonic	
Caprylic	
Œnanthylic	
Caproic	
Valeric	

91

Butyric
Propionic
Acetic
Formic

Acids produced from biatomic alcohols.

$C_4H_4''HOHO$ monoatomic alcohol.
$C_4H_4''OO\,2HO$ bi — — — — — .

In examining the oxidation of mono-atomic alcohols we found that aldehydes were first produced & then acids.

$C_4H_6''HO$
$C_4H_4\dot{O}HO$.
$C_4H_3\mathring{O}OO$.

Products of the oxidation of Glycol.
We find two acids result.
In the first 2 atoms of H in C_4H_4 are replaced by O.
In the second all the H is replaced by O.

Glycol ether $C_4H_4''OO$
glycolic acid $C_4H_2O_2''OO$
Oxalic —— $C_4O_4''OO$.
What would be the acid for methylene C_2H_2 if it were fully oxidized?
$C_2O_2''OO = C_2O_4 = 2CO_2$.

Formic acid $C_2HO'OO$
Carbonic $C_2O_2''OO$
Acetic $C_4H_3O'OO$
Glycolic $C_4H_2O_2''OO$

Glycolic acid.
Got by the slow oxidation of glycol.
It is a syrupy acid liquid

The anhydride is got by distilling tartaric acid.
Lactic acid $C_6H_6O_6 = 2HO\,C_6H_4O_4$
Occurrence. It is extensively distributed in the animal kingdom it is found free in the gastric juice. found in muscle, in

the pancreas, in milk, in the brain & lungs & abnormally in urine blood & saliva.

It is supposed to be the acid wh: dissolves out the mineral matter in bones & produces rickets.

It stands in the same relation to propylic   wh the latter bears the glycol.

Glycol or ethylene alcohol $C_4 H_6 O_4$, $-2H+2O$ $= C_4 H_4 O_6$ Glycolic acid.

Propylene alcohol $C_6 H_8 O_4 - 2H+2O$ $= C_6 H_6 O_6$ Lactic acid.

Prep. 8 parts of sugar are dissolved in 50 parts HO, 1 part of poor cheese & 8 of chalk are added, & fermented at 80°. Lactate of lime is thus got & by adding $HO\,SO_3$ you get the acid.

It is a transparent, uncrystalline liquid, of a sharp taste

It is not volatile, & can displace volatile acids. when heated it

loses HO & becomes lactic anhydride.
Lactates of alkalies do not crystallize
——— earths & metallic oxides do.
Lactate of Zn unites with 3HO.
Flesh juice lactates all contain
1 equivalent less of HO than those
of that got by fermenting sugar.
Fully oxidized olifine acids in wh
the H is substituted by O.
Formic acid $C_2\,HO''\,O\,O$
Carbonic $C_2\,OO''\,O\,O$
Carbonic oxide C_2O_2 is a radical.
Sulphocarbonic $C_2O_2S_2$ acid.
Chloro — — — $C_2O_2Cl_2$
Oxalic $C_4H_2O_8$
$C_6H_4O_8$
Succinic $C_8H_6O_8$
Lupinic $C_{10}H_8O_8$
— — —
Sebacic $C_{20}H_{18}O_8$.
Oxalic acid. $2HO\,C_4O_6$.
Occurs in vegetable juices, as acid

oxalates, in common sorrel, in lichens in rhubarb, sometimes free.

Rarely in the animal kingdom, as oxalates of lime in Calculi, & in urine in an abnormal state.

Prep. Heat starch gently with $HONO_5$. It has been obtained by another method.

Heat sawdust with caustic KO & NaO. The H is removed & the O goes

You get a mixture of oxalates of NaO & KO. Add CaO & you get insoluble oxalate of lime.

Add $HOSO_3$ & you get oxalic acid free.

$$2NaO,C_4O_6 + 2CaO = 2CaOC_4O_6$$

$$2CaO,C_4O_6 + 2SO_3 = 2CaOSO_3 + C_4O_6.$$

It is a crystalline acid, crystallizes in colourless transparent like Epsom salts, for wt:

it is sometimes mistaken.
The remedy is chalk, $CaOCO_2$
or magnesia
It forms a numerous class of salts, the oxalates. the principal are those of KO & NH_3.

Oxalate of KO. $2KO, C_4O_6 + 2HO$.
Soluble in HO. crystallizes in

There is a bin; & quadroxalate wh is is found in sorrel & cress.

neutral	Binoxalate	Quadroxalate
$\left.\begin{matrix}KO\\KO\end{matrix}\right\vert C_4O_6$	$\left.\begin{matrix}HO\\KO\end{matrix}\right\vert C_4O_6$	$\left.\begin{matrix}HO\\KO\end{matrix}\right\vert C_4O_6 + \left.\begin{matrix}HO\\HO\end{matrix}\right\vert C_4O_6 + 4HO$.

Oxalate of ammonia.
Prep. Saturate oxalic acid with NH_3 & crystallize.
It is largely used for testing, as for salts of lime, with wh it gives a white precipitate of

neutral oxalate of lime.

Oxalate of lime

Occurs native in the animal & vegetable kingdoms.

Succinic acid. $2HO C_8 H_4 O_6$

It is homologous with acetic acid

It occurs in amber in various fossil resins. in turpentine, & in the animal kingdom, in the spleen of oxen.

It is formed by the oxidation of some organic substances, by the putrefaction of plants of the asparagus kind & by the fermentation of malate of lime.

Prop. It is a white brilliant, crystalline acid, crystallizes in rhombic prisms, not easily soluble in cold alcohol, soluble in hot alcohol soluble in HO. From 175 to 180° C it sublimes.

It is a fixed acid not easily acted on by reagents.
Like most bibasic acids it forms neutral & acid succinates,

Negative radicals.

We have been considering positive radicals. the radicals of the alcohols, the general formula for wh is C_nH_n+1 as for example ethyl $C_4H_5 = C_4H_4+H$
The general formula of negative radicals is C_nH_n-1. as for example acetoyl C_4H_3
Allyl C_6H_5
Angelyl $C_{10}H_9$
How can we consider these as olifines?
C has a great tendency to unite with itself.
Allyl $C_6H_5 = \left(\left\{\begin{matrix}C_4H_4\\C_2\end{matrix}\right.\right)^{\prime} H$. C_2 having united with the C in the olifine, & the biatomicty of the radical thus formed not being fully

gratified by uniting with 1 of H.
as ethyl $C_4H_5 = C_4H_4''H$.
It is not mere speculation that C unites with itself.
It may be so in the case of allyl but it is known in the case of naphthaline $C_{20}H_8$ a body wh. chokes up gas pipes & wh. has all the characters of an olifine.
Allyl C_6H_5 or in the separate state $C_{12}H_{10}$. liquid S.G 0.58 boils at 59°C. It has the synonym acryl. It has been got in a separate state.
Got by the action of Na on iodide of allyl.
It is a volatile etherial liquid burns with an illuminating flame, unites with Br & I & forms compounds.
Sulphide of allyl or oil of garlic C_6H_5S. boils at 140°C.

Occurs in garlic & may be distilled from it & then forms sulpho of allyl. Oil of mustard is the sulphocyanide of allyl.

Oil of garlic C_6H_5S
— — mustard C_6H_5CyS.

It may be got artificially. Act on iodide of allyl by KS.
$C_6H_5\underbrace{I+K}S$

Allyl ether C_6H_5.
— — alcohol $C_6H_5O\,HO$.

When oxidized it forms an acid corresponding to acetic, acrylic acid.

Oxidized radicals of allyl.

Alcohol $C_4H_6O_2 - 2H = C_4H_4O_2$ aldehyde.
— — — $C_4H_6O_2 - 2H + 2O = C_4H_4O_4$ acetic acid
Allyl alcohol $C_6H_6O_2 - 2H = C_6H_4O_2$ acryl aldehyd
— — $C_6H_6O_2 - 2H + 2O = C_6H_4O_4$ acrylic acid.

Allyl or acryl aldehyde synonym acrolene.

It is the nasty smell you perceive when you blow out a can-

dle
In this case it is got from glycerin wh is distilled in the red hot part of the wick.
It has a frightful smell, extremely pungent. attacks the eyes, & if concentrated burns the skin.

Oxidized allyl alcohol.

Homologues of acrylic acid

Acrylic acid	$C_6H_4O_4$	same as acetic acid series (with 2C added)
Angelic	$C_{10}H_8O_4$	from Angelica root
Damaluric	$C_{14}H_{12}O_4$	in urine of cows.
Hypogaic	$C_{32}H_{30}O_4$	in earth nuts.
Oleic	$C_{36}H_{34}O_4$	in most fats.
	$C_{38}H_{36}O_4$	
	C	in mustard seed

Oleic acid. $C_{36}H_{34}O_4 = HOC_{36}H_{33}O_3$
Occurs in most oils & fats as a glyceride.
May be got from almond oil by saponifying & converting it

into a lead soap & acting on this by H Cl.

It is tasteless has no smell, does not act on vegetable colours

It is solid below 14°C, is insoluble in HO. soluble in alcohol & ether.

With NO_4 it forms a solid substance. Pass NO_4 thro' castor oil wh contains much oleic acid.

Glycerine. The basis of fats.

It appears to contain the same radical as allyl.

$C_6H_5'\,O\,HO$ allyl alcohol

$C_6H_5'''\,O_3\,3HO$ Glycerin

The atoms cannot be arranged in the same way

$$\begin{pmatrix}C_4H_4''\\C_2\end{pmatrix}HO$$

$\begin{pmatrix}C_4H_4\\C_2O_2\end{pmatrix}HO$ in Glycerine ether.

·Glycerin. $C_6H_8O_6$

Liquid S.G 1·97.

Prep. Distil fats with superheated steam.

It is a colourless, syrupy, liquid does not crystallize, has no smell, sugary sweet taste, not volatile except in the vapour of steam. When distilled by itself it is decomposed

When acted on by yeast it yields propionic, acetic & formic acid
When heated with KO
$C_6H_8O_6 + 2KO = \overset{\text{acetate of KO}}{KOC_4H_3O_3} + \overset{\text{formeate of KO}}{KOC_2HO_3} + 4H$
Made by synthesis.
Make iodide of allyl C_6H_5-I.
Act on it by 3 Br. $C_6H_5-I + 3Br = C_6\overset{'''}{H_5}Br_3 + I$.
$C_6\overset{'''}{H_5}Br_3 + 3KOC_4H_3O_3 = 3KBr + \overset{\text{teracetate of glycerine}}{C_6H_5O_3,3C_4H_3O_3}$
Decompose with HOKO or HOBaO.
$C_6H_5O_3.3C_4H_3O_3 + 3BaO,HO$

Saponification
Making soaps from glycerides

All ordinary fats are glycerides the 3 atoms of HO in glycerine being replaced by 3 atoms of a fatty acid.

$C_6H_5O_3 . 3HO$

$C_6H_5O_3 . 3$ acetic acid.

$C_6H_5O_3 , 3F$ F = fatty acid.

Glycerides or common fats.

Occur in the animal & vegetable kingdoms, embracing all the fats we know.

Fats may be prepared artificially.

Seal glycerin & stearic acid up in a tube & expose to a high temp.

These fatty glycerides are easily decomposed.

They are generally mixed with other fats.

To get stearine treat mutton fat with cold ether wh. dissolves out palmitine & oleine.

Stearine $C_{114}H_{110}O_{12}$ = tristearate of glycerin

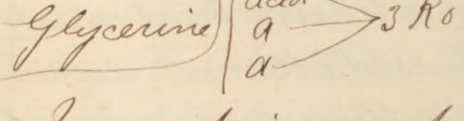
$$C_6H_5O_3 \left| \begin{array}{l} C_{36}H_{36}O_3 \\ C_{36}H_{35}O_3 \\ C_{36}H_{35}O_3 \end{array} \right.$$

It is a colourless pearly fat, melts at 63°C. Insoluble in HO, slightly in cold alcohol & ether.

Saponification is decomposing this fat, taking away the glycerin & putting in 3KO instead. Glycerine is triatomic so you put $3=^{s}$ of a monoatomic body instead

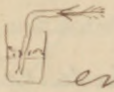
$$\begin{array}{l|l} KO & C_{36}H_{35}O_3 \\ KO & C_{36}H_{35}O_3 \\ KO & C_{36}H_{35}O_3 \end{array}$$

Mix hot alcoholic solutions of KO & of stearic acid on cooling you get a soap, the glycerine remaining dissolved in the alcohol.



In making soap. take a

glyceride & potash ley & pass steam thro' it.



When the heat is great enough to melt the tallow a soap is formed.

In ordinary soap making a soft soap is made when KO is employed; with NaO a hard soap is obtained.

It is easier to make a KO than a NaO soap because it saponifies more easily.

It is afterwards made into a NaO soap by salting.

$KOS + NaCl$

Yellow soap. Boil tallow or palm-oil with an alkali & add rosin & salt out.

Mottled is got from tallow or palm oil, an Fe soap makes the mottling

Castile or Marseilles soap is

got from olive oil & mottled with FeS. & alkaline sulphides.

Chief fats.

Palmitine. Tripalmitate of glycerin ether. Exists in most fats, especially the softer kinds, in palm & cocoanut oils

May be got from olive oil by cooling.

Margarine. Supposed formerly to contain margaric acid wh is now known to be a mixture of palmitic & stearic acids.

Oleine. Trioleate of glycerine ether

Expose olive oil to cold to separate the palmitine & the oleine remains.

Natural fats are of 3 kinds
1st Solid like tallow
2nd " Semisolid like butter
3d " Liquid like oil.

They are all lighter than, & insoluble in, HO; all soluble in ether, many in alcohol. They occur in the animal & vegetable kingdoms, in all animal fluids except urine.

Vegetable fats.

Cocoanut oil. Melts at 20°C, contains various acids glyceride of coccinic

Palm oil. Melts at 27°C. is a yellow butter like substance, 20000 tons of it are imported annually from Africa. it soon becomes rancid, contains palmitine & oleine.

Vegetable oils may be divided into drying & non drying.

Nondrying. Colza.

Drying. Linseed croton & castor oils

Animal fats.

Suet. Fat of oxen & sheep, melted & freed from nitrogenous matter. consists of oleine, stearine & palmitine

Lard contains stearine & palmitine.

Human fat is like lard melts at 25°C.

Spermaceti. When pure contains cetine, not glycerine but a substance corresponding to it.

Cetine $C_{64}H_{64}O_4 = \overset{\text{ethal ether}}{C_{32}H_{33}O}, \overset{\text{palmitic acid.}}{C_{32}H_{31}O_3}$

Sperm & codliver oil are examples of liquid animal fats.

Aromatic series.

There are several of these radicals.

Phenyl	$C_{12}H_5$
Benzyl	$C_{14}H_7$
Xylyl	$C_{16}H_9$
Cumenyl	$C_{18}H_{11}$
Cymyl.	$C_{20}H_{13}$

Phenyl. It is an important series. It contains benzole used in making coal tar colours.

Phenyl ether. $C_{12}H_5O$

It is got by distilling benzoate

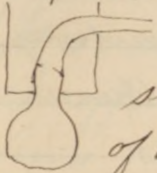
of Cu.

It is colourless, smells slightly like a geranium. it is soluble in alcohol.

Chloride of Phenyl. $C_{12}H_4Cl$.

Hydride of Phenyl or Benzol sometimes called Benzine. $C_{12}H_5\text{-}H$ corresponds to $C_4H_5\text{-}H$.

Prep. Distil coal tar.



A vessel filled with HO surrounding the neck of the retort is kept at a temp. of 170°, the temp. at wh. benzole distils, other substances wh. distil at a higher temp. are cooled & fall back into the retort while the benzole distils over.

It is used for cleaning white kid gloves. & for taking out grease spots. To use it rub the benzole

all round the spot without touching it, & bring it gradually over the spot.

It is a colourless, thin oil, of an agreeable odour when pure, solid at 0°C melts at 5°C, burns with a smoky illuminating flame increases the illuminating power of gas.

It is a good solvent for fats & camphors, it dissolves S. I. & Br readily, possibly uniting to some extent with them.

Benzyl $C_{12}H_5H$

Benzyl ether

—— alcohol $C_{12}H_5O,HO$.

When pure & free from HO it is a white crystalline solid substance.

Kreosote consists of carbolic, cressylic & probably of some higher acid

Phenyl alcohol or carbolic acid.

$C_{12}H_6O_2$: Boils at 185°

Found in cows urine, in coal tar.

Solid when quite dry & crystallizes in needles, wh. melt at 35° C.

It has a disagreeable smell, burning taste, is heavier than HO, in wh. it is slightly soluble. it is soluble in alcohol & ether.

It is an active poison to animals & plants.

It is a strong antiseptic.

A coffin filled with carbolate of lime preserved a body for 2 months.

Carbolate of lime & sulpite of lime form Macdougals disinfecting powder.

Nitrophenyl ether $C_{12}H_5NO_4$.

Usually called nitrobenzole.

It is $C_{12}H_5H$ having the H replaced by NO_4.

Prep. Act on benzol by fuming $HONO_5$.

It is a yellow oily liquid, solid at 3° C, smells like oil of bitter almonds, for wh. it is used in perfumery & confectionery with advantage since it is not poisonous while oil of bitter almonds often contains hydrocyanic acid. It has a sweet taste, insoluble in HO, soluble in alcohol & ether. Used in making anilene.

Anilene is NH_3 in wh. 1 equivalent of H is replaced by phenyl.

$$N\left|\begin{matrix}H\\H\\H\end{matrix}\right. \qquad N\left|\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right.$$

To obtain aniline act on nitrobenzol by some deoxidizing agent. That usually employed is acetate of Ko.

$$C_{12}H_5NO_4 + 2HO + 4Fe = C_{12}H_7N + 2Fe_2O_3$$

Or by acting with HS.

$$C_{12}H_5NO_4 + 6HS = C_{12}H_7N + 4HO + 6S$$

Nitrophenyl alcohol. $C_{12}H_2(NO_4)_3OHO$.

It is carbolic acid in wh. part of the H is replaced by NO_4 & has

the synonym of carbosotic acid
Prepared by the prolonged action of $HONO_5$ on kreosote or carbolic acid. It is formed by oxidizing silk, salicin, indigo, aloes, gum benzoate, & resins.

Prop. It crystallizes in brilliant yellow plates, may be sublimed with care, soluble in alcohol & cold HO, more readily in hot HO soluble in hot $HOSO_3$, is an active poison.

May be used in small doses instead of quinine but makes the patients skin yellow.

Used to dye silk & woolen.

It has been proposed to mix it with As. before selling it in shops. as it has an intensely bitter taste, & would be detected. In cases of slow poisoning it would make the skin yellow & thus draw attention

Carbosotates crystallize in well defined salts.

The acid characted is due to the electronegative character of the radical.

Benzyl $C_{14}H_7$

— — ether $C_{14}H_7O$.

It is an oily liquid & is got by the action of BO_2 on benzyl alcohol.

Toluol. Hydride of Benzyl. $C_{14}H_7H$

Obtained from light coal tar & Tolu balsam.

It is colourless & resembles benzol in its properties, is insoluble in HO soluble in alcohol & ether.

$HONO_5$ act on it in the same way as on benzol.

Benzyl alcohol $C_{14}H_7O,HO$.

It is an oily colourless liquid insoluble in HO soluble in al-

cohol & ether.
By oxidation it becomes the oil of bitter almonds.

In the olifine view.

Benzyl alcohol	$C_{14}H_6''HO\,HO$
——— ether	$C_{14}H_6''HO$
oil of bitter almonds = biatomic ether	$C_{14}H_6''O\,O$
benzoine is the aldehyd.	$C_{14}H_5O''HO$
Benzoic acid.	$C_{14}H_5O''OO$.

Oil of bitter almonds. general formula $C_{14}H_6O_2$.
liquid S.G 1.043 boils at 180°C.
Obtained when almonds are macerated & distilled with HO.
It is a fragrant oil, transparent very refractive, has a powerful smell, is used in perfumery, is not poisonous in itself but often contains hydrocyanic acid
When it contains this & is put in contact with lime it is

changed into benzoin
Benzoic acid.
Occurs in putrid horses urine

Obtained by sublimation from gum benzoate.
It is volatile, slightly soluble in HO soluble in alcohol & ether.
When taken as a medicine it is converted into hippuric & is found as such in the urine.
Benzoates are crystalline, when heated they are decomposed into benzoin. naphthaline
Let us now go back to the phenyl series & consider the coal tar colours.
The phenyl series differs from the benzyl by C_2H_2.
Phenyl $C_{12}H_5$ or as olefine $C_{12}H_4'' H$
Benzyl $C_{14}H_7$
Manufacture of benzol. nitro-

benzol &c.

When coal is distilled for gas. it produces various substances, HO & tar distil over along with the gas.

Ten to 12 gallons distil over of oil of from 1 ton of coal.

It was formerly a waste product & even yet it is sold at a penny to three halfpence the gallon.

To get naphtha pass steam thro' the tar

On a large scale 100 parts tar yield

Naphtha	9	parts
Dead oil	60	—
Pitch	31	—

Naphtha is nearly the only thing wh comes over with the steam the pitch & dead oil remain in the retort, & the is afterwards distilled by a common fire.

Naphtha is a rough commercial term & signifies a great variety of substances.

Roughly purified it is used for many purposes.

Crude naphtha contains 3 substances.

Basic oils
Acid oils
Neutral hydrocarbons.

Basic oils may be got from the naphtha by agitating with $HOSO_3$.

They are all compound ammonias.

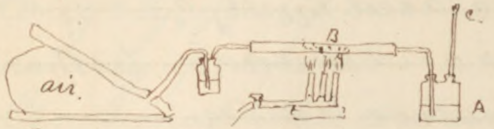
Aniline exists in the basic oils but is not got from them.

Acid oils.

Take naphtha & shake it with caustic NaO or KO the acid oils dissolve in the NaO or KO. & are separated by adding HCl.
When separated they form kreosote wh is carbolic acid $C_{12}H_6O_2$ & cressilic acid $C_{14}H_8O_2$
Carbolic acid is used in toothache & to preserve timber
When acted on by NO_5 it forms carbosotic acid.
Carbolic acid $C_{12}H_6O_2$
Carbosotic -- $C_{12}H_3(NO_4)_3O_2$
Carbosotic acid is a strong dying agent. Dissolve a little in a little hot HO & then add some cold, you get a solution excellent for dying silk yellow. Wet the silk in HO & rinse in the carbosotic acid. This is the first use of coal tar in colouring substances.

Neutral hydrocarbons.

Chiefly benzol & its homologues. The benzol is distilled by passing it thro' a cistern of HO at 177°. Benzol is very volatile, & it is possible to burn air charged with it.



Dried air is passed over heated asbestos B to heat the air, & thro' some benzol in A the air then may be burned as at c.

It may be used for setting enemy's ships on fire by pouring it on the HO & throwing some K on it wh. takes fire & inflames the benzol.

Nitrobenzol. $C_{12}H_5NO_4$

Benzol acted on by NO_5. It is used in perfumery.

To get colours from it, it is first

made into aniline

$C_{12}H_5NO_4 + 2HO + 4Fe = \overset{\text{aniline}}{C_{12}H_7N} + 2Fe_2O_3$

Aniline. $C_{12}H_7N$

It is a compound ammonia.

A short time ago ½ lb of aniline would have been thought very valuable in a laboratory & probably none possessed so much except perhaps who was making researches upon it

It was a short time ago sold for a few shillings per gallon but has now risen in price in consequence of the demand for it & is now a few shillings per pound.

From aniline are made

Mauve or purple

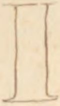
Violine

Rosein

Magenta or Rosaniline

Azuline

These tar compounds are capable of producing colours



Put 2 drops of pyroline in a jar & shakes up — moistens a piece of pine wood in the shape of a dagger with HCl & put it into the jar, — the moistened point becomes red.

Mauve.

Put some aniline (a very little will do) into a bottle & add a little acetic acid to assist its solubility. you get a solution of acetate of aniline, pour into

HO & add chloride of lime — it becomes brown at first but afterwards becomes purple.

On a large scale it is prepared by acting on sulpate of aniline by $KO,2CrO_3$ in equivalent quantities.

You get a dark powder, wash

this with coal tar & dissolve it in alcohol

The alcoholic solution is evaporated to dryness & you get a green powder wh is soluble in alcohol.

It is from the alcoholic solution that we dye the colours.

Pour a little tartaric acid into some hot HO & pour in a small quantity of alcoholic solution of mauve.

Wet the silk to be dyed & put it in.

The chemistry of the colour is not well understood.

It is easily tested by $HO\,SO_3$.

Add a little strong $HO\,SO_3$ to a little mauve & you get a dirty green solution.

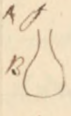
Add a little HO & you get a fine blue. Add a good deal of HO & it becomes mauve again

125

Magenta.

The true red colouring matter is rosaniline.

In making it take a weak deoxidizing agent instead of a strong as with mauve.



Take a small quantity of anhydrous bichloride of Sn as that in the sealed tube A, pour it into the flask B, add aniline cautiously, it forms a solid compound, gradually add more aniline till you have an excess. Heat cautiously over a lamp. The action is violent.

Any weak anhydrous

Acetic acid & $As\,O_5$ are also used. It is necessary to boil off the excess of aniline.

Bleu de Paris or azuline Is got from carbolic acid.

Put a very little mauve or magenta on a sheet of paper hanging up & spout alcohol from a washing bottle on it, the colour dissolves running over the paper.

The chemistry of some of these colours is known

Rosaniline is a triammonia 3 atoms of H coalescing into one. $NH_3 \times 3 = N_3H_9$. The compounds radical substituting H is unknown.

Let R signify rosaniline.

R unites with 1 or 3 atoms of acid.

R+1A gives the strongest colour.

R+3A — — a less strong — .

R is colourless by itself, but when dissolved in alcohol or acid it has a strong colour.

Magenta is acetate of R.

In the case of the purples we must use hot HO in dying but in the case of carbosotic acid & magenta, cold will do. All animal fibres take up these colours readily. Cotton does not & you must treat it with tannic acid.

Purple & violine are not true ammonias, they seem to be neutral

In cotton printing, albumen is put on the place wh is desired to be coloured & exposed to steam. & dried. It is then rinsed in a solution of the dye as silk is, the vegetable fibres do not take it up but the albumen does.

Malic acid $2HO\,C_8H_4O_8$

It is bibasic. It occurs frequently in unripe fruits, in the apple but is got most easily from the berries of the mountain ash. It has a strong acid, agreeable taste.

When heated it is changed into fumaric acid

Fumaric acid. $2HO\ C_8H_2O_6$.
It is readily obtained from Iceland moss or malic acid.
It forms micaceous scales wt require 200 parts of cold HO for solution.

Tartaric acid. General formula $C_8H_6O_{12} = 2HO\ C_8H_4O_{10}$.
Occurs in the tamarinds & mountain ash berries, but is got chiefly from grapes.
The substance called argol found in wine casks is bitartrate of KO.
It is obtained in rather a curious way from this by converting it into neutral tartrate of lime.

argol $\left.\begin{matrix}KO\\HO\end{matrix}\right\}\overline{T}$ Add CaCl & lime; if you added CaCl alone you would get $\left.\begin{matrix}CaO\\HO\end{matrix}\right\}\overline{T}$ but by adding lime too you get $\left.\begin{matrix}CaO\\CaO\end{matrix}\right\}\overline{T}$

Add $HOSO_3$ to this

$$\left.\begin{matrix}CaO\\CaO\end{matrix}\right\}\overline{T} + 2HOSO_3 = \left.\begin{matrix}HO\\HO\end{matrix}\right\}\overline{T} + 2CaOSO_3.$$

It crystallizes in oblique prisms is colourless transparent, of an acid agreeable taste, soluble in HO alcohol & wood spirit, its solution especially when hot exerts a right-handed rotation on polarized light

There are two different crystalline forms.

Sometimes, especially in the grapes of the Vosges, an acid of the same formula as tartaric acid called racemic.

Racemic acid is rather difficult to get as it only appears sometimes.

Racemates crystallize differently from tartrates & have a different number of atoms of

HO of crystallization.

It was supposed to be an isomer of $\overline{T}$ & to have its atoms arranged differently.

$\overline{T}$ produces a right handed rotation of polarized light

Racemic acid a lefthanded one.

The crystals were unsymmetrical but in different directions.

Pasteur showed that when put together they are symmetrical

It is thus the same acid in different crystalline forms.

Tartrates are used largely in medicine & the arts.

Used in calico printing.

If in calico printing you wish a part to remain white you use tartaric acid as a resist to the mordant wh. is always used.

The mordant forms a very soluble tartrate & does not remain on that place, & so the dye does not adhere to that place.

In all cases of bibasic acids as tartaric acid where you have 2 HO thus $\left.\begin{matrix}HO\\HO\end{matrix}\right\}\bar{T}$ you may replace 1 HO or both.

$\left.\begin{matrix}HO\\HO\end{matrix}\right\}\bar{T}$. $\left.\begin{matrix}KO\\HO\end{matrix}\right\}\bar{T}$ $\left.\begin{matrix}KO\\KO\end{matrix}\right\}\bar{T}$ $\left.\begin{matrix}NaO\\KO\end{matrix}\right\}\bar{T}$.

Argol is cream of tartar or bitartrate of KO

$\left.\begin{matrix}HO\\KO\end{matrix}\right\}\bar{T}$. It is hard white & crystalline difficultly soluble in cold HO, more soluble in hot HO; has a sour taste & feels gritty to the teeth. When heated it forms black flux. Bitartrate of KO is extensively used in medicine as a diuretic.

Neutral tartrate.

It is deliquescent.

All acids, even tartaric acid, convert it into cream of tartar.

Rochelle salts. $KO, NaO\,\bar{T} + 8\,HO$.

$\left.\begin{matrix}KO\\NaO\end{matrix}\right\}\bar{T}$. Crystallizes with 8 HO, in large clear. rhombic prisms, is used in medicine. forms the basis of seidlity powders.

Tartar emetic.

It is a double salt corresponding to cream of tartar.

$\left.\begin{matrix}KO\\SbO_3\end{matrix}\right\}\bar{T}$ + aqua.

Mix 3 parts SbO with 4 cream of tartar, & make into a paste, digest

It is soluble in 15 parts HO, is a violent emetic. in larger doses acts as a cathartic poison.

Kinic

Occurs in chinchona bark.

Crystallizes in colourless prisms wh. melt at 155°C. solid on cooling at a higher temperature it is decomposed.

Tribasic acids.

Citric acid $C_{12}H_8O_{14}$.

Occurs in the lemon, gooseberry cherry & tamarind.

As citrates in the tumours of the Jerusalem artichoke.

Only the fruits wh contain acid united with alkali become sweet on ripening the acid being converted into sugar.

Where acid is free as in the lemon, it does not become sugar.

It is prepared like tartaric acid but is more easily made since it has no tendency to become uncrystalline as tartaric acid is apt to do.

It crystallizes in large colourless prisms, very soluble in HO & alcohol, not in ether.

It is used in calico printing both as a resist & to heighten the colours.

Heated to 175° it is decomposed & becomes

$C_{12}H_8O_{14} - 2HO = C_{12}H_6O_{12}$

Fused with lime it forms oxalate & acetate of lime.

$C_{12}H_8O_{14} + 2HO$ from the $HOCaO = C_4H_2O_8 + 2(C_4H_4O_4)$.

Citrates are necessarily a large class. Citric is a tribasic acid.

$$\left.\begin{array}{l} HO \\ HO \\ HO \end{array}\right| C_{12}H_5O_{11}.$$

Aqunitic acid.

Found in aconitum

Forms warty crystals easily soluble in HO

It is the acid in opium, it is a white silvery acid, loses its HO of crystallization at

Gallic acid. $2HOC_{14}H_6O_{10}$

It is bibasic, is contained in gall nuts in mango seeds in sumach.

It is got artificially by the splitting up of tannin when it is boiled. It is white, silky. crystalline. soluble in 3 parts of boiling HO & 100 cold HO, with a salt of Fe it forms ink. When heated to 210° it is decomposed, it loses C_2O_6 & becomes pyrogallic acid.

Pyrogallic acid. $C_{12}H_6O_6$ =
Used for estimating O.
With a little alkali it absorbs O completely.

Tannic acid.

Tannic acid is a general name for organic substances wh. precipitate gelatine & form leather. It is contained in the leaves & bark of most forest trees, especially the oak, elm
in the whortleberry, tea & coffee. Tannic acid except that from coffee. precipitates protosalts

of Fe a blue black, or in acid solutions of a dark green.
Some like tannic acid from catechu precipitate it a dark green.

Gallotannic acid $C_{54}H_{22}O_{34}$

Obtained from gall nuts.
Take an ethereal solution of gall nuts, it divides into two parts the upper part is gallic & the lower tannic acid.
Obtained thus it is a white, crystalline body soluble in HO. soluble in weak alcohol & ether.
The aqueous solution absorbs O

Gallotannic acid should be called tannin, it is a glucoside.
Act on it by acid wh. bring HO into play.

$C_{54}H_{22}O_{34} + 8HO = 3(C_{14}H_6O_{10}) + C_{12}H_{12}O_{12}$.

Boil tannic acid with HCl,

It is not certain whether it is a bi- or tri~~atomic~~ basic acid.

It is used in medicine as an astringent.

Ink. Gallotannate of Fe.

Take ¾ lb of bruised gall nuts, dissolve them in 1 gallon of cold HO, add 6 oz of $FeOSO_3$. 6 oz of gum arabic 5 drops of kreosote to prevent it moulding, digest at common temps. for 2 or 3 weeks, shaking frequently.

Ink stain = Fe_2O_3 To take it out heat with a little oxalic acid. it forms soluble oxalate of Fe.

Gallotannate or tannate of gelatine.

The object in tanning is to unite the skin with acid to prevent putrefaction, & yet leave the skin supple.

The time required varies, as, the hippopotamus skin is 2 inches thick & requires nearly a year. while the kids' skin is only a fraction of an inch thick & requires only a few weeks.

The processes are,

1st. Place the skin in lime. the root of the hair is attacked by it Remove the hair with a knife & open the pores by placing in a pit of $HOSO_3$ & HO.

Layers of skins & oak-bark are laid in pits for 3 months, they are then taken out & fresh bark is added, the skins are then placed in again so that the one wh had been at the top is now at the bottom & allowed to remain there for some time.

It is strange that no quicker

process can be employed

The use of hydraulic presses to force the liquor into the pores, & of stronger solutions does not make such good leather

If Simon the tanner of Joppa came back to this world he would find the trade precisely as he left it.

In white kid gloves no tannic acid is used, it is protected by aluming

Tawed leather.

The skins are cleaned & treated with $Al_2 Cl_3$ made by mixing alum & $NaCl$, & then rubbed with oily substances

In chamois leather as much oil is put in as possible.

Compound haloid radicals.

The chief representative is cyanogen $C_2 N$.

It has perfectly parallel characters with any other haloid.

$$\left.\begin{matrix}Cl\\Cl\end{matrix}\right\}\begin{matrix}4\\\text{vols}\end{matrix}\qquad \left.\begin{matrix}Cl\\H\end{matrix}\right\}\begin{matrix}\text{hydro-}\\\text{chloric}\\\text{acid}\end{matrix}\qquad \left.\begin{matrix}Cl\\K\end{matrix}\right\}\begin{matrix}\text{chloride}\\\text{of K}\end{matrix}\qquad \left.\begin{matrix}Cl\\I\end{matrix}\right\}\qquad \left.\begin{matrix}Cl\\O\end{matrix}\right\}$$

$$\left.\begin{matrix}C_2N\\C_2N\end{matrix}\right\}\begin{matrix}4\\\text{vols}\end{matrix}\qquad \left.\begin{matrix}C_2N\\H\end{matrix}\right\}\begin{matrix}\text{hydro-}\\\text{cyanic}\\\text{acid}\end{matrix}\qquad \left.\begin{matrix}C_2N\\K\end{matrix}\right\}\begin{matrix}\text{cyanide}\\\text{of K}\end{matrix}\qquad \left.\begin{matrix}C_2N\\I\end{matrix}\right\}\qquad \left.\begin{matrix}C_2N\\O\end{matrix}\right\}\begin{matrix}\text{cyanic}\\\text{acid}\end{matrix}$$

Cyanogen was the 1st compound radical clearly established in organic chemistry.

Cyanogen C_2N. = 26. if it has 2 vols. 52 if 4 vols. S.G of gas 1.806.

Symbol. Cy. It is monoatomic. The reason for this is that though N is pentatomic but is joined to 2 of C wh is biatomic & has thus 4 atoms filled up & only 1 left.

$$\overset{'''''}{N}-\overset{''''}{C_2}=C_2N'$$

Cy has the power of doubling itself & forming other radicals.

Cy C_2N
Bicy. C_4N_2
Tricy C_6N_3
mellan $C_{18}N_{13}$.

Cy is best got by heating cyanide of Hg in a tube. This corresponds to the method of getting O.

HgO_2 heat = $Hg + 2O$
$HgCy_2$ — = $Hg + 2Cy$.

A black substance is left in the tube wh. has the same composition as Cy.

Prop. It is colourless, has a peculiar prussic acid odour, at a pressure of 3 atmospheres it becomes liquid & the liquid solidifies at -35°C, it burns with a purple flame, producing CO_2 & N, it is soluble in HO & alcohol the latter takes up 22 vols. of it. The solutions decompose & urea is formed.

Urea is an anomalous cyanate of NH_4.. NH_4OC_2N

K unites with Cy as it does with Cl.

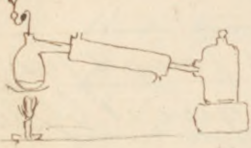
Hydrocyanic or prussic acid.
$HCy = 27$. S·G of the gas 0·9476.
4 vol vap. formula.

Occ. Probably never found free but various seeds give it by distillation owing to the action of ferments on it. Almonds, peaches, apricots, the leaves of peaches & the kernels of plums yield it.

Mode of preparing it. Distil KCy with $HOSO_3$, pass over $CaCl$ & condense by ice. S·G of liquid 0.967 boils at 26°C solid at -15°C Has a smell like bitter almonds is an intense poison is soluble in all proportions in HO & alcohol.

Does not keep well, after a while perhaps 2 or 3 years it becomes black & is apt to explode, you then break it under HO to prevent this, Aqueous solution of HCy

Prep. Distil yellow prussiate of



KO & $HOSO_3$. You get a solution of unknown strength.

The medical strength is 2 percent of prussic acid.

The London pharmacopia process for getting a solution of known strength, is:-

Suspend $48\frac{1}{2}$ grams of cyanide of Ag in 1oz HO & add $39\frac{1}{2}$ of HCl.

An extemporaneous solution of HCy may be made by adding KCy to $\overline{T}$ & stirring, you get bitartrate of KO & a solution of HCy.

The aqueous solution is more permanent if you add a little mineral acid.

Solution of HCy under the action of strong acids or alkalis decom-

-poses into formiate of NH_4.
$C_2NH + 4HO = NHOC_2HO_3$
HCy is easily tested.
Test: Take $FeOSO_3$ wh has been a little rusted in air. If not rusted add a few drops of a persalt of Fe. Add HOKO to precipitate the oxide of Fe. Add HCl to neutralize the KO & take up the Fe. Add these to the suspected solution & if HCy be present prussian blue is produced.
The rationale of this process is. HCy, KO & a salt of Fe make yellow prussiate of KO. if you add HCl to make a solution of Fe prussian blue is produced.
Another test. Put the suspected solution in a watch glass & add a drop or 2 of sulphide of NH_4. to

neutralize it, put over it another watch glass &

evaporate it to dryness in a hot water bath. Add perchloride of Fe. You are producing sulphocyanide of K wh. has the property of striking a blood red colour with perchloride of Fe.

When used as a poison it quickly escapes from the system on account of its volatility so that 3 days after you cannot detect it, in the body.

Cyanides resemble the haloid salts of Cl & are got in the same way.

To get KCl $HCl + KO = KCl + HO$

— — KCy $HCy + KO = KCy + HO$.

On a large scale KCy is got by heating yellow prussiate of KO with $KOCO_2$.

Yellow prussiate of KO. $K_4Fe_2Cy_6$

$K_4Fe_2Cy_6 + 2KOCO_2 = 5KCy + KOCyO + 2Fe + 2CO_2$. You can prevent the formation of $KOCyO$ by adding a little C.

$K_4Fe_2Cy_6 + 2KOCO_2 + 2C = 6KCy + 2FeO + 2CO_2 + 2CO$.

Dissolve it out & evaporate it down. It is used largely in electrotyping to dissolve Ag & Au, & as a reducing agent.

Bicyanide of Hg. $HgCy_2$.

Boil 4 parts prussian blue 3 of peroxide of Hg & 40 of HO.

It crystallizes in prisms, soluble in HO more difficultly soluble in alcohol, very poisonous. Alkalis do not precipitate HgO from it.

Cyanide of Ag. $AgCy$.

Prep. Add KCy to a salt of Ag. It unites with KCy & readily forms double salts.

Haloid ethers of Cyanogen.

Cy unites with ethyl as Cl does.

· Prep. of cyanide of ethyl.
Add KCy to C_4H_5-I.
C_4H_5-I + KCl = C_4H_5Cl + KI. Prep. of chloride of ethyl
C_4H_5-I + KCy = KI + C_4H_5-Cy cyanide of ethyl.
We find the Cy has gone in more intimately to the ethyl than we would suppose

· On this account
These compounds are called Nitriles.
Cyanide of ethyl. $C_4H_4C_2N$.
It is a colourless liquid, mobile of an agreeable but garlicky odour
Does not comport itself with alkalis like ordinary ether.
It is soluble in alcohol & ether.
C_4H_5-Cl + KOHO = KCl + $\underset{\text{propionate of KO}}{C_4H_6O_2}$
C_4H_5-C_2N + KOHO + 2HO = KO$C_6H_5O_3$ + NH_3
Propionic acid one above C_4H_5 in the series.

Act on a nitrile by an alkali & you get the acid one above it in the series.

Double electro negative cyanides.

The cyanides form a remarkable series of salts when certain metals combine with them, especially Fe

$4KCy + 2FeCy$ = yellow prussiate of KO.

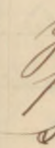
If you get an insoluble cyanide of Fe. by adding $FeOSO_3$ to KCy & add excess of KCy to the insoluble salt it gradually dissolves & you get a solution of yellow prussiate of KO.

Suppose the Fe has formed a compound radical with Cy. Fe_2Cy_6'''' called Ferrocyanogen.

Yellow prussiate of KO is this +4K & crystallizes with 6HO.

Add HCl to this

$Fe_2Cy_6 + 4K + 4HCl = 4KCl + Fe_2Cy_6 4H.$



Has a solution of yellow prussiate of KO in the tube, add HCl & ether

$Fe_2Cy_6 4H$ = Hydroferrocyanic acid, is insoluble in ether.

A bluish white compound is formed.

Occurs in crystalline plates, soluble in HO, is readily precipitated by ether.

The solution quickly becomes blue, when boiled HCy is evolved,

When the $4H$ are substituted by $4K$ you get yellow prussiate of KO.

Yellow prussiate of KO.

It is used in the arts largely.

Prep. Cast off woolen garments, horns & hoofs of cattle, flesh & blood any thing that contains N are mixed with scrap Fe & Montreal pearl ashes & heated.

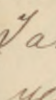
$Fe_2Cy_6 4H$ = Hydroferrocyanic acid

$Fe_2Cy_6 4K$ = yellow prussiate of KO. It is formed when a substance containing N is fused with $KOCO_2$ & Fe or allowed to digest on Fe. Occurs in lemonyellow tabular crystals soluble in HO not soluble in alcohol, of a bitter taste & purgative but not poisonous. If you take away 1 of K & make red prussiate it becomes intensely poisonous

Yellow prussiate is tetrabasic.

$$Fe_2Cy_6\left\{\begin{matrix}2Ba\\2K\end{matrix}\right. \qquad Fe_2Cy_6\left\{\begin{matrix}3Cu\\K.\end{matrix}\right.$$

We have doubled the formula on this account.



Add yellow prussiate to $CuOSO_3$ & a mahogany red is produced.

Ferrocyanide of NaO. Na_4Cy_6 + 10HO.

Ferrocyanide of Fe.

Take a solution of $FeOSO_3$ & add yellow prussiate. you get a a precipitate, white at first but wh absorbs O from the HO & becomes blue.

It has this composition. $Fe_2Cy_6\left\{\begin{matrix}3Fe\\K\end{matrix}\right.$.

Add yellow prussiate to a persalt of Fe & you get prussian blue at once. Fe_7Cy_9.

Prussian blue

Prop. It is a beautiful blue of a coppery lustre when dry, after being washed in HO it may be dissolved in oxalic acid.

This when thickened with gum forms Steven's blue ink.

It is readily decomposed by alkalis. Add caustic NaO or KO to prussian blue, it produces a reddish colour & forms oxide of Fe.

Put a cloth dipped in a salt of Fe into prussiate of KO & it is dyed blue.

Ferridcyanogen.

It has the same composition as ferrocyanogen but is tribasic instead of tetrabasic

Fe_2Cy_6'''' radical of yellow prussiate

Fe_2Cy_6''' — — red — —.

Pass Cl thro' a solution of yellow prussiate. $Fe_2Cy_6 4K + Cl = KCl + Fe_2Cy_6 3K$.

Hydroferridcyanic acid.

Is got in the same way & has much the same properties as Hydroferrocyanic acid.

Add HCl to red prussiate of K. & add ether.

Or Add $HOSO_3$ to ferri cyanide of Pb.

Crystallizes in brown needles, bitter easily decomposed.

Ferridcyanides are generally red.

They are distinguished from ferrocyanides by giving no precipitate with perchloride of Fe.

yellow prussiate with a Protosalt of Fe gives a white precipitate

Red prussiate — — — — — — blue

yellow — — — Persalt —— blue

Red — — — — — — dark brown.

Ferridcyanide of K.

Is generally called red prussiate of potash

Crystallizes in ruby red right rhombic prisms, soluble in HO insoluble in alcohol, gives a precipitate with metallic salts in wh all 3 of K are replaced by metal.

$K_3Fe_2Cy_6 + 3AgONO_5 = 3AgFe_2Cy_6 + 3KONO_5$.

Turnbulls prussian blue, is prussian blue got from red prussiate & $FeOSO_3$.

Nitroferrocyanides or nitroprussides.

Fe_2Cy_6''''

Fe_2Cy_6'''

Fe_2Cy_5NO''.

Nitroprusside of Na.

Made by the action of NO_5 on

Nitroprusside of K.
When you add sulphide of NH_4 to this a beautiful purple colour is produced wh. is very transitory. It is the best test for S.
Put a lock of hair into a test-tube & dissolve it in caustic NaO or KO. heating it to aid the solution.
You must always convert the S into an alkaline sulphide.
Adds a good deal of HO so as not to act on the filter & filters it.
Adds nitroprusside of Na & a deep purple is produced showing the presence of S in the hair.
The nitroprussides give a salmon coloured precipitate with salts of H.
Oxides Chlorides & Sulphides of Cy.
It must be recollected that there are 3 sorts of Cy. Cy Cy_2 & Cy_3.

Cyanic acid CyO.

Cyanates are easily got by heating a cyanide with an oxide such as of Pb. CyO is not so easily got.

Distil cyanuric acid & collect the product in a freezing mixture. It is colourless. mobile

A drop on the skin produces a sore. Above 0°C it changes into a porcelain like mass.

Cyanates.

General formula MO CyO corresponding to MO ClO.

They bear heating to redness without decomposition. You do not obtain CyO by acting on them by acids

Cyanate of KO. KO CyO.

Prep. Heat prussiate of Ko with

an oxidizing agent such as MnO_2.
It is soluble in HO, the solution is decomposed when heated.
$KOC_2NO + 3HO = NH_3 + \left.\begin{matrix}HO\\KO\end{matrix}\right\} C_2O_4$.

Cyanite of NH_4. NH_4OCyO.
Prep. Act on cyanate of KO by NH_4OSO_3
It is white crystalline, soluble in HO & alcohol, it is not urea, wh. is an anomalous cyanate of ammonia NH_4OC_2NO.
Chloride of Cy. NC_2Cl.
vap. density 2.124
Act on cyanide of Hg by Cl.
Colourless, very poisonous gas, of a disagreeable pungent smell, at -53° C it becomes liquid.
In closed tubes it becomes double
$CyCl = Cy_2Cl_2$.
Sulphocyanogen.
Sulphocyanates correspond to cyanates S playing the part of O.

CyO

CyS.

It has never been got in a separate state.

A yellow compound got, has been called CyS but does not behave as such.

It forms sulphocyanates w^{h} are interesting because $NaCyS$ at least exists in the saliva of man & the sheep.

Put some saliva in a watch glass & add perchloride of Fe.

Sulphocyanide of K. $KSCyS$.

Prep. Heat together yellow prussiate of $KO, KOCO_2$ &

Bicyanogen Cy_2 C_4N_2.

Not known in its separate state

Bicyanic acid Cy_2O_2.

It has the synonym fulminic acid.

$2HO\,Cy_2O_2$ Fulminic acid
Not known free.
Fulminate of Hg. $2HgO\,Cy_2O_2$
Prep. Heat $HgO\,NO_5$ & alcohol together
It crystallizes in white needles
very explosive, not soluble in cold
HO but soluble in hot.
Add Zn to the solution & Hg is
deposited & fulminate of Zn
remains.
Act on fulminate of Zn by Cl, &
it becomes chloride of Cy. & $C_2(NO_4)Cl_3$
chlor-carbasotic acid.
It is possible that ½ the N in fulminic acid may not be present as Cy.
It is closely allied to Cy.

Persulphocyanic acid.

Little soluble in alcohol & ether
With alkalis it forms soluble

& with heavy metals insoluble salts.

Bichloride of Cy

It is formed when $Cy\,Cl$ is left in a sealed tube.

It is a colourless liquid boils at 15 °C.

Tricyanogen. Cy_3.

Forms cyanuric acid $Cy_3\,O_3\,3HO$.

Got by the action of terchloride of Cy on HO. $CyCl_3 + 6HO = 3HO\,Cy_3\,O_3 + 3HCl$

Transparent crystals, no smell or taste, reacts acid.

Cyanurates

$Cy_3\,Cl$

Expose anhydrous

Crystallizes in brilliant needles wh melt at 140°C boil at 190°C

Smells like the excrements

of mice, difficultly soluble in HO readily soluble in alcohol & ether.

Characters of Cy.

Cy has the character of a radical closely resembles Cl but has the power of duplicating & triplicating itself + forming other radicals

Unites so intimately with metals as to appear to form radicals

Polymerizes itself.

Mellone $C_{18}N_{13}$

Organic bases representative of alkalis & metallic oxides in organic chemistry.

The bases resemble NH_3

They act like NH_3 on hydracids without expelling the H.

They almost all unite with $PtCl_2$ to form double salts.

It is belived that they are all constituted on the NH_3 type.

The general name is amines.

NH_3 Primary Secondary Tertiary

$N\left|\begin{matrix}H\\H\\H\end{matrix}\right. \quad N\left|\begin{matrix}A\\H\\H\end{matrix}\right. \quad N\left|\begin{matrix}A\\B\\H\end{matrix}\right. \quad N\left|\begin{matrix}A\\B\\C\end{matrix}\right.$ Monamines

Example

$$N\left|\begin{matrix}C_4H_5\\H\\H\end{matrix}\right. \quad N\left|\begin{matrix}C_4H_5\\C_2H_3\\H\end{matrix}\right. \quad N\left|\begin{matrix}C_4H_5\\C_2H_3\\C_{10}H_{11}\end{matrix}\right.$$

All these are true ammonias, form salts with hydracids & take up HO when they unite with oxyacids. They are volatile alkalis & have a peculiar odour generally resembling NH_3.

The replacing radicals are generally the common compound radicals.

$\left.\begin{matrix}C_{12}H_3Cl_2''\\H\end{matrix}\right|N$ Chlorphenylamine

$\left.\begin{matrix}C_{12}H_3(NO_4)_2\\H\end{matrix}\right|N$ dinitrophenylamine

When you have such substitutions as these, electro negative bodies replacing H, the basic power of the body is much impaired & in some cases destroyed.

Glycocol $\left.\begin{matrix}C_4H_3O_4\\H\\H\end{matrix}\right| N$ neutral

Benzamic acid $\left.\begin{matrix}C_4H_5O_4\\H\\H\end{matrix}\right| N$

Production of these compound ammonias.

They are produced by the action of an iodide of an alcohol radical on NH_3.

$$N\left|\begin{matrix}H\\H\\H\end{matrix}\right. + C_4H_5I = N\left|\begin{matrix}C_4H_5\\H\\H\end{matrix}\right. + I \;\cancel{+4HO+6S}$$

Or by deoxidizing a nitro compound as in aniline*

Ethylamine

S.G 0.696 boils at 18.7°C

It is a colourless liquid of an ammoniacal odour, its causticity is nearly equal to that of KO.

It blues red litmus, neutralizes powerful acids, raises a blister

* $C_{12}H_5(NO_4)+6HS = N\left|\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right. + 4HO + 6S.$

on the tongue, drives NH_3 from its salts

Tri

It is a colourless liquid, inflammible slightly soluble in HO less so than ethylamine.

Act on this with C_4H_5I, & you get iodide of ethylammonium a compound corresponding to NH_4I. $N \left| \begin{matrix} C_4H_5 \\ C_4H_5 \\ C_4H_5 \end{matrix} \right. + C_4H_5I = N(C_4H_5)_4I$.

Act on the last body by AgO & you get $AgI + N(C_4H_5)_4O$ corresponding to NH_4O.

Oxide of tetrethylammonium

You cannot distinguish it from KO in its chemical characters

It acts as a caustic & forms a soap with fats. It precipitates metallic oxides like KO

Add it to $CuOSO_3$ & CuO is precipitated & sulphate of tetrethylammonium formed

In coal tar there is a remarkable set of organic bases

You get them by treating with $HOSO_3$, decomposing by KO & distilling

Pyridine $C_{10}H_5'''N$

Picoline $C_{12}H_7'''N$

Lutidine $C_{14}H_9'''N$

Lecoline $C_{18}H_7N$

Lepidine $C_{20}H_9N$

Put a mixture of Lutidine into a sealed tube into hot HO, they being less soluble in hot than cold HO float on the top of the liquid in the tube

Diamines.

Where 2 atoms of NH_3 have coalesced into one.

$N_2\left|\begin{matrix}H_2\\H_2\\H_2\end{matrix}\right.$ You may have primary, secondary & tertiary diamines $N_2\left|\begin{matrix}A_2\\B_2\\C_2\end{matrix}\right.$

Urea belongs to this class.

Common urea. $N_2 \left| \begin{matrix} C_2O_2 \\ H_2 \\ H_2 \end{matrix} \right.$

Urea forms from 77 to   per cent of human urine

Prep. Evaporate urine till it becomes syrupy & add an equal volume of colourless NO_5 of S.G 1.35. It forms nitrate of urea, separate the acid by BaO & the urea by alcohol & crystallize.
Artificial urea. $KO\,C_2NO + NH_4O\,SO_3 = KOSO_3 + NH_4O\,C_2NO$.
Prop. It crystallizes in 4 sided prisms like $KONO_5$

Soluble in HO & alcohol, when heated it is converted in great part into NH_3 & Cyanuric acid.
Unites with acids & forms salts.

$$N_2\left|\begin{array}{c}C_2O_2\\H_2\\H_2\end{array}\right. \quad N\left|\begin{array}{c}C_2O_2\\C_4H_5\\H_2\end{array}\right.$$

Triamines.

$$N_3\left|\begin{array}{c}H_3\\H_3\\H_3\end{array}\right.$$

Organic alkaloids.

It was long the opinion of chemists that vegetables only produce neutral & acid substances.

In 1803 got an alkali from opium & in 1804 got another alkali.

Yet it was 12 years after, that the opinion became prevalent that alkalis were produced by vegetables.

General properties.

They behave like NH_3.

They neutralize acids & form salts. They are all solid or liquid, generally fixed, a few are volatile.

Some are soluble in HO some in alcohol.

The sulphates, nitrates, chlorides & acetates are soluble.

The tartrates

They are generally violent poisons or active remedial agents.

They may be divided into 3 classes

A. Volatile alkalis free from O.

B. Bases readily soluble in alcohol sparingly in HO.

C. Bases soluble both in HO & alcohol.

A. Example. Nicatine.

Prep. Macerate tobacco in HO.

The malate of nicotine dissolves

Ni = nicotine. $\bar{M}$ = malic acid

$Ni\,O\bar{M} + KO = Ni + HO$

The Ni distils over.

B. Prep. These bases are united

with acids such as Kinic acid or meconic acid.

Add HCl the chlorides are dissolved out, add lime wh. forms CaCl & precipitates the alkali. Take it up by & crystallize from alcohol

C. Dissolve in HCl & form chlorides. Neutralize the chloride by NH_3 & precipitate by oxalate of ammonium. Decompose by BaO & crystallize.

Conia is a secondary monamine $N\left|\begin{matrix}C_{16}H_{14}''\\H.\end{matrix}\right.$

It is prepared from hemlock chiefly from the seed.

It is a colourless oil of a penetrating odour & burning taste it is a strong poison, in presence of HO it acts strongly alkaline, difficultly soluble in HO.

especially when warm, readily soluble in alcohol & ether.
Act on it by C_4H_5-I & you get ethylconia.

Sparteia. A tertiary monamine
$N \big| C_{16}H_{13}'''$

Got from broom, heavier than HO. the liquid boils at 287°C. Alkaline & narcotic poison, has an odour like aniline

Nicotine. it is a diamine $C_{20}H_{14} \big| N_2$

Occurs in tobacco chiefly in combination with malic
It is a colourless liquid. absorbs O readily & becomes brown, has a burning taste, slight odour of tobacco, is intensely poisonous There is from 2 to 7 Per cent in tobacco.

The mild kinds of tobacco as

Havannah used for smoking contain the least quantity. Those sorts used for snuff contain most.

The strength of snuff is due to nicotine, its pungency to ammonia salts.

Snuff. The leaves of the tobacco are allowed to ferment for 18 months. During this time there is a considerable absorption of O & the temp. often rises to 100°.

They are then ground & sifted.

In fermenting $\frac{2}{3}$° of the nicotine is destroyed, NH_4OCO_2 is formed & a volatile oil to wh. the aroma is due, & 2 P.C. of nicotine remains.

Alkaloids in opium.

They are numerous.

Morphia $C_{34}H_{19}O_6N$ probably a monamine.

Codeia $C_{36}H_{21}O_6N$.
Thebeia $C_{38}H_{21}O_6N$.
Papaverin $C_{40}H_{21}O_6N$
Narcotin $C_{46}H_{25}O_{14}N$.
Narcein $C_{46}H_{29}O_{18}N$
Opianine
Pseudomorphine & phorphyroxine
Morphine.

In crystallizing it takes 2HO.
Occurs in opium in combination with meconic & sometimes sulphuric acid.
It is present in from 6 to 12 P.C.
Smyrna opium contains most.
Crystallizes in brilliant prisms.
taste slightly bitter, has a slight alkaline reaction when heated it parts with its HO of crystallization & at a higher heat is decomposed.
HO dissolves $\frac{1}{1000}$th part of its wt. of it; it is readily soluble in

alcohol slightly in ether

It is a strong narcotic poison when heated with soda lime it becomes methylamine.

Muriate of morphia.

It crystallizes with 6 HO in fine silky prisms, soluble in HO & alcohol. When impure it crystallizes in large crystals, the purer it is, it is more difficultly crystallizable.

It forms double salts with $PtCl_2$.

Acetate of morphia

It is a deliquescent salt, crystallizes in thin needles.

Sulphate of morphia

Salts of morphia are largely used in medicine.

5 grains to the ounce are administered like laudanum in small doses. Though less powerful than laudanum.

Test. Salts of $Fe_2O_3 3SO_3$ give a blue colour with it, concentrated NO_5 a red colour at first fading to yellow.

Conine
Crystallizes with 2 HO.
Occurs in opium to the extent of 1 P.C..
Though homologous with morphia it is not analogous to it in its properties.
Soluble in 8 parts cold HO & 17 hot. Melts at 150°C. decomposes at higher temperatures is poisonous, produces tetanic convulsions like strychnine.

Papaverin
Is not poisonous.

Narcotin
Is present from 6 to 8 PC in opium
Crystallizes in small rhombic prisms, little soluble in alcohol & ether.
Has very feeble alkaline properties many of its salts are decomposed by HO. Is poisonous.
20 grains will kill a dog.
There are 3 homologues of narcotine in opium.

Alkaloids in cinchona bark
There are four.

Quinine	$C_{40}H_{24}O_4 \| N_2$
Cinchonin	$C_{40}H_{24}O_2 \| N_2$
Chinidin	$C_{36}H_{22}O_2 \| N_2$
Aricin	$C_{46}H_{26}O_8 \| N_2$

They are all diamines. They are found united in cinchona bark with kinic & kinotannic acid.

Quinine

Found chiefly in the yellow bark in about $3\frac{1}{2}$ P.C. Crystallizes in silky needles from ether, as a white curdy precipitate from its salts, soluble in ether, in 200 parts boiling H_2O, more soluble in lime water.

Readily soluble in alcohol & ether. Intensely bitter, alkaline, melts at 120°C.

Unites with acids so as to form 2 classes of salts.

The pill used by Dr Livingston in cases of African fever & wh never fails if the patient be removed to a higher district.

3 to 4 grains resin of jalap
3 to 4 — calomel.
3 to 4 quinine

A drop or two of tincture of cardamums to dissolve the resin &

form the bolus. It ought not to purge but to occasion gentle movement

Sulphate of quinine

It unites with 1 atom of $HOSO_3$, crystallizes with $7\,HO$ in long brilliant prisms, easily loses $5\,HO$, difficultly soluble in pure HO.

Acid salt $Q\,HO\,SO_3$.

Used in medicine, add a drop or 2 of $HOSO_3$ to assist its solubility.

It is often adulterated with $CaOSO_3$ sugar, calomel, fats, starch & salicin.

To detect adulteration, burn a portion if $CaOSO_3$ is in it, the $CaOSO_3$ remains.

If with calomel or sugar you can smell them.

If not completely soluble in dilute $HOSO_3$ it contains fats or starch.

If salicin be mixed with it.

dissolve in 6 times its wt of $HOSO_3$ add 12 parts HO, salicin will be precipitated.

Cinchonine.

Found chiefly in the grey bark Crystallizes in large anhydrous prisms, soluble in alcohol & ether The salts are intensely bitter, precipitated by gall nuts, heated with KO it becomes

Chinodin or quinidine

~~Violent~~ Brilliant prisms soluble in alcohol difficultly in ether

Aracin.

Found in China cusco.

Alkaloids of strychnine family.

found in seeds & bark of nux vomica in the

Ignatia bean.
Contains 2 alkaloids
Strychnine $C_{42}H_{22}O_4N_2$
Brucin $C_{46}H_{26}O_8N_2$

Colourless 4 sided prisms, scarcely soluble in alcohol or HO, intensely bitter, soluble in aqueous alcohol when boiling, frightful poison

Nitrate.
have been used in medicine
Tests. Add to the suspected solution $KO\,2CrO_3$ & $HOSO_3$, it it produces a violet-blue, passing to red.

Brucin
With 8HO.
Crystallizes in colourless prisms 4 sided insoluble in HO & ether

readily in alkalis with strong oxidizing agents it forms methylic ether.

Alkaloids of the Solanacea family. There are 3.
Nicotin
Hyocyamin. —
Atropin $C_{34}H_{23}O_6N$.
Occurs in atropa
White , sharp bitter taste
soluble in HO & alcohol.
Fuses, & decomposes at higher temps.
Salts decompose readily.
Violent poison. dilates the pupil of the eye.
Salts are soluble but difficultly crystallizable
Hyocyamin.
Has properties similar to Atropin.
Veratrin $C_{64}H_{52}N_2O_{10}$

Found in veratrum, produces sneezing is a violent poison.

Dervin. $C_{60} H_{46} N_2 O_6$

Delphinine $C_{64} H_{32} N_2 O_4$

Colchecine

Aconitin

Alkal

Caffeine or theine.

Found in tea & coffee & paraguay tea. In 3 quarters of the globe men have derived a beverage wh. they take about the same time of the day, from plants not only of the same sepecies but of a different order

They all contain the same alkaloid theine or caffeine call it caffeine.

Caffeine $C_{16} H_{10} O_4 N_4$ tetramine

You may view diamines or triamines as monamines.

$$N_2\left\{\begin{matrix}H_2\\H_2\\H_2\end{matrix}\right. \text{ maybe} = N\left|\begin{matrix}NH_4\\H\\H\end{matrix}\right. \quad N\left|\begin{matrix}\overset{NH_3.}{H}\\H\\H\end{matrix}\right.$$

In wh. the radicals of compound

ammonias replace the H
Theine or Caffeine.
Occurs in tea & coffee.
Prepared from tea by subliming it.
Crystallizes in thin brilliant needles
174°C sublimes at a higher temp.
Difficultly soluble in cold HO, is a weak base its salts are decomposed by HO.
In large doses it produces increased action of the heart, irritability of temper

If you take 3 grains of theine a-day about 2 cups night & morning you ~~If ho~~ may retain you usual temper & state of nerves.
If you take 4 or 5 grains it produces irritability of temper & nervousness.
If you feel in a nervous state

without being able to account for it, it is very probably from this cause.

To cure it, take chocolate instead of tea or coffee for some days when it will most probably be cured.

Theobromine

Occurs in cocoa.

It is methyl theine.

Hydrates of Carbon

Under this head are included all bodies wh have the general formula $C_m H_n O_n$

Such bodies are starches, sugars gums, bodies wh have a neutral or indifferent character.

Dilute acids convert most of them to grape sugar

Actg on sawdust by $HO SO_3$ & it is converted into grape sugar.

Oxidizing agents convert them to oxalic acid.

The veiws of their chemical constitution are not certain

They are at present supposed to be alcohols

If the H & O be not present as HO it is in a form nearly approaching it. Take grape sugar for instance $C_{12}\underbrace{H_{14}O_{14}}$ It has the same volume as 14 atoms HO frozen to ice the C occupying no appreciable bulk

When dissolved it occupies the same volume as 14 atoms of liquid HO. The H&O comport themselves in solution as HO & when solid as ice.

Cellulose. $C_{36}H_{30}O_{30}$.

It is the basis of vegetable structures. You have it nearly pure in cotton wool.

Occurs in the sap of growing vegetables.

It is the same in composition from whatever source derived

Is nearly pure in the pith of the elder rice paper, linen & cotton.

Prop. It is a white, solid, semitransparent

Its S.G is a little higher than that of HO.

Its composition is the same but its physical characters differ according to the source whence it has been derived.

It is compact in the branches of trees hard & dense in the shells of the filbert & cocoa nut.

It is digested or not-digested by animals according to its physical condition.

It is easily transformed

$HOSO_3$ boiled with it converts it into dextrin & then to grape sugar.

These all being the same in percentage composition.

Digested with $HONO_5$ it forms gun-cotton.

Puts cotton in a mixture of $HOSO_3$ & $HONO_5$ washes & drys it.

Part of the H has been substuted by NO_4.

There are several kinds according to the length of time it remains in the acid.

Cellulose		$C_{36} H_{30} O_{30}$
Gun cotton	A	$C_{36} H_{21} (NO_4)_9 O_{30}$
————	B	$C_{36} H_{22} (NO_4)_8 O_{30}$
	C	$C_{36} H_{23} (NO_4)_7 O_{30}$
	D	$C_{36} H_{24} (NO_4)_6 O_{30}$

Common paper is cellulose or lignin in another form.

A curious transformation is effected by $HOSO_3$ wh. converts it into vegetable parchment.

Take 2 volumes of the strongest oil of vitriol & one volume of HO carefully measured.

Dip ordinary unsized paper, white blotting paper into it & wash well the last HO should have a little NH_3 in it to remove all traces of $HOSO_3$. Wash again to remove the NH_3 & dry it.

The strength of the paper is much increased, a slip of paper that would have before broken by 5 lbs will afterwards require 72 lbs to break it.

Starch. $C_{12}H_{10}O_{10}$.

Is very extensively distributed in nature. It varies in its forms according to the source from wh^{h} it is obtained.

Grains of starch in Tous les Moïs are $\frac{1}{260}^{th}$ in. in diameter. Those in wheat are $\frac{1}{1000}^{th}$ in. & in rice $\frac{1}{3000}^{th}$ in.

Starch exists in various quantities in vegetables used for food. There is in

Wheat flour	57 to	67 P.C. of starch
Rice	85 –	86
Barley	39	40
Oats	30	40
Rye	54	61
Lentiles	39	40
Maize	65	66
—— flour		77
Buck wheat	43	44
Beans	37	
Peas.	38	
Potatoes	23.	

Prop. It is white tasteless, insoluble in cold HO & ether, when put in hot HO it swells up & forms a jelly. This is not a true solution for freezing separates it into grains of starch.

The youngest grains separate first

Test. Put a little Cl into a mix.

ture of the starch solution & KI.

The Cl is to liberate I.

Dilute acids convert starch into dextrin

Heated with dilute $HOSO_3$ it becomes grape sugar

NO_5 dissolves starch & HO precipitates it as an explosive compound as gun cotton in fact

By carefully heating it from 160° to 200°C it becomes dextrin.

British gum is made in this way.

Manufacture of starch.

It exists with gluten in flour.

To get rid of the gluten, subject starch to fermentation by wh the gluten is destroyed. This causes a very bad smell.

A new process has been proposed Dissolve the gluten by alkalis & then the starch remains.

To get it from potatoes.

Grate the potatoes & put them on

a seive, pour HO on them stirring them all the time The starch passes thro' the seive & settles at the bottom of the vessel placed below it. Wash the starch once or twice

Special Starches.

Several are sold for food

Sago is got from the pith of the sago palm. It is made into a paste & pressed thro' a perforated metallic plate, & then exposed to the heat of steam to dry it.

Tapioca. Is got from the root of the manioc. This root contains HCy w^{h} is separated in the process of making.

Arrowroot. Is got from the root stocks of various plants.

Salep. Is made from the root of the male orchis.

Starch in the animal kingdom
Sometimes in healthy animal tissues, granules of starch have been found in the brain.
The waxy appearance of the liver

Inulin $C_{24}H_{20}O_{20}+3HO$.
Distinguished from starch by not giving a blue with I.
Exists in chicory, dandelion

Becomes yellow with I.
Long boiling converts it into dextrin & then to grape sugar.
Lichenin
Found in Iceland moss, soluble in hot HO.
Irish moss contains another kind $C_{10}H_{10}O_{10}+3HO$.
Peculiarly distinguised by forming a precipitate with gelatin.

Take a solution of Irish moss.
& add it to a solution of gelatin
no precipitate is formed
Add a drop or two of alum & you
get a stringy precipitate.
Glycogen.
Got from mans liver.
I produces a dark red colour
with it.
It has no taste or smell forms
a paste with Ho

Found in the saliva, pancreatic
juice
Diastase & dilute acids

Its formula is given as $C_{12}H_{10}O_{10}$
$C_{12}H_{12}O_{12}$, & as $C_{12}H_{14}O_{14}$.
Dextrin $C_{12}H_{10}O_{10}$.
It is a product of the transformation of starch
Got by roasting starch.

10 parts of starch are moistened with 3 of HO, the HO is to contain $\frac{1}{150}$th of its weight of $HONO_5$. The paste is allowed to dry spontaneously.

It is a colourless transparent body like gum, deviates the plane of polarized light to the right hand, there seems to be an intermediate compound between starch & dextrin, soluble in HO wh starch is not & blued by I wh dextrin is not.
Distinguished from gum by forming a beautiful blue solution with $CuOSO_3$ & KO. When this is heated suboxide of [illegible] Cu is deposited.
Dextrin is used as a gum for

machinery as in calico printing To prepare glutinous bandages to reduce fractures.

Gums.

They have the same composition as starch, form a mucilaginous solution with HO.

They all give mucic acid with $HONO_5$ instead of oxalic acid as starch does.

Quantities of cellulose & gum

In one lb of the following substances there are.

In Potatoes	327 grs cellulose	27 grs gum
Rice	218	87
Wheat	109	109
Barley	2oz	146
Oats	2oz	218.

Gums have the same percentage composition wherever obtained but seem to have different combining proportions

Gum arabin or arabic $C_{12}H_{11}O_{11}$

Unites with bases as acetate of Pb. Is soluble in cold HO

A solution of 18 P.C is so thick that it cannot be filtered, it is insoluble in alcohol.

Cerasin The gum from cherry trees.

Bassorin. Found in gum tragacanth seems to be a modification of pectin or vegetable jelly

Pectin

The gelatinous principle of fruits carrots, turnips &c.

It is probably identical with Bassorine. It only swells in HO without dissolving.

It seems to be a feeble acid.

It is rendered soluble by long boiling & passes into ordinary gum.

Sugars

Cane	$C_{12}H_{11}O_{11}$
Fruit	$C_{12}H_{12}O_{12}$
Grape	$C_{12}H_{12}O_{12}+2HO$
Milk	$C_{24}H_{19}O_{19}+5HO$
Mellitose	$C_{24}H_{24}O_{24}+4HO$
Eucalyn	$C_{12}H_{12}O_{12}+2HO$
Sorbin	$C_{12}H_{12}O_{12}$
Inosite	$C_{12}H_{12}O_{12}+4HO$

Under the name of sugars are included all vegetable substances, wh have a sweet taste

They are formed during the life of the plant but are perfectly definite chemical compounds & crystallize.

They are so distinctive in their characters that they may be divided into 2 classes.

Sugars susceptible of vinous fermentation by yeast.

Sugars not susceptible.

Grape sugar or glucose $C_{12}H_{12}O_{12}+2HO$ is in crystallized state really $C_{12}H_{14}O_{14}$.

Occurs in the juice of grapes, in plums, cherries & dried fruits.

Occurs in many of those as fructose.

Fructose is uncrystallizable.

Honey becomes crystalline after some time from the fructose in it becoming grape sugar.

It occurs in the animal kingdom as a normal constituent of the liver.

Occurs in diabetic urine.

It is formed very quickly in the body under certain circumstances.

If the fourth ventricle of

the brain is irritated by a needle diabetic sugar appears in the urine a few minutes after.

Test. Heat a solution suspected of containing it, with $CuO\,SO_3$ & a few drops of KO. Cu_2O is formed. It first appears as a yellowish hydrate but afterwards reddish

It is prepared on a large scale by allowing starch & HO at 130°F to flow into a vat containing HO & 1 P.C. of $HOSO_3$. It is boiled for ½ an hour when all the starch is converted into grape sugar.

Neutralize by CaO & crystallize.

Prop. It crystallizes with difficulty in warty concretions

Tastes less sweet than cane

sugar, is soluble in HO & alcohol. Turns the plane of polarized light to the right.

At 100°C it melts & loses $2\,HO$ at a higher heat it becomes brown does not taste sweet & is then called caramel, whose formula is $C_{12}H_9O_9$ & is used for colouring

Grape sugar unites with bases & forms saccharides

$2(C_{12}H_{12}O_{12})\,3\,PbO$ sesquisaccharate of Pb.

Unites with $NaCl$ & forms a crystalline compound

It is also said to combine with organic acids.

It is easily oxidized

With $HOSO_3$ it forms conjugate acids, act on that by stong bases & it forms glucic acid $C_8H_5O_5$.

When a solution of grape sugar is acted on by yeast it is converted into alcohol & CO_2.

$C_{12}H_{12}O_{12}$ acted on by yeast = 2 eq. alc.
4 " CO_2.

When cheese, muscle, or other nitrogenous ferment acts on sugar the change is quite different.

Lactic acid
$C_{12}H_{12}O_{12} = (C_6H_6O_6)2$.

If you carry this farther & the putrid cheese acts more on it.

$C_{12}H_{12}O_{12}$ = 1 Eq Butyric acid $C_8H_8O_4$
4 -- CO_2 C_4O_8
4 H H_4
$C_{12}H_{12}O_{12}$.

Ultimately sugar is converted into mucic acid or rather into a slimy acid whose composition is not well known.

Fruit sugar or fructose

Has the same composition as grape sugar & only differs from it in not being crystallizable.

Is found in honey & fruits.

Cane sugar $C_{12}H_{11}O_{11}$.

Introduced into Europe some centuries before the Christian era but did not come into general use till the discovery of America.

Occurs in sugar cane, beetroot, sugar maple.

Readily crystallizes in 3 forms. in the crystalline form as sugar candy, in the vitreous state as barley sugar.

Barley sugar gives out much heat in passing into the crystalline form

The same thing takes place

with AsO_3.
Readily crystallyzes in 4 sided rhomb

The taste is sweeter & purer than that of grape sugar.
Is soluble in $\frac{1}{3}$ its wt. of HO less soluble in alcohol than glucose.
Heated to 160° it melts to a colourless liquid & cools in the vitreous state as barley sugar.
Barley sugar after a time becomes crystalline.
By a strong heat sugar becomes ~~crystalline~~ caramel.
When a solution is boiled with dilute acid it becomes fructose & if for 2 hours longer grape sugar.
With strong bases it forms saccharides. $C_{12}H_{11}O_{11}BaO$.
Cane sugar cannot be fer-

mented by yeast without becoming grape sugar.

If you take equal wts of cane & grape sugar, the cane sugar will require more yeast than the glucose to ferment it, the extra yeast being employed in converting it into glucose.

Manufacture of sugar.

It exists in various substances. but that used in this country is chiefly obtained from cane. The sugar cane is cut before flowering & the juice expressed. The juice contains a good deal of albumen wh would act as a ferment & wh is separated by coagulating the albumen This is called defecation. You put in a certain quantity of lime or as lately practised of $CaOSO_2$. Boil & the albumen is coagulated.

The syrup is then evaporated.

If you evaporate at too high a temp. it is converted into fructose, to prevent this it is boiled in vacuum pans in wh it boils at   instead of 220°. It is then transferred to wooden cylinders & crystallized.

It is drained from molasses by means of an extremely rapidly rotating perforated cylinder called the Jim Crow & sometimes the devil.

The best canes contain about 18 PC of sugar but only 7 to 10 PC is got

On the Continent sugar is got from beet root.

The roots are pulled in October

They are rasped & the juice

expressed.
The juice contains 10 PC of sugar but the manufacture is so much better conducted than that of cane sugar that 7 PC is obtained. In one manufactory in Belgium they got 8½ P.C.
There is the same defacation & evaporation as in cane sugar It is filtered thro animal charcoal. The crystals are longer & flatter than those of cane sugar, & its taste not so sweet.
Maple sugar
Holes from ¼ to ½ an inch deep are made in the wood of the maple & the juice collected from them by reeds or spouts wh are stuck into them.
The juice is collected in March April & May.

Each tree yields 3 lbs of sugar in a season & continues to do so for 30 years

The juice is concentrated & crystallized every 24 hours.

Refining of sugar.

Raw sugar is dissolved in lime HO & mixed with bone charcoal & steam blown thro' it & if very impure bullock's blood is added.

It is filtered thro' bags of twilled cotton, & thro' animal charcoal (burned bones).

It is evaporated in vacuum pans.

The syrup if evaporated in air may rise to 230° wh converts it into fructose, while if evaporated in vacuum pans 140° to 150° is sufficient.

It is evaporated till the syrup is so strong that a thread

drawn from the finger will return to it without breaking.
It is heated to 170° F
run into conical moulds.

Sweetness & uses of sugar.

The sweetness of sugar is definite.

1 lb of cane sugar is equal to 2½ lbs of grape or 3 lbs of milk sugar in sweetness.

It is chiefly useful as a food in supporting active respiration, useful in keeping up the animal heat.

It is good for infants for this purpose since being soluble it is more easily assimulated to the system. For this reason it exists in large quantity in milk.

In the United States the consumption of sugar per head of the population is $\overset{40}{28}$lbs. In France 4 lbs in Belgium 6 in Austria 2½ in Russia 2½ in the united kingdom 28 in Benzuela 110.

Cane sugar is found in plants during the germination of seeds & previous to the unfolding of their buds.

The bark of birch contains a good deal

Grasses & palms contain most when about to blossom.

Jaggery, cocoa nut & wine palms

In America sugar is got from the stalks of maize.

Relation of H & O in sugar.

The H & O stand in the proportion necessary to form HO

In such a state also as if it were present in the form of HO.

9 atoms of HO in the state of ice is equal in volume to 9·8 atoms of HO.

$C_{12}H_{11}O_{11} = \frac{171}{\text{sp.gr.}=1.6} = 106$ atomic vol.
$9.8 \times 11 = 107.8$ — — of
11 atoms of HO in the state of ice.
The bulk of an atom of sugar is the same as that of the HO in it in the state of ice the C occupying no sensible space.

Milk sugar $= \frac{180}{1.543} = 116.6$ at. vol

$9.8 \times 12 = 117.6$ at. vol
of HO in it.

If you dissolve sugar in HO you only increase the HO by the bulk of the HO in the sugar the C occupying no sensible space.

Sugar of milk. $C_{12}H_{11}O_{11} + HO$ or more usually $C_{24}H_{22}O_{22} + 2HO$.
Milk sugar is only found in the animal kingdom

Prep. Evaporate whey after the separation of the curd & crystallize on twigs.

Crystallizes in 4 sided prisms terminated by 4 sided pyramids,

The crystals are hard & gritty, febly sweet, soluble in H_2O, more difficultly than other sugars. in 6 parts of cold H_2O & 3 to 4 of hot.

It does not become syrupy, on account of its small solubility & does not deliquesce in air.

At 130°C it loses its H_2O of crystallization, at higher temps. it becomes brown & is called Lacto caromel $C_{12}H_{10}O_{12}$

It forms saccharides.

Precipitates Cu_2O from solutions even in cold but less readily than glucose.

Dilute acids convert it into lactose wh. has the same formula as grape sugar but does not form a compound with $NaCl$. Although milk sugar does not ferment the Tartars ferment mares milk & make cumase

Other fermentible sugars.

Trehalose $C_{12}H_{11}O_{11}$

Found in a substance called Trehala a substance used in the East for food a product of insects.

Megatose. $C_{12}H_{12}O_{12}+2HO$.

Got from the twigs of the larch

Mellitose $C_{12}H_{12}O_{12}+2HO$.

From the manna of Eucaliptus

Non fermentable sugars.

Inosite $C_{12}H_{12}O_{12}+4HO$.

This is muscle sugar

Found in the muscle of the heart in the brain & nerves in unripe common beans & in the cells of the lung & the liver

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Prop. Crystallizes in small crystals efflorescing in air.
Soluble in H_2O & weak alcohol insoluble in alcohol & ether.
At 210° it melts to a clear liquid. Dilute acids do not change it.
It does not reduce Cu
It does not suffer vinous fermentation, by cheese it suffers lactic or butyric fermentation.

Scyllite
Is found in the liver of shark
If you evaporate Inosite nearly to dryness & add CaCl

Sorbite is
Is got from the berries of the mountain ash.
Its taste is sweet
It does not ferment & does not produce grape sugar when boiled with acids

Sugars unite with various organic substances

Salicin is one of these.

They are called glucosides.

Salicin $C_{26}H_{18}O_{14}$.

It is an antipyriodic like quinine

When boiled with sugar it breaks up into sugar

Occurs in the willow, poplar

Crystallizes in small brilliant colourless prisms, intensely bitter, melts at 120° C

Soluble in hot HO, difficultly in cold, soluble in alcohol not in ether.

Concentrated $HOSO_3$ dissolves it with a purple red colour.

By the action of amulcin, the ferment of almonds[x] it splits up into saligenin & grape sugar.

$C_{26}H_{18}O_{14} + 2HO$ taken up by the action of the amulcin $= \overset{\text{saligenin}}{C_{14}H_8O_4} + \overset{\text{glucose}}{C_{12}H_{10}O_{12}}$

[x] Or by the action of ptyalin the ferment in saliva.

Heated with acids it breaks up in a similar way but loses 2HO $C_{26}H_{18}O_{14} = C_{14}H_6O_2$ saliritene + $C_{12}H_{12}O_{12}$ grape sugar.*

Saligenin is the alcohol & saliritene the ether of the alcohol.

There is a large number of glucosides.

Populene $C_{40}H_{26}O_{20}$

Obtained from poplars.

By the action of amulcin it is converted into glucose saligenin & benzoic acid.

$C_{40}H_{26}O_{20} \rightarrow C_{12}H_{12}O_{12} + C_{14}H_8O_4 + C_{14}H_6O_4$

Quercitene

Got from the quercus & the bark of the horse chestnut

Convolvulene.

Obtained from jalap roots.

Tannine.

Is tannic acid & glucose.

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* Salicin distilled over CaO gives carbolate of lime.

Colouring matters

These are associated together more by technical use than by chemical relations.

They are unlike bodies.

They are found in all parts of different plants.

They are difficult of isolation.

Method of doing so.

Boil with HO, alcohol & ether according to their solubility; agitate with PbO wh. takes up the colouring matter. Decompose the Pb compound by HS & evaporate in vacuo.

Sometimes the colouring matter does not exist in the plant but is formed by oxidation or by the action of a ferment.

Thus, madder root does not contain the colouring matter in it, till it has been acted on by a ferment wh the root itself contains.

It yields a whole series of colouring matters.

Most of these colours attach themselves to an animal substance much more readily than to a vegetable one.

Put a little white of egg wh has been coagulated by heat in the bottom of a vessel into a colouring matter wh dyes it while a vegetable substance is not much affected unless a mordant is put on it.

Silks & woolens are dyed directly by these colouring matters.

To dye calico print a pattern on it by an acetate.

To produce red with madder print with acetate of alumina

For purple with acetate of alumina & acetate of Fe.
For black with acetate of Fe alone
The cloth is hung up & the acetic acid flies off.
Puts a cloth printed with alumina in logwood

Mordants act more by their acid than basic characters they are sesquioxides
Protoxides are not good mordants.
One method of dying is if you can put into the pores of the cloth a colour naturally insoluble & render it insoluble in the cloth itself.
This is done in the case of indigo.
Mix FeO & KO or CaO with indigo blue, this gives indigo white.
Indigo blue differs from indigo

white by 1 H.

Indigo blue $C_{16}H_5NO_2$
——— white $C_{16}H_6NO_2$

When indigo white is poured from one vessel to another the H is oxidized to HO & it becomes insoluble indigo blue.

A is a large jar in wh is indigo white the sediment is at the bottom.

It is called an indigo beck.

Dips a cloth printed with an oxidizing substance ($CuOSO_3$) into indigo white. The printed parts are left white, because the $CuOSO_3$ oxidized the indigo white & rendered it insoluble on the surface of the cloth so that it could not penetrate.

Adds some alum & a little NH_3 to a solution of cochineal. The A_2O_3 precipitates it as a lake.

It is this property wh. enables the mordant to take down the colour with it & fix it.

Madder.

Madder is got from the root of the Rubia tinctorum found in Turkey, Holland, & the south of France.

Fresh madder does not contain colouring matter but contains a resin called rubio erithric acid $C_{32}H_{18}O_{18}$.

By the action of a natural ferment within itself it becomes alizarin the colouring principle of madder & glucose.

$C_{32}H_{18}O_{18} = C_{20}H_6O_6 + C_{12}H_{12}O_{12}$

The is a large number of colouring matters in madder

Alizarin . sublimming is orange

it is red.

Alizarin $C_{20}H_6O_6$
Crystallizes in fine red prisms orange red after subliming.
Sparingly soluble in cold HO readily soluble in alcohol, ether & hot HO. Alkalies dissolve it
CaO & BaO give blue lakes.
Al a deep red.
Fe_2O_3 a purple
It has very much the composition of naphthalin. If you replace some of the H in naphthalin by Cl you get a chlor-alizarin.
It is alleged that alizarin is obtained in France from naphthalin.
Purpurin $C_{18}H_6O_6$
Occurs in old madder not in

new.
Prepared from alizarin acted on by yeast
Crystallizes in yellow red prisms
Fuses easily & sublimes.
Alkalis dissolve it yellow.
BaO & CaO give purple lakes.

Rubiacine $C_{32}H_{11}O_{10}$
A yellow colouring matter.
Is a product of the natural fermentation of the original resin

Crystallizes in yellow needles gives the yellow shades in madder dyeing

When madder has been used in dyeing one half of the colouring matter is taken up the other half used to be thrown away. The spend madder is now digested with very dilute $HOSO_3$ & steam blown thro' it. It is then produces dyes as good & perhaps even of more brilliant shades than the original did.

Logwood.

It contains a honey yellow ~~yello~~ substance wh is called Hæmitoxalyn wh has no relation to the colouring matter of the blood. Its formula is $C_{32}H_{14}O_2$

It forms a red with Al

—— —— black —— Fe.

Crystallizes in violet microscopic crystals wh dissolve red. By a nitrogenenous ferment especially by ammonia if produced it becomes much more powerfully tinctorial

Brazil wood.

None of the yellow dyes have been much examined

Quercitron C.

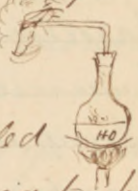
Indigo.
It is got from plants of the genus Indigofera, from isatus tinctoriá or woad, found in the urine of cows & in that of men in some diseases.
Sometimes occurs in milk to wh. it gives the blue colour.
Prep. The leaves of the indigo plant are macerated & CaO added & allowed to ferment; the indigo white is formed wh. soon becomes insoluble indigo blue.
Add a per salt of Fe to indigo white & it becomes indigo blue.
Indigo blue as it occurs in commerce has S.G 1.35.
Crystallizes when quite pure in crystals wh. have a coppery lustre.

$HOSO_3$ dissolves it completely
Pure indigo blue may be fused.
You may suppose indigo blue to be the radical & indigo white the hydrate.
Indigo blue $C_{16}H_5NO_2$
—— white $C_{16}H_5NO_2H$.
There is one other method of dyeing.
Topical dyeing.
It is the means by wh. you can get an insoluble powder on the surface of the cloth

Albumen from blood & casein from cheese is sold for this.
Casein is dissolved in NH_3 mixed with the colouring matter & heated so as to allow the NH_3 to evaporate.
Very often these topical ap-

plications are arsenic green.

Or take albumen & colouring matter such as ultramarine, expose to steam to coagulate the albumen.



This method has enabled many styles of printing to be employed.

Cu or As colours should not be employed as they occasion great injury to the health.

Many colouring matters are glucosides. They seem to be weak bases. The best mordants are those oxides on the verge of being acids. Mordants are the metallic oxides

Chemically they are called lakes.

Colouring matter of lichens.

They readily split themselves up into several acids, some of wh readily give colouring

matters with NH_3.
Erythric acid $C_{46}H_{22}O_{20}$
Orsellenic $C_{16}H_8O_8$
Orsellic $C_{32}H_{14}O_{14}$
Evernic $C_{34}H_{16}O_{14}$

Some when treated with stronger acids as $HOSO_3$ or $HONO_5$ break up into new compounds & produce colouring matters

adheres to albumen

Albumen is printed on the cloth & coagulated by steam & dyed by the archil colour.

One or two animal colours are employed in the arts.

Cochineal.

It consists of the dried bodies of insects wh. feed on a certain kind of fig.

This dye contains carminic acid $C_{28}H_{14}O_{14}$

This unites readily with bases.
Another insect forms the lac dye used for dyeing cloth red.

Volatile oils, resins & caoutchouc.

Essential oils.

They are occasionally found ready formed in plants as in the orange & lemon.

In other cases it is made by the action of HO on seed as in bitter almond & mustard oil.

In the animal kingdom these are rare, altho' they occur in ants.

The general classification of essential oils is more pharmaceutical than chemical

They are either solid or liquid

When solid they are easily fusible & are volatile

Though the boiling points of some are high they generally go over readily in steam.

They produce a temporary stain on paper, fixed acids produce a permanent one.

They have a peculiar penetrating odour generally agreeable.

They are rarely pure in commerce

They contain a solid substance wh is the oil oxidized or hydrated & wh are called Stereoptenes.

The oils are prepared in some cases as from the orange & lemon by pressure.

More usually as from aromatic plants by hanging the plants in bags & passing steam thro' them & condensing it.

They are prepared for perfumery by a peculiar process.

A cake of tallow is taken & the flowering plants spread over it. It is then gently heated not enough to melt the tallow.

The tallow gradually extracts the oil.

The tallow is then treated with alcohol wh. dissolves out the oils.

They may be divided into different classes.

1st Essential or volatile oils free from O.
2nd — — — — containing O.
3d — — — — — — S.
4th — — — wh. suffer change by distillation.

The central formula around wh. they all turn is that of camphine $C_{20}H_{16}$ for a 4 vol. formula.

Some have only half that $C_{10}H_8$.

Some have these two formulæ united. $C_{30}H_{24}$

Essences isomeric with camphine.

Essence of bergamot
— — — — lemons
— — — — orange
— — — — birch
— — — — camomile
— — — — juniper
— — — — copaiba $C_{30}H_{24}$
— — — — carraway
— — — — cloves
— — — — ginger
— — — — cubebs.
— — — — thyme
— — — — valerian

Turpentine.
By this is meant camphine $C_{20}H_{16}$.
Boils at 160°C S.G 0.864.
Got by wounding pines, when it flows out, this is distilled & gives essence of turpentine

In this state it is a colourless transparent oil with a peculiar disagreeable odour & burning taste.

Insoluble in HO, difficultly in common alcohol readily in absolute alcohol & ether concentrated acids dissolve it.

It converts O into ozone.

If you shake some up in a bottle with air you may detect the presence of the ozone formed by applying the test.

It contains so much H that if you moisten some cotton wool with it & having warmed it put it into some Cl HCl fumes are formed & it takes fire.

It combines with HO & forms solid stearoptines. $C_{20}H_{16}+4HO$

$C_{20}H_{16}+3HO$, $C_{20}H_{16}+2HO$ & $C_{20}H_{16}+HO$.

These are called camphors of turpentine.

Essences not isomeric with camphine.

Oil of peppermint $C_{20}H_{18}$

Contained as a solid hydrate in certain oils $C_{20}H_{18}+2HO$.

Essence of cedar wood $C_{32}H_{26}$

$C_{32}H_{26}+2HO$ is a solid hydrate.

Oxygenized essences.

Camphors

Common Camphor

True laurel camphor $C_{20}H_{16}O_2$

Obtained from camphor wood by chopping the wood in branches & distilling in HO.

Fuses at 175°C boils at 205°C.

Vap. density 5.32.

Difficult to pound from its elasticity; but may be done easily by putting a drop or two of alcohol on it & then pounding it.

Borneo camphor $C_{20}H_{18}O_2$.

Got by puncturing the tree.

Crystallizes in 6 sided prisms colourless & transparent.

Other camphors.

Stearoptines of many plants are really camphors.

In peppermint & cedar oil

$C_{20}H_{20}O_2$

$C_{32}H_{26}O_2$

Resins

These are exudations from

They appear to be formed by the oxidation of the essential oils more oxidized than the camphors.

Camphors $C_{20}H_{16}O_2$

Resins $C_{20}H_{16}O_2 - nH + nO$.

They are used for varnishes by mixing pounded glass with pounded resin & treating with alcohol or wood spirit.

Copal, Mastic, Sandarac
Common varnish for maps
24 parts Mastic
3 — Venice turpentine
1 — Camphor
10 — pounded glass
Mixed with 72 parts of oil of turpentine + filtered.

Lac.

Sold in 3 forms.

Stick lac. An insect perforates certain trees & the lac
It is sold in commerce on the twigs.
This is pounded & treated with $NaOCO_2$ wh dissolves out the colouring matter wh is used

for dye.
The lac is melted in canvass bags & is squeezed on bamboos. & is then called shell lac.
Got on Ficus indicus or ficus religiosa.
Used for sealing wax & for stiffening hats for wh purpose it is dissolved in wood spirit.
Sealing wax

48 parts	lac
12	venice turpentine
1	Balsam of Peru
36	Vermilion stirred up with it.

For making lacquers of wh there are several kinds, the usual one is, Lac is mixed with ½ its wt of sandarac & a little venice turpentine, dissolved in 10 to 12 parts alcohol. The brass is heated before it is applied.

Guayacum.
Obtained from guayacum officinalis

It is bluish green or brown
The alcoholic solution is a good test for ozone wh makes it blue
Jalaps.
Contain glucosides
Jalapin is a glucoside.
Amber
It is a fossil resin found in coal but chiefly thrown up on the shores of the Baltic between Memel
Often contains insects of extinct species but related to present species: Seems to have been an exudation
S.G 1.065. Insoluble in alcohol & ether, soluble in essential oils. After having been

once fused it is soluble in turpentine & then forms amber varnish

By dry distillation it yields succinic acid & amber oil.

With $HONO_5$ it forms artificial camphor having a smell like musk.

Caoutchouc.

It is a resinous substance suspended in the milky juice of various plants.

In its ordinary state in commerce it is impure.

When separated from its impurities its formula shows it to be a hydrocarbon $n\,C_8H_7$

Soluble in chloroform but is precipitated by alcohol. melts at 120°C & at 200°C it begins to decompose.

Insoluble in HO & alcohol

Soluble in turpentine, benzol

naphtha & chloroform.
The solution in naphtha is used for waterproofing cloths.
Unites with S & forms vulcanized india rubber.
Got by treating with sulphide of C or usually with chloride of S. S_2Cl.

Gutta percha.

Is like india rubber in its composition & many characters except its want of elasticity at common temps.
Is the concrete juice of percha. Scarcely elastic at common temps. but becomes elastic at 212° F. Is worked at a high temp.; welds when soft is soluble in the same reagents as caoutchouc.
Is not attacked by HFl.
Vulcanized india rubber grad-

-rally loses its S & becomes brittle especially if kept in contact wh metal wh takes the S.

Asphalt & bitumen

Occurs extensively in nature as springs some of wh contain the asphalt in solution

The salt of the earth spoken of in the Bible probably means bitumen & when it is spoken of as having lost its savour it means that it had lost some of its volatile hydrocarbons.

It was ordered to be used in burnt sacrifices & was probably smeared over the bodies & thus rendered them more combustible.

Asphalt is the residue of mineral oils wh have lost their volatile hydrocarbons.

Occurs in Turkey Persia Egypt & even in our own country

There was a spring near Edinburgh & there are in the Industrial museum several black candles made from it.

There is one near Alfreton in Derby from wh paraffin was first made.

There are many mineral hydrocarbons like asphalt.

Ozokerite C_2H_2 n.

Sheerit

Found in brown coal in Germany

Fichtelite C_8H_7

Found in fossil pines.

Hartit-C_6H_5.

Idrialit $C_{80}H_{28}O_2$

Found with cinnabar in Idria.

Animal Chemistry.

We could make urea & grape sugar waste products of vital agency but chemistry has yet made but small progress in producing the

The ruling agency in vegetable & animal life is vital agency. When we see plants growing on the same soil, nourished by the same substances, watered by the same rain & stimulated by the same manure & yet producing substances as different as starch & morphia we cannot tell what the hidden force wh produces these transformations is.

Latterly we have got a more exact idea of force & know that, heat, electricity, chemical affinity &c

are all resolvable into motion.
But although our ideas of force are extending & we can compare the animal body to a steam engine yet one force is left of wh we know nothing viz., vital force.

We know the engine but not the engineer.

Histogenetic substances.

All those wh build up the framework of the animal body are termed histogenetic.

They are the substances of wh the organs consist. Fat is not an organ & is not a histogenetic substance.

Albumen
Fibrin
Casein
Syntonin Fibrin in muscle
Globulin Found in the eye.

Hemato-crystallin.

Most of them, the first three at least are found indifferently in the animal & vegetable kingdoms.

If you stir fresh blood with twigs fibrin coagulates on them.

Whip fresh juice of cauliflower with twigs & you get fibrin

Boil cabbage juice & you get albumen.

You can get it from blood

Add an acid such as HCl to casein & cheese is formed

Add HCl to solution of peas & you get the same casein

These substances exist both in plants & animals.

General properties whencesoever derived.

Uncrystallizable, translucent of a yellowish colour, tough when dry, adhesive or jelly like when moist.

Brittle gelatinous plates when dry.

Exist in 2 forms

In the soluble state as fibrin in the blood

In the insoluble state as when the blood is out of the body.

The exact cause of the transformation from the soluble to the insoluble state is not known

They part with 2 P.C of some proximate constituent* when they become insoluble.

They insoluble varieties seem to dissolve unchanged in acetic & phosphoric acid.

Mineral acids decompose them

All are transformed by long boiling in HO

When oxidized by $HONO_5$ or

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* As soda or potash generally alkalies

other oxidizing acid they produce acids of the alcohol series beginning at formic & going up to caproic acid.

They also produce aldehydes.

Some in oxidizing produce oil of bitter almonds & acids of benzyl series

Digested with $HO SO_3$ or strong HCl they produce almost invariably Leucine & Tyrosine & commonly Glycine, besides NH_3 salts under the influence of caustic alkalis

When moistened they putrefy the elements dividing themselves according to their greatest affinities.

Putrefaction thus differs from decay wh is a combustion.

Among the products of their putrefaction are the carbonate butyrate & valerate of NH_3, NH_4S

Common test for these; for any of these nitrogenous bodies.

Moisten with a salt of Hg having an excess of Hg + heat to 212°. They become red on the surface. Do not heat too violently.

This is a test for all histogenetic substances.

Mulder argued that they all contain'd a substance called protein wh was the basis of them all. According to Mulder it has the formula $C_{36}H_{25}N_4O_{10} + 2HO$ wh can be driven off by heat.

Percentage composition of protein according to this formula.

C = 54·7

N = 14·2

H = 6·8

O = 24·3

He supposed other bodies to be

protein combined with PPS. Though his veiws are no longer held by chemists the nomenclature is retained & they are called protein compounds.

Probably they are all the same as regards organic composition & their ground work is the same in all & they differ merely in form.

Albumen

Is the chief type of the group. Exists in various states probably owing to the amount of alkali with wh it is united.* Occurs in vegetable juices in blood, chyle & lymph in all serous liquids, in the juice of flesh & cellular tissues, in white of egg.

Prop. 1st. Soluble albumen

As obtained from white of egg it is transparent, yellowish,

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* Thus its reactions are not always the same

soluble body of a glairy consistence. S.G 1.261. When put in HO it swells & dissolves, the solution reacts alkaline from the NaO it contains. Remove this by acetic acid & add HO & it becomes insoluble

Metallic salts precipitate albumen

Add $HgCl$ to albumen & it forms an insoluble coagulum, on this account albumen is used in cases of poisoning by $HgCl$. When heated to 63°C it becomes opaline at 75°C it coagulates entirely. It is then insoluble in

Tannic acid precipitates albumen.

Albumen of blood. Is not coagulated by dilute $HOSO_3$

Insoluble albumen

When albumen is acted on by heat it appears to be the first form from wh. all the other nitrogenous substances are formed.

It requires very little change to become muscle or the contents of nerve tubes

Fibrin

Occurs chiefly in blood, lymph & chyle in a state of solution

Prop. Separates in an insoluble state in delicate filaments. We know nothing of pure soluble fibrin

Coagulated fibrin is opaque yellowish fibrous mass hard & brittle when dry

Swells in HO but is insoluble in it; dissolves in solution of $KO NO_5$ at 40° C but is coagulated by boiling & acetic acid

Digested at 150°C with HO under pressure, by sealing it up with HO in a tube. The fibrin is apparently converted into albumen. It becomes soluble & is coagulated by acids & behaves exactly like albumen.

Vegetable fibrin is prepared by putting flour in a muslin bag & kneading it in a stream of HO. The starch is carried thro' the pores & the fibrin remains behind. Gluten of wheat is identical with fibrin

Syntonine.

Is fibrin of muscle

Is the chief constituent of the striated muscles, is in smaller quantity in the smooth muscles & in the arterial coat & spleen

When first taken from the body it is snow white.

Soluble in HO containing 1 P C of HCl, insoluble in $KONO_5$.
Is precipitated from its solutions in alkalis by KCl. or NaCl
The solution in lime water is coagulated by heat.

Casein.

Occurs in the milk of mammals, in small quantity in blood under the name of serum casein.
It exists in yolk white of egg so intimately mixed with albumen that it used to be thought a separate substance & was called vitellin
Exists in the juice of flesh in the juice of the thymous gland.
In the vegetable kingdom in the seeds of leguminosæ
Prop. Chiefly differs from the other allied substances in its mode of coagulating.
May be got from milk by adding HCl or rennet

Acetic & Lactic acid precipitate it from solutions. Strong acetic acid however dissolves it.

Rennet coagulates it.

It is not precipitated by heat.

The skin formed on the top of boiled milk is caused by the oxidation & not by the coagulation of Casein.

If boiled with Ca Cl or $Mg\,O\,SO_3$ it is precipitated but the base goes down along with it.

On account of this property it is used for cement for glass & earthenware.

A poor cheese is made into a paste with lime.

Vegetable casein of leguminosae or Legumin

Occurs in leguminosae from 20 to 25 P.C.

They are even too nutritive

The casein is obtained by coagulating their infusion by rennet or by adding acids.

Casein of animals & vegetables is exactly the same

Cheese is sold in China made from beans.

Its solution when heated forms a skin on the top like milk heated.

Globulin.

Forms 36 P.C of the crystalline lens of the eye, & got its name from being supposed to be identical with the coagulable part of the corpuscles of the blood.

Differs from albumen by coagulating at 93° C.

The solution is not coagulable by acetic acid or NH_3.

It becomes turbid when the acetic acid solution is heated.

Is precipitated by CO_2

Hemato-crystalline
It is albumen in a state in wh
it can be crystallized
Got from the blood of the guinea
pig from wh it crystallizes
in tetrahedra.
Is in the blood of rats & mice
It is difficult to get from man's
blood but from it & from the
blood of carnivora it is in prisms
From the hamster in rhombohedrons
Differs from all other albuminous bodies by not being precipitated by metallic salts of Cl, & NO$_5$.
It is obviously a glucoside*
The characteristic of all histogenetic substances is that
they all contain 15 P. C of N.

B. Derivatives from the albumenous group

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*The substance wh remains besides glucose has the same composition as albumen

They closely resemble albumenous bodies but contain rather less C.

They differ in physical characters

They do not form cells but form organic bases of certain tissues

With strong HCl, $HONO_5$ & prussiate of KO they are not precipitated

Ossein.

Prep. Put a piece of bone in dilute HCl, & treat with alcohol & ether to take out the fat.

Insoluble in HO, is converted into glutin by boiling.

*Glutin.

It is a transformed condition of ossein. Is called gelatin in commerce.

It is colourless transparent & horny

Brittle, heavier than HO,

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* Different from gluten wh is in wheat; Glutin is the general name for gelatine

tasteless insoluble in cold HO
soluble in hot
Water with 1 P.C of glutin is
gelatinous. Long digestion in HO or
destroys its gelatinous property
Forms a precipitate with tannic acid.
Dry distillation produces various bases from it as methylamin
Glutin does not appear to be
in the body except in the spleen.

Chondrin

Prep. Boil the permanent &
articulate cartilages
It much resembles glutin.
It is precipitated by acetic
acid, per salts of Fe, HCl, alum
Treated with

Many albumenous bodies pass
into glutin when boiled

Glutin & elasticin are known to us as common glue

Glue is made from the parings of ox hides boiled in a coarse cloth cut into blocks & dried.

Size is a less strong glue made from the parings of parchment & used in a liquid state.

Confectionery gelatine

Made from the swimming bladders of fish & the parings of fine hides. Abroad it is made from the tendons of rats.

In the abattoirs where horses are slaughtered, the carcases are put into rooms plastered so that the rats cannot make holes in them & two or three bricks are left wh can be removed & replaced at pleasure.

The rats are allowed to enter at night to clean the bones of the horses before the bones are sold to the P. makers. In the morning the bricks are replaced & a man having a mask & thick gloves & armed with a bludgeon enters & kills the rats, their skins are made into kid gloves & their thigh bones cleaned & made into toothpicks for the London Clubs; the rest of the body is boiled down for gelatine.

Leather is a tannate of gelatin

There are various nitrogenous substances wh occur as derivatives in the animal body. These substances are formed probably by the transformation of histogenetic substances arrested in their passage to complete oxidation.

They are probably amides

Amides contain their N as

amidogen NH_2.

Kreatin $C_8 H_9 N_3 O_4 + 2HO$.

Occurs in the striped & smooth muscles in urine in the brain in blood.

It is best got from the flesh of fowls or skate fish in wh. there are 3 parts of kreatin to 1000 parts of flesh.

It is a clear, transparent colourless brilliant body crystallizes in rhombic columns loses 2HO at 100° C. Insoluble in strong alcohol but soluble in dilute spirits of wine. Has a bitter taste, neutral in reactions. When heated with strong acids it becomes converted into kreatinin a substance wh. also occurs in urine.

$C_8 H_9 N_3 O_4 = C_8 H_7 N_3 O_2 + 2HO$.

When heated with BaO it takes up 2HO, & becomes urea & sarkosine

$$C_8H_9N_3O_4 + 2HO = \overset{\text{urea}}{C_2H_4N_4O_2} + \overset{\text{sarkosine.}}{C_6H_7NO_4}$$

Kreatinine

Occurs in blood muscle & urine is is formed by the action of acids on kreatin Crystallizes in colourless rhombic prisms, soluble in HO & hot alcohol, the solution reacts alkaline & is a feeble base, when concentrated it tastes like dilute NH_3.

By long keeping it becomes kreatin, especially in presence of lime water

Kreatin & kreatinine are products of the oxidation of the tissues on their way to urea.

Sarcosin. $C_6H_7NO_4$

Although to be expected, yet it is not perfectly certain that it exists in the urine

Prep. Act on kreatin by alkalies. $BaO\,HO$

It crystallizes in rhombic

prisms soluble in HO
Seems to be ami
When Kreatin

$2(C_8H_9N_3O_4) + 10HgO = 10Hg + 2HO$
$+ 4CO_2 + (2C_4H_7N_3, C_4H_2O_8)$
Methyluramine $C_4H_7N_3$.
It is probably a triamine
It is a strong base, precipitates oxides. drives NH_3 from salts, its constitution is unknown.
Sarkin $C_{10}H_4N_4O_2$
Occurs in the flesh of horses, oxen & men.
Crystallizes in colourless transparent needles readily soluble in HO difficultly in alcohol

Fuming NO_5 converts it into Guanin
Guanin $C_{10}H_5N_5O_2$.
Occurs in guano & spider's

excrements in the liver & cavities of pancreas

White or yellowish isomorphous mass without taste or smell

Insoluble in HO alcohol & ether, soluble in alkalis.

Unites with salts as Zn Cl.

By NO_5 or $HOSO_3$ & MnO_2 it becomes Xanthin.

Guanin $C_{10}H_5N_5O_2$

Xanthin $C_{10}H_4N_4O_4$

Xanthin occurs in urine occasionally, forms calculi has been found in flesh & salivary ducts

An amorphous white mass

Soluble in acids & alkalis, little soluble in HO.

Resembles sarkosin &
is less decidedly basic than they.

Cystin $C_6H_6NS_2O_4$

Is a rare constituent of urinary

calculi. Has been lately found in nerves & liver

Crystallizes in colourless transparent 6 sided ~~prisms~~ tables. Neutral, insoluble in HO & alcohol soluble in acids & alkalis.

Allantoin $C_8H_6N_4O_6$

Occurs in cows' allantoic fluid, & in the urine of calves & dogs

Is got by the oxidation of uric acid

Is most easily got from calf's urine.

Crystallizes in colourless brilliant prisms, tasteless having no smell neutral, soluble in hot HO & alcohol insoluble in ether soluble in alkalis but is decomposed when boiled with them taking up 10 HO.

$$C_8H_6N_4O_6 + 10HO = 2\overset{\text{oxalic acid}}{(C_4H_2O_8)} + 4NH_3$$

Tyrosin C_{18} ~~H_{11}~~ $H_{11}NO_6$

Occurs in the liver, pancreas in cochineal in root of

& is a general product of the decomposition of albuminous bodies by acids & alkalis.

Prop. Occurs in white silky crystals. Soluble in hot HO insoluble in alcohol & ether

Dissolves without change in alkalis, & acids forms conjugate bodies with $HOSO_3$.

Aloxan $C_8H_2N_2O_8 + \begin{cases} 2HO \\ \text{or} \\ 8HO \end{cases}$

Made from guano.

By the oxidation of uric acid by NO_5.

Occurs in octahedral crystals Soluble in HO, the solution colours the skin red. It reddens litmus paper.

At 100°C it loses HO.

Forms like alkalis

$HONO_5$ oxidizes it & forms parabanic acid.

Reducing agents as HS convert it into aloxantin.

Aloxantin is readily changed

Thyanuric acid $C_8H_5N_3O_2S_2$

Formed when aloxane is treated with SO_2 & saturated with NH_3.

Aloxantin $C_8H_5N_2O_{10}$

Got by acting on aloxan by reducing agents

Crystallizes in colourless prisms dissolves in NH_3 with a purple colour.

The solution is acid. it gives a violet precipitate with BaO.

It's products of oxidation are similar to those of alloxan.

Cerebrin $C_{34}H_{33}NO_5$

Occurs in the brain.

It is a white porous powder, tasteless, having no smell, insoluble in HO, soluble in alcohol & ether neutral.

Decomposed by boiling acids at 80°C

Amide acids.

Taurin $C_4H_7NO_5$-S_2.

Occurs in the muscles of all mollusca, in the lungs, sometimes in the kidneys & often in the liver of higher animals.

Produced by the action of acids on Taurocholic acid a constituent of bile.

Prep. Heat ox bile with HCl. Evaporate & exhaust with alcohol.

It has been got artificially by heating isatinate of ammonia

$C_4H_9O_8NS_2$ it loses 2 HO

$\underline{H_2O_2}$

$C_4H_7O_6NS_2$ Taurin

It is thus the amide of isatinic

acid
It forms colourless transparent 6 sided prisms dissolves easily in HO, insoluble in alcohol & ether. dissolves in acids, is neutral.

Leucin $C_{12}H_{13}NO_4$

Exists in blood vascular glands spleen, in thymous gland
In liver & bile, the pancreas & salivary glands & their secretions.
In the contents of the small intestines in the lungs & kidneys*
It is always produced by the action of strong acids & alkalis on albumenous bodies

Prepared synthetically by heating valeric anhydride with HCy.

valeric anhydride

$C_{10}H_{10}O_2 + HC_2N + 2HO = C_{12}H_{13}NO_4$

Leucin is the amide of caproic acid. Caproic acid $C_{12}H_{11}O_3$, HO

Leucin $C_{12}H_{10}(NH_2)O_3$, HO

*Has been found in diseased brain

Prop. When quite pure it crystallizes in colourless brilliant plates.
Freely soluble in HO less so in alcohol & insoluble in ether. The solutions are neutral. With $HONO_5$ it gives various products among others Leucic & Lactic acid.

Uric acid.
$C_{10}H_4N_4O_6$ It is biatomic = $2HO\ C_{10}H_2N_4O_4$.
Occurs in small quantity in the urine of man & carnivora, scarcely at all in that of herbivora. The urine of birds & serpents chiefly consists of this & also that of tortoises. Largely in the excrements of butterflies & beetles
Traces of it in healthy blood
Increases in gout & Bright's disease
Is in excess in cholera, bronchitis & pneumonia
Is a frequent substance in calculi.

Prep. Urates in serpents escrements are urate of amonia principally. Treat with alkalis $^{(KO)}$ & add HCl & the sparingly soluble uric acid is precipitated.

It is a white crystalline powder difficultly soluble in HO insoluble in alcohol & ether.

When heated it is converted into urea, cyanuric acid, NH_4OCO_2 HCy.

Peroxide of Pb makes it into alantoin, urea, oxalic acid & CO_2.

This is important.

It is only a feeble acid but is bibasic & forms acid & neutral salts.

Urates. General formula

$$\left.\begin{matrix}MO\\HO\end{matrix}\right\}\overline{\overline{U}}\text{ric}$$

Urate of NaO. $\begin{matrix}NaO\\HO\end{matrix}\Big|\overline{U}$

1 eq of HO in Uric acid is replaced by 1 of NaO.

Difficultly soluble in cold HO, more so in hot.

This is the reason that urine sometimes though clear when ejected becomes turbid on cooling.

Acid urate of ammonia. $\left.\begin{matrix}NH_4O\\HO\end{matrix}\right|\bar{U}$

Crystallizes in fine needles or an amorphous precipitate scarcely soluble in cold HO.

Urate of lime $\left.\begin{matrix}CaO\\HO\end{matrix}\right|\bar{U}$

Occurs in calculi & sometimes as a urinary sediment

Forms chalk stones in the joints of gouty persons. White amorphous & difficultly soluble in cold HO.

Derivatives of Uric acid.

When $HONO_5$ acts on uric acid, it is dissolved with a yellow colour & various products are formed. By careful evaporation to dryness & treating with NH_3, it becomes purple.

Best way.

Take 4 grs. aloxantin & 7 of hydrated alloxan, dissolve in ½ an oz. of HO by boiling. Add to $\frac{1}{6}$ oz. by measure of saturated solution of $NH_4O\,CO_2$, & murexide is formed. It must be boiling before adding to $NH_4O\,CO_2$.

Murexide. $C_{16}H_8N_6O_{12}$

Has the synonym of purpurate of ammonia. Is used in dyeing.

It is owing to the formation of murexide that the guano colours are formed.

Guano consists of the excrements of sea fowl

It is treated with KO to dissolve the uric acid. The uric acid when treated with NH_3 forms murexide.

It is then treated with salts of Pb & Hg.

Properties of murexide

Crystallizes in 4 sided prisms, of a golden green beautiful metallic lustre. Difficultly soluble in HO readily in KO with a purple colour.
Test for uric acid. Dissolve uric acid in $HONO_5$ & alloxan is formed

It is supposed that murexide contains a compound called purpuric acid & that it is a NH_3 compound of this.

$$\left.\begin{matrix}NH_4O\\HO\end{matrix}\right\}\overset{\text{purpuric acid.}}{C_{16}H_3N_5O_{10}}$$

No substance has yielded so many compounds to organic chemistry as uric acid.
Some of the chief are,
Uric acid & nitric acid form alloxan

$$C_{10}H_4N_4O_6+2HO+2O=\overset{\text{alloxan}}{C_8H_2N_2O_8}$$
$$+\overset{\text{urea}}{C_2H_4N_2O_4}$$

Act on alloxan by a feebly oxidizing agent as KO.

$$C_8H_2N_2O_8 + 4HO - \overset{\text{mesoxalic acid}}{C_6H_2O_{10}} + \overset{\text{urea}}{C_2H_4N_2O_2}$$

Cynuric acid
Seems to take the place of uric acid in the urine of the dog.
Crystallizes in 4 sided prisms
Melts when heated & exhales the odours of benzonitrile
Dissolves in acids & alkalis & has all the characters of a feeble acid.

Inosic acid. $HO, C_{10}H_6N_2O_{10}$.
Found in the juice of flesh in small quantity. Forms a solid white uncrystalline mass, soluble in HO, insoluble in alcohol & ether.
Reddens litmus, tastes like flesh forms salts.

Acids of bile.

Bile besides less essential constituents contains NaO salts of 2 nitrogenous acids.

These acids are like glucosides
They do not contain grape sugar
but bodies corresponding to it.
The one contains glycin the other
taurin instead of glucose.
Both contain the same acid.
viz., cholic acid.
Cholic acid with taurin & glycin
forms conjugate acids.

Glycocholic acid. $HOC_{52}H_{42}NO_{11}$
Occurs as glycocholate of Na.O in
bile.
Is the main constituent of
ox gall & is in small quantity
in that of other animals except
the pig.
Glycocholic acid crystallizes in
very delicate needles, soluble in
hot HO & alcohol, difficultly in
ether. The solution tastes sweet
& then intensely bitter, reddens litmus
With $HOSO_3$ & sugar it gives

an intense purple red.

Soluble in concentrated acids, without colour at first but absorbs O & becomes coloured.

When long boiled with BaO it is decomposed

$$C_{52}H_{43}NO_{12} + 2HO = \overset{\text{cholic acid}}{C_{48}H_{40}O_{10}} + \overset{\text{glycin}}{C_4H_5NO_4}$$

Glycin is the amide of acetic acid & is a product of the action of acids on gelatin

Hence glycocholic acid is a conjugate acid.

Taurocholic acid $C_{52}H_{45}NO_{14}S_2$

So called because it contains taurin instead of glycin.

It is the second chief acid in bile

Occurs as the NaO salt in the bile of man, ox, dog, goat, frog boar, anaconda &c.

In certain fresh water fishes.

Has been detected in the blood in transudations

* In the boar is is apparently alone not accompanied by other acid

& in urine in cases of suppressed excretion of bile.

White amorphous bitter powder soluble in HO

Easily decomposed by heating

Is decomposed by boiling with BaO taking 2 HO.

cholic acid taurin

$C_{52}H_{45}NO_{14}S_2+2HO=C_{48}H_{40}O_{10}+C_4H_7NO_6S_2$

Taurin is the amide of isithionic acid.

With $HOSO_3$ & sugar it gives the same reaction as glycocholic acid

With ferments the tauro & glyco-cholic acids are broken up as with ~~ferment~~ alkalis.

Cholic acid $C_{48}H_{40}O_{10}$.

Crystallizes in transparent colourless tetrahedral crystals

Has a bitter but sweet taste, readily soluble in alcohol & ether, difficultly in HO. Its alcoholic solution reddens litmus & drives CO_2 from its salts.

With alkalis it forms crystalline salts.

With $HOSO_3$ & sugar it gives the purple reaction of bile.

Hyoglycholic acid. $C_{54}H_{43}NO_{10}$.

Substitutes these other acids in the bile of the pig.

Not found in that of any other animal.

A White resinous substance melts in boiling HO. Insoluble in HO & ether

It is a conjugate acid & contains glycin & Hyocholic acid

Hyocholic acid $C_{50}H_{40}O_8$.

There is another corresponding to it in the bile of the pig.

Hyotaurocholic acid. $C_{54}H_{45}NO_{12}S_2$.

Lithofellinic acie $C_{40}H_{36}O_8$.

Exists in oriental.

in the biliary concretions of antelopes & goats, of wh it forms the chief part.

It belongs to the same class as these others

When cholic acid is acted on by acids it forms several substances one of wh is called choloidic acid.

cholic choloidic

$C_{48}H_{40}O_{10} - 2HO = C_{48}H_{33}O_{8}$

Amorphous mass melts on boiling readily soluble in alcohol.

Cholosterin $C_{52}H_{44}O_{2}$.

It is a crystalline fatty substance found in bile but generally in biliary concretions.

It is like a monoatomic alcohol

Found in the brain, blood, lungs

It is neutral melts at 145 °C sublimes at 360°

Gives an aromatic oil by distilling, having a smell like the geranium

Insoluble in cold alcohol, soluble in boiling alcohol & ether.

* Found abundantly in biliary concretions

Solutions of bile dissolve it readily. It unites with one equivalent of acetic acid with displacement of one eq. of HO. Compound ethers may be got from it as from alcohol

$C_{52}H_{44}O_2\,C_4H_3O_3$.

All bile of animals is coloured by a substance wh forms a bile pigment. Originally brown in man but becomes green by oxidation

Solid constituents of animals

Bones.

Those of vertebrate animals are tolerably constant in composition. When dried at 212° they have $\frac{1}{3}$ of their weight of organic matter & $\frac{2}{3}$ds of mineral matter. Large bones & those wh have much work have more mineral matter. General average of the composition of bones taken from various analyses.

$3CaO, PO_5$	57 parts.	
$CaO CO_2$	8	
$Ca Fl$	1	
$3MgO, PO_5$	1	— Mineral Matter 67
Cartilage	33	

The mineral matter in bones increases with age.

The teeth, resemble the bones in composition.

Dentin is like dense bone.

Organic matter in it 28 P.C.

The enamel contains no cartilage.

Mineral matter in teeth

$3CaO, PO_5$.	81 – 88 P.C
$CaO CO_2$	7 – 8
$Ca Fl$	3 – 4
$3MgO, PO_5$.	1 – 1½

Muscular Tissues.

They are extremely complicated & contain many substances but may be on an average.

HO	74 – 80 P.C
Solid ingredients	26 – 20 P.C.

Among the solid ingredients

there are in the 26 parts.

Syntonin	15·4 – 17·7
Gelatinous substances	0·6 – 1·9
Albumen	2·2 – 3·0
Kreatin	Traces
Kreatinine	
Inosite	
Inosic acid	
Hypoxanthin	
Fat	1·50 – 2·30
Lactic acid	0·60 – 0·68
PO_5	0·66 – 0·70
NaO	0·07 – 0·09
KO	0·50 – 054
MgO	Traces.
ZnO 0·02–0·03	

NaO is chiefly confined to the blood & KO is in the flesh.

Many of these are dissolved in the fluid surrounding the fibres of the muscles. Healthy muscles have an alkaline reaction but after the rigour of death an acid reaction. Contraction of muscle is always accompanied by oxidation CO_2 being evolved

In this the sapid constituents of the meat reside & the bodies wh. are so important for nutrition as the phosphates.

If you take the flesh of the fox & venison & express the juice & dip the flesh of the fox in the juice of the venison & cook it, you cannot distinguish it from venison.

If you take away these juices

Supposing you wish to make soup, you wish to get out the sapid constituents, in boiling meat you want to keep in these.

To make the strongest soup.

Mince the meat, put it in cold H_2O & gradually raise the temperature. You must go beyond 158°F before you coagulate the blood & till this is done the soup has a red colour.

To boil meat plunge it at once into boiling HO for about ¼ hour, & then reduce the temp. to 160° by adding cold HO.*

The boiling HO at once coagulates the albumen on the surface & the sort of crust thus formed keeps in the sapid & nourishing constituents.

To make the strongest possible soup for invalids

Take one lb of lean beef mince it & mix with 1 lb of HO, heat it very slowly till it boils & all the soluble & gelatinous matters are extracted. You then strain it thro' a cloth

The effect on the patient is very different if you leave it with its straw colour or colour it with burnt sugar or burnt onion.

If you colour it they think it is much stronger.

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* Keep simmering & about the end of the operation you may raise to 212° again

Evaporate this to dryness & you get the true extract of flesh. That sold in shops is only glue.

In boiling beef the albumen coagulates at 140°F but the blood globules do not coagulate before 158°F. On this account in roast meat although it is perfectly cooked, the inside sometimes appears raw, the heat there having never been up to 158°.

Relative values of meat.

In 1 lb of each.

	Veal	Beef	Mutton	Pork
HO	10oz 0grs.	8oz 0grs	7oz 16.	$\overset{3grs}{6\text{-}69}$
Gelatine	1-2	1-62	1-52	0-385
Fibrin & albumen	1-199	1-122	0-385	0-315
Fat	2-281	4-340	6·176	8-0
Mineral matter	0-312	0-350	0-245	0-105.

Salting of meat.

When meat is placed in salt a curious action goes on.

From its affinity for HO the salt takes the HO from the outside of the meat & dries it. The juice from the inside of the meat is then diffused into this & thence into the brine. But the brine does not easily penetrate into the meat. The sapid constituents & the mineral salts come out.

A great part of its nutriment is thus removed from salted meat. When it is long used scurvy & other diseases arising from defective nourishment make their appearance.

Components of the brain.

They are not satisfactorily made out.

Among them are oleine, oleic acid, leucin, margaric acid cholosterine, stearic & palmitic acid

The two characteristic ingredients are cerebric acid & oleophosphoric acid.

Cerebric acid.

It is a phosphorized fatty acid. & is found partly free & partly in combination with NaO.

Insoluble in HO but swells like starch when the HO is heated.

Oleophosphoric acid.

It is a greasy oily liquid partly found free & partly in combination. Found also in the yolk of egg.

When long boiled it is decomposed into oleine & phosphoric acid.

Mineral ingredients are of very small amount. They amount in the human brain to 0.027 P.c

Of these

$3KO,PO_5$ – 55 P.C

$3NaO\,PO_5$ - 23 PC
$3MgO\,PO_5$
$3FeO\,PO_5$.
$3CaO\,PO_5$

There is also PO_5 either as strongly acid phosphates or free. also SiO_2

Glands & their juices

Leucin is in the pancreas & spleen, in thymous gland in thyroid body & in liver of ox.

Tyrosin

Hypoxanthin in the spleen thymous gland

Uric acid in spleen.

Formic, acetic, succinic, & lactic acid are found in these glands.

Inosite in the spleen, liver, kidney thymous gland pancreas & lungs.

Cystin. Taurin

Guanin in the pancreas of ox.

The mineral ingredients in glands vary much

In the liver the KO salts predom-

inate over those of NaO.
The reverse is the case in the spleen.

Cl forms $2\frac{1}{2}$ P.C. of the ash of the spleen & $\frac{3}{10}$ PC of the spleen

PO_5 forms 33.5 PC of ash of liver & 18.5 P.C of ash of spleen. CaO & MgO in small quantity

In spleen K is abundant; forming 7 to 16 PC of the ash.

Mn, Cu & Pb are commonly but not always found both in the liver & spleen. Zn occasionally

Digestive fluids

Saliva

S.G 1.004 to 1.006

It is always alkaline but more so during meals than when fasting.

The saliva of the parotid gland contains Ptyalin as a marked ingredient

It has the same power as diastase of converting starch, first into dextrine & then into sugar

It is an albuminous matter in a state of change

Ptyalin.

It is ~~like~~ an albumenate of NaO. Forms $\frac{1}{3}$ of the whole solid residue of saliva. It is very prone to decomposition or putrefaction.

It is a strong ferment. The conversion is almost instantaneous.

Composition of saliva of parotid gland. In 1000 parts. From the dog.

HO	995.3
solid residue	4.7
Of the residue	
Organic matter	1.7
Alkaline chlorides & sulphocyanides	2.1
$CaO\,CO_2$	1.2

In certain animals the sulphocyanides exist more than in others. Add a per salt of Fe to saliva & a red colour is produced showing the presence of sulphocyanogen.

The composition of human saliva is like that of the dog's.

HO	994·10
solid residue	5·90

The presence of sulphocyanide of NaO is characteristic.

The daily secretion of saliva by an adult man is about 48 oz. but differs according to his food. Mineral matter in it consists of KO, NaO & CaO salts. The last when acted on by the air & converted into $CaOCO_2$ forms the solid incrustation froth on horses mouths.

$CaOCO_2 . 3CaOPO_5$ & mucus form tartar.

The sulphocyanide of K on the teeth is increased when S is taken as a medicine

The function of saliva is partly chemical & partly mechanical. Healthy saliva is frothy & carries down O into the stom-

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*The $KSCy$ exists chiefly in saliva of man & sheep ach wh aids the digestion

Its chief function is to convert the starch of food into sugar.

The ~~staliva~~ saliva from the pyrotid gland alone has not this power.

Various nations have found out this power of saliva.

The formation of diastase is the use of malting.

In South America there is a fermented drink made from maize. Old women chew it & spit it into jars, it is then fermented.

The pancreatic fluid is like saliva. It is alkaline like it & converts starch into sugar

It is a colourless clear, frothy, tenacious substance S.G 1.008.

Coagulates only slightly when heated gives 1·36 P.C of solid matter

Contains a solid substance, like albumenate of NaO but not identical with it is prone to decomposition

Ptyalin

An adult man secretes 10 lbs of pancreatic juice daily.

Pancreatic juice of dogs.

HO	980.45
solid residue	19,56
pancreatic ferment	12.71
Mineral bodies	6.84

Its chief juse is to convert into sugar the starchy matters wh. have escaped the action of the saliva.

Bernard of Paris asserts that it acts as amulcin & breaks up fats.* Pancreatic juice does this out of the body

It is possible that the pancreatic juice may reform the $NaCl$ broken up in the process of digestion.

Gastric juice

It is the fluid poured out from

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*Into glycerin & fatty acids

the lining membrane of the stomach.

It is neutral in the empty stomach. acid when food has been recently taken in.

S.G. 1.0023,

The acid is generally lactic acid.

Shmidt's analysis

HO	994.4
solid ingredients	5.596
peculiar ferment pepsin	3.195
free HCl	0.2
CaCl	0.06
NaCl	1.46

Lactic acid is with it in varying quantity. The saliva is mixed with it in the analysis.

Marked ingredients.

Pepsin & free acid.

Pepsin.

It is an albumenous body soluble in HO insoluble in alcohol.

The HO solution is precipitated by salts of Hg, Pb.

Converts coagulated albumen into the soluble form only does so in the presence of free acids
The fresh gastric juice of the dog dissolves $\frac{1}{20}$th of its wt. of coagulated albumen.
Its function is to render the nitrogenous parts of the food soluble but to accomplish this it must have free acid.

Bile immediately suspends the action of pepsin.*
The quantity of gastric juice secreted by animals is almost incredible, about ¼ of their wt. daily.
In the case of Katharine Cutt a person who had a fistula thro' wh. the stomach could be observed it was about 30 lbs daily.
Yet it is not sufficient to dissolve all the albumenous bodies introduced as food.

*Thus the gastric juice has no effect on food after it has passed into the intestine

The stomach is protected from the action of the gastric juice by the epithelium & not by its vitality for the hind legs of a frog introduced into the stomach thro' a fistula were digested, the vitality of the frog not preventing it.

The intestinal juice seems to combine the effects of the pancreatic & gastric juice. About 10 oz are secreted daily)

Bile is the liquid produced from venous blood by the liver.

It is a viscid tenacious fluid of a brown or green colour & musky odour & bitter taste

S. G 1·02. It putrefies readily but if freed from mucus it does not change.

Sometimes alkaline often neutral.

Composition.

HO	~~7944~~ 90·44.
Biliary bodies	8.

Aqueous extract, ealkaline salts. phosphates

chlorides & lactates	0·85
mucus	0·30
NaO + KO	0·41

Characteristic bodies

Resinous matter. Cholic acid. Tauro & Glyco-cholic. It unites with alkalis like resins

Cholosterine is always in healthy bile in small quantity 1 part in 10000 parts of bile.

Retention of bile concentrates it.

A man of 10 stone secretes 5 lbs daily.

Its main use is to promote the digestion of fatty matters. Lehmann considers the bile as the waste matter of formation of blood corpuscles

If you moisten one capillary tube with HO & the other with bile & put them in a fatty substance the fat rises higher in the tube wetted with bile than in that wetted with HO.

It probably neutralizes the acid chyme from the stomach.

Excrement

It consists of undigested particles of food, of epithelium & mucus decomposed biliary constituents.
Its smell is due to decomposed biliary constituents or the imperfect combustion of albumen.
If you distil albumen with KO HO you get essence of excrements.
When the diet is mixed the colour is yellow brown, on a flesh diet it is darker & on a milk diet it is yellow.
Its action is generally alkaline
In an adult man there are about 5 oz. daily.
It contains 73 PC HO

27 PC. solid constituents.

The N in the faeces & in the urine

correspond closely to the N introduced in the food.

There are few soluble salts in the foeces these having passed out in the urine. There is more MgO than CaO in proportion to the food, showing that some CaO has been taken into the system.

The foecal ash gives 31 P.C. of tribasic PO_5.

Taurin is always found & a peculiar crystalline body very unpleasant to prepare called excretin $C_{78}H_{78}O_2S$.

Intestinal gases

They owe their origin partly to air conveyed to the stomach & partly to the decomposition of the intestinal contents

The O has disappeared in the large & middle of the small intestine

The chief gases are CO_2 & N.

H sometimes appears & when it does so in large quantity to extent of 25 P.C
Carbonetted H sometimes appears.
HS rarely exceeds 1 - 2 P.C.

Blood.

General properties.
It is a thick viscid fluid, S.G 1.055 in human blood, usually of a bright cherry red, arterial blood is lighter coloured than venous when removed from the body it changes & separates into the clot or crassamentum & serum. When warm it has a peculiar odour stronger in the blood of man than women.

If you add $HOSO_3$ to blood it gives a stronger smell

If you add $HOSO_3$ to the blood of the horse & heat the smell of the stable becomes perceptible, & if to cow's blood, the smell of the cow.

house.

The S.G of women's blood especially during pregnancy is less than that of men's.

Blood is not only a solution but an emulsion holding solid particles suspended in it.

It contains blood corpuscles, lymph corpuscles fat globules

Blood corpuscles.

They are thick circular slightly biconcave discs.

In human blood they about $\frac{1}{3200}$th of an inch in diameter.

In most mammals except the elephant they are smaller than in man.

In amphibia they are very large.

Lymph corpuscles.

They are lighter than blood.

The fluid in wh they float is called the liquor sanguinis

& contains fibrin in addition to the solid constituents of the serum

The clot is coagulated fibrin & contains the blood corpuscles & some serum. The composition of living & dead blood is different

Living blood	Dead blood 2 minutes after being taken from body.
Blood corpuscles	Clot = Fibrin & corpuscles
Liquor sanguinis	Serum.

Average of 22 analyses of healthy human blood.

HO	781·60	in 1000 parts.
solid constituents	218·40	

Of the solid constituents.

Blood corpuscles	136·0
Albumen in serum	70·0
Fibrin	2·50
Fats	1·55
Soluble salts	6·0
Earthy phosphates	0·35

Fe 0·55

Extractive matter 2·45

Various analyses have been given of blood corpuscles & liquor sanguinis.

The blood corpuscles contain

16·75 hæmatin } in 1000

241·07 hematocrystalline } parts

Liquor sanguinis contains neither of these but contains

4·05 Fibrin

78·84 Albumen.

The two characteristic constituents are hematin & hemato crystalline.

Hematocrystallin is a glucoside

Prep. of Hemat

Mix defibrinated blood with a saturated solution of $NaOSO_3$ & wash with alcohol & ether.

$C_{44}H_{22}N_3O_6Fe$. Hæmatin

Occurs in blood in the soluble form.

It is got also as a brownish black substance without smell or taste

On ignition it leaves a considerable quantity of Fe_2O_3

Dissolves in alkalies but is precipitated by acids.

If you add $KONO_5$ to blood, the fibrin does not coagulate.

KCl, $NaCl$, $KOSO_3$, acid phosphate of KO & of NaO, tribasic phosphate of CaO & MgO are the mineral constituents of blood.

In the liquor sanguinis $NaCl$, phosphate of NaO & KCl in small quantity are found.

Gases in blood.

CO_2, N & O.

They are found almost entirely in the blood corpuscles & hardly in the serum. If you shake up serum with gases it does not absorb them, but the blood corpuscles do to a considerable extent.

In arterial blood there is relatively but not positively more O than in venous blood.

Ratio of O to CO_2 in arterial blood is as 6 to 16 & as 4 to 16 in venous blood.

Coagulum.

The clot is produced by the coagulation of fibrin.

The cause of this is due to a considerable extent to the escape of NH_3.

1 part NH_3 keeps 3000 parts of blood fluid ~~in~~ a close vessel at 98°7.

Agitation hastens coagulation & [illegible]

Dilute solutions of salts retard coagulation. In inflammatory diseases there is a constant increase of fibrin in the blood. In inflammatory blood it is covered with free corpuscles. In dysentery the fibrin also increases & albumen diminishes

Serum

After the separation of the blood corpuscles & fibrin the serum is sometimes turbid owing to fat globules, in drunkards & pregnant womens blood

It is usually a straw coloured liquid

The serum of womens blood contains 1 P.C. more of HO than mens. In mans blood 90·71 P.C.
— womens — 91·71

The serum of arterial contains more HO than that of venous blood.

Albumen in serum 7·9 – 9·8
——— in collective blood 6·3 – 7·1

Albumen decreases in most diseases especially scurvy, Brights disease
In intermittent fever & Cholera it increases, & after drastic purgatives,
Dropsy begins when the albumen in the serum is below 6 P.C.

Various salts in small quantity are found in the serum.

Analysis of ash of serum.

KCl	4·054 P. C.
$NaCl$	61·087
$NaOCO_2$	28·78
acid phosp. NaO.	3·195
$KOSO_3$	2·784

$NaOCO_2$ + $KOSO_3$ probably exist in the blood as lactates of NaO + KO.

Chyle

It is the liquid into wh the nutritious portion of the blood is converted.

Its composition varies according to the food.

It is an opalescent fluid, has a feebly alkaline reaction. & mawkish taste

When boiled it deposits a small quantity of flocculent albumen.

That from the lacteals does not coagulate.

The fibrin in chyle seems to be less elaborated than in blood

Casein, fat, lactic acid & sugar are said to occur in chyle.
There have been few opportunities of examining healthy human chyle. That of animals seems to be a dilute kind of blood.
When exposed to air it becomes red.
There is 12 P.C. of mineral residue in the solid residue. $NaCl$ is abundant & alkalis combined with albumen.

Lymph.

It is a colourless or yellowish fluid got from the lymphatic.
The ingredients seem to be the same as those of blood
It coagulates in from 5 to 20 minutes after being taken out.

Analysis of Lymph.

HO 957.6 } in 1000 parts.
Solid ingredeints 42.4
Fibrin & lymph corpuscles 0.37

Albumen & extractive matter	34.72
Mineral matter	7.31

It is supposed that 22 lbs of lymph are formed in the body of an adult man in 24 hours.

Fluids of generation & development

The seminal fluid has been mixed with secretions of prostate & other glands before analyzed. It is commonly heavier than HO slightly alkaline, is coagulated by alcohol but not by heating.

Characteristic ingredient Seminal filaments.

The motions of these are arrested by various solutions, as of kreosote.*

Fluids of the egg.

Generally consist of 2 parts the yolk & the white.

The yolk contains fat globules & corpuscles surrounded by fluid

The corpuscles are phosphorized

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*And neutral salts &c.

Fat-probably glycerophosphoric acid
The molecular granules are casein
They form 14 P.C. of yolk.
albumen 3.
Collective fats 30.
Glucose is always in the yolk.
There are two pigments yellow & red.
Mineral constituents 15 P.C.
White of egg contains 12½ P.C of albumenous ingredients, salts Margarine oleine & glucose.
The mineral ingredients are soluble & consist in a great measure of NaCl.
The shell contains 97 P.C. of $CaOCO_2$.
& a little phosphate of CaO, MgO & organic matter

Milk.

It is an opaque fluid, of a white, bluish white or yellow colour.
It is generally alkaline, sometimes acid.*
S.G of womens milk 1.032.

*as in carnivora.

Under the microscope it is a clear liquid with fat globules wh. have a fibrous covering.

When this cover is broken in churning it allows the butter to gather

These globules floating to the top produce cream.

It does not coagulate but on heating it forms a scum from oxidation.

Average of 89 analyses of human milk.

HO	889.08	in 1000
solid ingredients	110.92	
Milk sugar	43.64 P.C.	
Casein	39.24 P.C.	
Butter	26.66	
Salts.	1.38	

The quantity of casein increases with animal food

During suckling the milk becomes changed. The butter remains tolerably constant

The casein increases as the child becomes developed

Milk of dark haired women is better than that of blondes & is richer in fats.

The composition of asses milk is nearer that of women than any other animal.

Composition of Cows Milk.

HO	86·2 P.C
Casein	4·2
Butter	5.
Milk sugar	4·1
Mineral matter	

Urine.

The urine is a liquid secreted by the kidneys from the blood. It removes the nitrogenous parts of decomposed tissues.

Human urine is a clear fluid of a bitter saltish taste & bright amber colour

S.G 1.015 to 1.025. In a state of health it never exceeds 1.03. It has an acid reaction. In clean vessels it has no great tendency to putrefy but if there is any decaying organic matter present it does so readily.

As it cools it often deposits a cloudy sediment, especially morning urine. On standing crystals of uric acid appear

The composition of urine varies according to the food & exercise.

In an experiment a man of 11 stone passed 52 oz of urine in the 24 hours. In this

Urea	520 grs.
Uric acid	8
*Hippuric acid	15
Kreatin	7
Kreatinine	4.5
Xanthin & Hypoxanthin	Traces

*Found after eating greengages & fruit containing benzoic acid

Mineral matter 376 grs.
Of wh. $NaCl$ forms 266 grs.

The chief characteristic ingredient is urea.
It is a product of the oxidation of the tissues.
It is said that when albumen is oxidized by MnO_2, urea is produced but this is doubtful.
It is however certainly produced in the system from the oxidation of the tissues
It is also got by the oxidation of uric acid & by the action of alkalis on kreatin & ~~kreatinine~~ alloxan.
$NH_4O\,CyO$ when heated becomes urea
Urea has the same empirical formula as $NH_4O\,CyO$, though it is arranged in a different way

$$N_2\left\{\begin{matrix}H_2\\H_2\\H_2\end{matrix}\right. \qquad N_2\left\{\begin{matrix}C_2O_2\\H_2\\H_2\end{matrix}\right.$$

313

Crystallizes in 4 sided prisms like $KONO_5$ soluble in alcohol & HO forms salts.

It forms 77 to 82 P.C of urine evaporated

There are about 25 parts of urea in 1000 parts of common urine.

A man of 10 stones wt excretes daily
442 grs urea.

——— 11 — ——520 grs.

From 58 observations on young men the average is 549 grs per day.

The average of 58 observations on young women is 425 grs.

If the same weight of children from 6 to 3 years old & of old men. Then children secrete 3 times as much as the old men.

The average of urea is 244

Adult man on mixed diet 518 grs
— ——— — - vegetable - 389 -

Adult woman on mixed diet 412 grs
——————— vegetable — 309

Professor Fry of Trinity College Dublin made various experiments on the students.

Well fed flesh eating wine drinking students yielded 576 grs daily

Well fed water drinking vegetarians 394 grs

Certain diseases influence the quantity of urea. it is increased in typhoid fever, in pneumonia pleurisy & rheumatic fever.

Uric acid in urine.

In urine it is generally combined with NaO. It is rarely more than $\frac{1}{10}$ P.C in urine. From 7-8 grs in an adult man.

In perfect health there ought to be no uric acid.

In Professor experiments on students he found

Beef eating wine drinking students
$4\frac{1}{2}$ grs daily

HO drinking vegetarians $1\frac{1}{2}$ grs —

Hippuric acid.

Occurs chiefly in the urine of herbivora. If you become a vegetarian, hippuric acid takes the place of uric acid in the urine.

A large amount of HO taken into the system lessens the uric acid as also sulphate of quinine taken as a medicine.

Xanthin & Hypoxanthin

Kreatin 5 – 7 grs in 24 hours

Kreatinine is a product of the metamorphosis of kreatine.

Extractive matters are less abundant in the urine of the child than of adults.

Extractive matters are uncrystallizable bodies w^h we do not

know.
In starvation the exceed the ureae in quantity.
Among them are damaluric, carbolic & other acids & some volatile acids.

Urine pigments.
Indican the glucoside of indigo blue.

Mineral ingredients.
Of these NaCl is far the largest in amount
Daily average in 8 students.
.269 grams in 24 hours
The average is generally taken as 200 grs. for an adult male & less for women & children
In acute diseases of the febrile sort the chlorides rapidly diminish, but when convalescence begins the chlorides increase rapidly.

The chlorides are carried off in the watery stools & in perspiration

Sulphates.

They occur in varying quantity

The $HOSO_3$ excreted daily as sulphates is 32 grs.

The proportion rises in the afternoon & during digestion

Animal food & active exercise increases the amount of sulphates.

Phosphates

PO_5 is found in the urine partly as $NaOPO_5$ & partly as phosphate of MgO & CaO

In an adult man 50 to 60 grs of PO_5 are excreted daily as phosphates.

The maximum & minimum is the same as with the sulphates.

Animal food increases the phosphates.

Earthy phosphates excreted daily

are	15 grs.

Fe in minute quantity is in urine. SiO_2 & Fl in very minute traces.

Secreted daily by an adult man.

NaCl	266 grs
$HOSO_3$ (as sulphates)	32
PO_5 (as phosphates)	55
Alkalis, CaO MgO & other salts.	Undetermined.

Abnormal ingredients.

The presence of albumen in the urine often indicates Bright's disease, but it may be due to accidental causes.

The urine may sometimes coagulate in health.

Taking cantharides or a stimulant diuretic & pressure of blood in the kidneys as in heart disease produces albumen in the urine.

In boiling urine always add a

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drop of NO_5 after the operation
When albumen remains persistently in the urine it is a dangerous symptom.
Fibrin sometimes occurs in urine

Sugar does not exist in healthy urine but in diabetes & gout

When the floor of 4th ventricle of the brain is punctured sugar appears in the urine & remains for some hours
Sugar appears to be in the foetal urine.
Fat does not occur in healthy urine but does in Bright's disease & chronic insanity.
in in rapid emaccation but generally from fatty degeneration of kidneys
Biliary compounds are found in jaundice.
NH_3 never occurs in healthy urine unless it has been accidentally

changed in the kidneys as by too long retention.

In scarlatina

it appears even though the urine be acid.

When urine is alkaline NH_3 generally is present, urea being very readily decomposed.

Urine of animals

The composition of that of the carnivora most nearly approches to the human.

It is light yellow & nasty odour bitter taste

Has an acid reaction

It contains much urea, little or no uric acid & much pigment. Dogs urine contains cyanuric acid

That of the herbivora is yellow turbid.

Contains hippuric but no uric acid.

oxalate of lime & only a small am

ount of phosphates relatively to man When they are fed on animal diet as the calf while suckling they give urine like that of the Carnivora.

The urine of birds forms a white coating to the solid excrement consists chiefly of urates of NH_3 & CaO

The urine of frogs is liquid & contains urea NaCl & phosphates.

That of serpents is at first pulpy but soon dries & consists mainly of urates of alkalis, with a little urea

Urinary sediments

The occurrence of sediment in fresh urine as soon as cooled may sometimes show disease. It consists either of organized or unorganized substances.

Inorganic sediment	Organized.
Uric acid	Mucus & epithelial scales.
Urates	

Inorg.	Org.
Hippuric acid	Blood corpuscles
Oxalate of lime	Pus corpuscles
Earthy phosphates	Cancerous & tubercular matter
Cystin	Fibrinous coats of the tubes of the kidneys
	Spermatozoa fungous bodies and infusoria

Uric acid.

Only occurs in strongly acid urine in any quantity; may be deposited after fermentation from decomposition of urates

When free lactic acid is voided it decomposes urates & deposits uric acid.

Uric acid sediment is always coloured, generally yellow or brown.

Test. With $HONO_5$ & NH_3 it forms murexide.

The urates are the most common of the sediments all occur in acid urine except that of NH_3

Their colour varies from greyish white

to brownish red or purple.

Urate of NaO.

The cause of the sediments is partly their greater solubility in hot than cold HO. Sometimes from the HO in the bladder having exuded & left too little to dissolve them.

Hippuric acid rarely occurs as a sediment. If a fruit like greengages containing benzoic acid be taken freely or if benzoic acid be taken as medicine or otherwise, hippuric acid appears in the urine

Oxalate of lime

It is sometimes produced by changes in old urine so it is not to be confounded with that deposited from fresh urine

Earthy phosphates always appear when the urine is alkaline.

Urinary Calculi.

They are formed in the kidneys or bladder by the deposition or retention of urinary sediment.
Around a nucleus more matter gradually accumulates.
Sometimes the matter is not all of one kind
The composition of the calculi is generally the same as that of the sediment.

Uric acid or urates
Xanthin
Cystin
Oxalate of lime
$CaO\,CO_2$.
Phosphate of lime
Phosphates of MgO & NH_3. Fibrin & mucous compounds
Phosphate of MgO may be formed by throwing $MgO\,SO_3$ into urine & allowing it to stand.

The substances valuable as man-

ure may thus be removed.
Fibrin & mucous compounds

Respiration.

The act of respiration consists essentially in the interchange of gases existing in the blood with those in the air.

In animals low in the scale it takes place on the surface of the body but most animals have definite respiratory organs.

The gases given out from the body are in the venous blood, but this does not come in direct contact with the air

The lung tubes branch out into small ramifications & thus present an immense surface in small space.

The air & blood are separated by a thin moist membrane thro' wh. the gases interchange by excmosis.

The O is changed for CO_2.

The change of colour in the venous blood from dark to light red is due not so much to the absorption of O as to the expulsion of CO_2. If the CO_2 be expelled & H substituted the same change takes place.

The O taken in is in greater volume than the CO_2 given out. The reason of this is that the O has to oxidize the tissues & convert them into urea & to make H into HO.

When O is converted into CO_2 it occupies the same volume, so the interchange would be volume for volume if the O had not more work to perform in the body.

For each volume of O absorbed in the lungs, there is only 0.8516 vol. of CO_2 evolved. Hence there is $\frac{1}{7}$th more O taken into the body than what is required for conversion into CO_2

When we examine the volume of air expired after it has cooled & dried it is less than that inspired.

The aqueous vapour expired in 24 hours is from 11 to 14 oz. Some of this is due to the HO taken as drink as well as to that formed in the system.

The N in the air is little affected by respiration.

A very slight increase of N in the air expired may be due to that dissolved in the HO we drink.

The air expired is 0·402 ricer in O than that inspired.

There is a very small quantity of NH_3 to be detected in the air expired.

The most important gas is CO_2.

The expired air of a healthy man contains 4·334 P.C of CO_2.

Only a small part of the O of the air is taken up.

Weight of gases expired by an adult man taking a general average during 24 hours.

CO_2	27.8 oz
N in excess of that inhaled	'5
Aqueous vapour	14.

Inhaled. O. 23.3

So that about 3 oz of O are retained in the system or go out in other excretions.

The amount of CO_2 in expired air depends on the frequency of respiration

In Gerhardt's experiments

Acts of respiration per minute	CO_2 in 100 vols. of air expired
6	5.528
.12	4.262
24	3.355

48	2.984
96	2.662

When the breathing is undisturbed 30.5 cub. in. are expired in one respiration. But the rhythm of the respiration is

Not all the CO_2 in the pulmonary vessels is removed as it passes thro' the lungs.

The respiration of air richer in O than common air produces no marked difference in the CO_2. An animal breathes undisturbed though the O be increased to 3 times its normal amount. When decreased by one third they show no change but when decreased by two thirds they show great distress & if reduced to 3 P.C. they rapidly die.

CO_2 if added gradually to air does not impede respiration up to 12 P.C. When the animal has absorbed about $\frac{1}{3}$ of their bodily volume of CO_2 they show symptoms of poisoning tho' the O supplied along with the CO_2 be abundant. The CO_2 cannot escape by diffusion

The largest portion of inhaled air goes back unchanged, only $\frac{1}{5}$th of the air in the lungs is changed in one respiration.

Gases have no tendency to diffuse into themselves & when the air is charged with CO_2 that in the system does not diffuse out.

It is this wh renders CO_2 a poison. A rabbit may breathe in an atmosphere of 20 P.C. CO_2 for 20 hours if there be a constant supply.

CO in minute quantity will produce death if there be no ready method of diffusion.

An atmosphere of 1 P.C. CO_2 has been known to produce death especially if mixed with CO.

According to Dr. Edward Smith's experiments the expiration of CO_2 is less in the hot parts of the season than in the cold.

In the middle of August the CO_2 is 30 P.C. less than in the cold season.

The maximum is in April & May, & begins to fall at the end of May or in the beginning of June.

It ascends in October & is high in December. Moisture in the air increases

When there is change of barometric pressure in either direction there is an increased amount of CO_2.

The effect of fasting is to diminish the amount of CO_2.

Some cats experimented on at first converted 80 P.C. O into CO_2.

77 P.C the 2nd day, & when they died of starvation 73 P.C.

Dr E. Smith fasted for 27 hours & expired 0.25 P.C less CO_2.

There was a remarkable uniformity in the composition of the expired air but the number of respirations was less.

Influence of sex & age.

The male expires more CO_2 than the female. Boys of like age expire more than girls.

Charling's experiments

	age	weight in kilogrammes	CO_2 per hour in grams	CO_2 per hour for every 1000 grams of wt.
Man	35	65·5	33·53	0·5119
Youth	16	57·75	34·28	0·5887
Soldier	28	82·	36·62	0·446
Girl	17	55·75	25·34	0·454

Boy	10	22·	20·338	0·924
Girl	10	23·	19·162	0·883

Effect of exercise

Exercise increases the CO_2.

Influence of food.

The food influences the CO_2 evolved.

More O is absorbed to form CO_2 when starch is used than when animal food is used.

Less N is evolved on a vegetable than on an animal diet.

In dogs fed on suet 69·4 P.C of the absorbed O was evolved as CO_2.

Fats contain a good deal of H as well as as C & O is required to oxidize this. In starch the H is combined with O.*

Respiratory equivalents or amounts of food required to produce the animal heat in the body itself.

100 parts fat require 292·14 Oxygen

*Animal food requires much O to oxidize albuminates & form urea

100 Starch	118·52
100 Sugar	106·67
Malic acid	82·78
Albumenous bodies	153·31

Dr. E. Smith has drawn some conclusions wh. however require farther confirmation.

He says that food may be divided into 2 classes, those wh. excite respiration & those wh. do not.

Exciters. Nitrogenous foods, milk sugar rum, beer, stout, the cereals

Nonexciters. Starch, fat, certain alcoholic compounds, volatile elements of wine & spirits & coffee leaves.

Pure alcohol, rum, ale, & porter generally increased the respiration. Sherry lessened the air inspired but increased the CO_2. Tea coffee, chicory, & cocoa are respiratory exciters. Tea is the most

*Brandy lessened it.

powerful,* next coffee, next cocoa & lastly chicory.

The addition of sugar & milk increases the respiratory effect.

Its influence is immediate, its maximum is in about 20 minutes its duration is from 1 to 2 hours.

Cause of sleep

When trying to sleep the first thing we do is to take away the pressure of the column of blood on the heart, wh. we do by getting into a horizontal position.

We lessen the respiration by lying in a fixed posture.

The amount of O dissolved in the blood in the system is lessened.

At every vital act there is a change of matter.

They are only destroyed in the act of oxygenation.

*Therefore recommends tea to be given in suspended animation as a respiratory exciter.

In every thought a portion of the brain is destroyed & as we get the O diminished in the blood the brain finds more difficulty in manifesting itself to the external world.

In the case of the drunkard the O unites with the alcohol & the brain refuses to manifest itself & he becomes dead drunk.

Sleep of hybernating animals

During summer they accumulate fat round the heart & gradually push up the diaphragm against the lungs, this prevents the O being inspired. readily & it falls asleep.

Some wh do not accumulate so much fat, as the tortoise take a roll of grass to push up the diaphragm.

They are like a lamp slowly

burning the fat being the fuel. When this is consumed the diaphragm falls down the lungs begin to play, the brain becomes active & the animal awakes.

The conditions in wh. we are most prone to sleep are when we have taken a large dinner wh. pushes up the diaphragm. As there will be less combustion during sleep & so less animal heat we draw near the fire to compensate for this.

Respiration of the lower animals.

Carnivora living on ordinary food exhale more N & CO_2 in proportion to their wt. than herbivora

Active birds consume 10 times more O than sluggish birds- Frogs & lizards convert 75 P. C & the salamander 82 P. C of O into

CO_2.

The wakeful ones consume 9 times & the half torpid ones 3 times as much as those wh are entirely rigid in winter.

Origin of the CO_2

It was once supposed that the CO_2 was produced in the lungs. There seems to be no combustion at all in the lungs, for if there were the blood should be warmer there. This is not the case, as the blood is cooled in the lungs the blood of the left side of the heart is 2° colder than that on the right side: It seems to be produced in the tissues.

Every vital tissue of animals yields CO_2 to the air pump.

Gustave Liebig says that the muscles of the frog possess irritability[*] so long as the exhale

[*] So long as they can absorb O. If placed in H their irritability stops.

CO_2.

The changes are produced in the muscles.

General conclusions

That 8½ oz of C are converted into CO_2 in 24 hours, for wh 22.66 of O would be necessary, but as only 85 P.C of O is used for CO_2, 26.7 oz of O or 1½ lb are daily consumed by an adult man.

He destroys daily 117 oz of air wh is equal to 164900 cub.in.

In the course of the year he destroys 7 hundred weight of O.

⅕ is made into the body.

It is an old tradition that the body of an animal changes once in 7 years, but this is not true as all the C would be burned in 3 days*.

A man of 11 stones has

4 lbs albumenous bodies in blood.

27.5 in tissue

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* If there were no supply of C. You may calculate the rate of waste from the N in the urine & excrement.

5 lbs in bones

The whole body would be changed in 18 weeks supposing that they were all changed at the same rate.

Animal Nutrition

Plants live on mineral food, wh. they find in the atmosphere, CO_2 HO & NH_3. They assimilate the C from the CO_2 into their system & give out the O. They get their N from NH_3 & sometimes though rarely from NO_5 but not from the N of the air. They get their H from HO.

They have nothing to do with volition & on this account they have the property of moulding inorganic substances into organic forms. Animals have the functions of volition to perform & so have not this property.

All animals are essentially herbivorous, even carnivora being so although indirectly.

All food may be divided into 2 classes characterized by one essential difference.

Those wh. contain N.

Those wh. are destitute of it.

Nothing destitute of N can build up the muscle of an animal.

Those wh. contain N are the histogenetic substances, casein, albumen &c, whether got from plants or animals

We may call the one sort wh. contain N flesh formers & the other heat givers.

There is a necessity for a mixture of food of both classes*

It was long supposed that gelatine was an extremely nourishing substance but a commission both

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* If only one kind be given the animal dies just as if it received no food as only one part of its wants is supplied

of France & Holland appointed to examine into this found that when animals were fed entirely on it they died.

In milk there is an admirable admixture of both kinds of food.

Casein	flesh formers
Butter, sugar	heat givers

There is also mineral matter in it

In all cookery we try to obtain this mixture. We eat beef with potatoes, mutton with rice & pork with peas or beans

Nitrogenous food or flesh formers.

All the tissues wh. form any part of an organ of an animal contain 15 P.C of N. Animals are certainly unable to take N from the atmosphere. There is one apparent exception. when an animal takes benzoic acid containing no N it voids hippuric acid wh. does. This is however a question of excretion not of nutrition.

There is no ground to suppose

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* and also the blood

that flesh can be formed from non-nitrogenous substances by assimilating N from any other source. The nutrition of a carnivorous animal is very simple. It takes the flesh & blood wh it finds ready formed & appropriates them to its own system.

That of a sucking animal is equally simple. It is like a carnivorous animal eating its mother. It finds casein in the milk & appropriates it.

The nutrition of every animal is equally simple.

We find the histogenetic substances in plants.

Thus the juice of the cauliflower contains fibrin instead of blood. Animals do not form the components of their flesh & blood out of unlike matters but they find them ready formed in vegetables The process of nutrition consists in extracting them & giving them a place room in the organism.

This is the great law of animal nutrition

Plastic elements

Flesh animal or vegetable	Fibrin
Blood	Albumen
	Casein.

This excludes gelatine

Gelatine may indirectly act as food by supplying food for the cellular tissue & thus saving the other food. Gelatine may thus in the case of a very weak person be of use when administered along with some other food, not alone, by supplying material for the cellular tissue wh has been much wasted by illness. & thus allowing the other food to be applied to the purpose of building up the organs.

Non nitrogenous substances.

Fat, starch, gum, cane sugar, grape sugar, milk sugar, pectin bassarin, wine beer & spirits

Since they are wholly free from N they cannot build up the frame work of the body yet they fulfil a very important function viz., supporting the animal heat.

The temp. of fishes and amphibia is only a few degrees above the medium in wh they live.

That of quadrupeds is 99–100°F
birds 105
man 98–99
child 102

In lower animals even in health the temp. is to a certain degree regulated by the medium in wh they liv

In the higher animals there is always a fixed temp. in health. Depression of this temp. is attended with a depression of the functions of an animal. There must be some means of regulating this temp. since the temp. of a man at sunny Palermo or of a traveller in the polar regions is the same. The appetite of the man is the regulator.

Nonnitrogenous substances are usually the fuel, though the tissues of the body are sometimes as in the carnivora.

The hyena moves about in order to burn his tissues to keep up the animal heat.

From the known composition of food it is easy to calculate how much food is required to keep up the same temp. on different kinds of food.

The heat giving equivalents

or the quantity of food required to keep the animal heat the same. Weights of different bodies required to produce the same amount of heat.

Fat	40.2	Cane sugar	100
Alcohol	53.8	Grape —	106
Starch	97.2	Flesh	309.7

Flesh has 8 times less respiratory value than fat.

After deducting the heat necessary to evaporate HO as vapour in the breath we find that the rest taken in diet is sufficient to raise 143 lbs of HO from 32° to 99° & the specific heat of the substances wh compose the body is less than that of HO.

Varying quantity of respiratory food.

The body of a man may be represented as a chamber to be kept at the same temp. in summer & winter & in different climates.

If you transport a man from India to the poles the temp. of his body remains the same but you must put in more food to sustain it.

In extreme cold man takes enormous quantities of food. Sir John Franklin says that during the whole of the march they found that no clothing could keep them warm as long as they were fasting but when they could go to bed with full stomachs they could sleep comfortably.

Parry took an Esquimaux lad not full grown & set him down to a weighed repast. the quantities he devoured are the following.,

	lbs oz
Sea horse flesh hard frozen	4 - 4
——— ——— boiled	4 - 4
Bread & bread dust	1 - 12
Rich gravy soup	1¼ pints
Spirit 3 glasses	
Strong grog	1 tumbler
Water	1 gallon 1 pint

Ross says that an Esquimaux eats daily on an average 20 lbs of flesh & oil

Admiral Sarcheff says that a Yacot took in 24 hours the hind-quarters x of an ox & 20 lbs of fat.
x & a proportionate quantity of melted butter for drink.

These accounts are not more astonishing than the difference between the coal we burn in summer & winter.

The character of the food is made to suit the climate.

Fruits & rice contain 20-30 PC of C.
Blubber 80-90

In India beer & butter are freely

taken but apparently less as food than to unctuate the body & prevent excessive perspiration.

Ordinary food contains fat

In Cocoa	50 PC
In coffee	12 PC

A man inhales daily to consume these about 3000 gallons of air, much of the O of wh is burned by the food.

The starchy matters & fat in the food produce fat in the body.

In a grate where there is a free access of air the fuel is converted into CO_2, but in a gas retort where there is only a very limited supply of air various tarry matters distil over.

Thus in the muscular arm of an Arab who is almost constantly in the open air & taking exercise there is no fat, but in a man leading a sedentary life & taking little exercise the fat accumulates.

If there is a free introduction of air the starch is converted into CO_2.

In hybernating animals the fat is formed by imperfect combustion of the food in summer & in winter they live on it.

There was a very fat pig weighed to be sent to an agricultural show, but just before being sent a slip of land from a neighbouring hill overwhelmed it.

It was thought to be dead & no farther trouble was taken about it. About 120 days after the slip was removed for the purpose of building & the pig was found alive but it had decreased

140 lbs in weight.
Proportion between flesh formers & heat givers.

	Plastic	
Cows milk	10	30
Womans — -	10	40
Lentiles	10	21
Beans	10	22
Peas	10	23
Fat mutton	10	27
— pork	10	30
Beef	10	17
Hare	10	2
Veal	10	1
Wheat flour	10	46
Oat meal	10	50
Rye —	10	57
Barley	10	57
White potatoes	10	86
Blue —	10	115
Rice	10	123

Buck wheat meal	10	130

Mineral matter in food

The body of a man weighing 150 lbs contains

Phosphate of lime	5 lbs 13 oz 0 grs
Carbonate — —	1 - 0 - 0
$CaFl$	0 - 3 - 0
$NaCl$	0 - 3 - 376
$NaOCO_2$	
acid phosphate of soda	0 - 0 - 400
$KOSO_3$	0 - 0 - 400
FeO	0 - 0 - 150
KCl	0 - 0 - 12
Phosphate of potash	0 - 0 - 100
$3MgOPO_5$	0 - 0 - 75
SiO_2	0 - 0 - 3

The different organs exercise a selection, thus, P is taken to the brain,* $CaFl$ to the teeth, SiO_2 to the hair & nails, S is generally distributed but is taken especial-

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* $3CaOPO_5$

ly to the hair, phosphates of MgO & KO to the flesh, phosphate of NaO to the blood & cartilages.

$NaCl$ may act by facilitating absorption of HO by diffusion or by aiding the solubility of albumen or by affording HCl to the gastric juice & NaO to bile & pancreatic fluid.

Fe is an essential ingredient of blood, gastric juice, hair & the black colouring matter of the eyes.

To find the proportion of flesh formers in the food estimate the N in it & multiply by $6\frac{3}{10}$ths.

Amount of the several kinds of food required

The circumstances of age variation of climate &c. influence this.

There are two ways of finding how much food is required.

We might find how much C was expired as CO_2 & how much C & N

are in the foeces & urine,

An adult man

Expires as CO_2	8.8 oz C daily
in urine & foeces	2.2 oz C
N in urine foeces & mucus	334 grains

The C excreted daily is thus about 11 oz & the N is equal to $4\frac{8}{10}$ oz of flesh formers.

Average diet
4 oz flesh formers
3 oz fat.
$10\frac{1}{2}$ oz amylceous food
1 oz injested salts.
84 oz H_2O.
33 oz O.

Another mode is to take the experience of public dietaries We find by these on an average that for an adult man, daily
5 oz flesh formers
10 oz C

* The amount of N in the excrements in health indicates the amount of tissue wasted in the day. By multiplying it by 6·25 you get the amount of tissues

are required

When we contrast the diet of the aged with this we find that with them the flesh formers have sunk to 4oz but that the C is the same

The proportion of C in the heat givers to that in the flesh formers is now as one to five.

In children from 10 to 12 years of age

flesh formers	2½ oz
C	8 oz

In the young the process of supply is greater than that of waste.

In the adult it is equal & in the aged less.

It is during sleep that the body is built up.

An adult spends 17 waking hours & in mechanical labour & 7 in sleep.

An infant spends 4 waking

hours & 20 in sleep during wh. its growth takes place.
An old man spends 20 waking hours & 4 in sleep.

In an adult the waste is to the supply as	100 to 100
In an infant as	25 to 250
In the aged as	125 to 50

In an infant there would not be ptyalin enough to convert its amylaceous food into sugar & so it finds the sugar ready formed in the milk;
The casein is also in a soluble state. in the milk so the gastric juice has not to convert it into a (soluble state
In cooking we try to get the same proportion of the different kinds of food as in milk.

Pauper & prison diets.

Prison diets were & still are by no means well regulated.

It was thought that a man on long confinement required much more food than one on short confinement. The question however is what is the waste of the tissues.'

Work-house diet is about 3¼ oz of flesh formers daily.
The hard labour diet is no more than this & is quite insufficient for hard labour. Besides they are on the system of alteration according to the time of punishment.

1st Cereals yield nutritious meals of varying composition.
The finest flour is not the most nutritious on an average they contain

14·6 PC flesh formers

69. heat givers

Mineral matter 1·6 P.C

Oats contain	5 P.C.	of fat
	17	flesh formers
	66.4	heat givers
	3.0	mineral matters

Probably half the human race partake of tea

Tea leaves contain	5 P.C.	HO
	3	Theine
	15	Casein
	6.7	aromatic oil

The casein does not come out unless you put in soda.

The peculiar aroma of coffee is due to an essential oil wh it contains

Action of alcoholic beverages.
Their action is to reduce the waste of the tissues

When the amount of food is sufficient this is injurious acting like too much food
The cheapest way of taking alcohol is in beer
The cost of one oz. of alcohol taken in different beverages is as follows

in beer	2D.
spirits	4D
wines	1S 6D.

For the support of strength you can get an equal amount of nourishment from vegetables or animals.

The character of men depends much on the food they take.

It requires 5 oz. of flesh-formers daily to do a good day's work.

To get this from potatoes, it is necessary to take 25 lbs, but even an Irishman's stomach can only take in half that quantity, so that an Irishman living on potatoes alone could only do half a day's work.

The Irish famine caused new material for food to be introduced[*] w^{h}. being more nourishing than potatoes

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[*] And spread his work over the whole year instead of only 2^{ds} a year

enough for a good days work could be taken without inconvenience.

Who gave us trouble in the Indian mutiny?

Not the rice eaters of Bengal but the pulse eaters

We may sum up the general conclusions in the words of Prior.

Was ever Tartar fierce or cruel
Upon the strength of water-gruel.

Balance between animal & vegetable life

The functions of animals & vegetables are precisely opposite in a chemical sense.

A vegetable is a reducing apparatus, reducing CO_2

An animal is an apparatus for oxidation.

Vegetables are fixed
Animals have the power of locomotion

A vegetable	An animal
evolves O	absorbs O
absorbs heat & electricity	evolves heat & electricity
Decomposes CO_2	Produces CO_2
——— HO	——— HO
——— NH_3	——— NH_3
Produces organic substances	Consumes organic substances.
Transforms inorganic matter into organic	Transforms organic matter into inorganic
Derives its elements from earth & air	Restores its elements to earth & air

Functions of vegetables.

Animals find their substance in vegetables.
The vegetable kingdom is

the great laboratory of organic life.

They are powerful reducing agents.

For every cubic foot of CO_2 they reduce 1 cubic foot of O is restored to the atmosphere.

The vital force of a plant growing in the dark is unable to reduce CO_2. light is required for this.

Nitrate of ammonia is formed by lightning flashes.

Functions of animals.

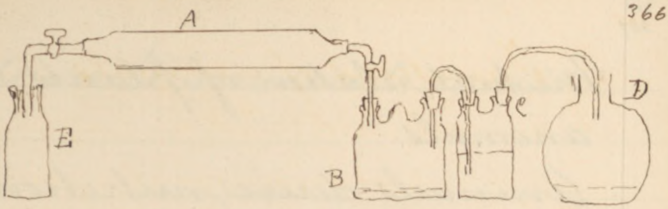
In animals we certainly find organic matter in its highest forms but for a limited time only. Their function is not to create organic matter but to transform it into inorganic matter.

They use the organic matter of vegetables & make it into organs wh have high functions to perform.

Broken down from the complex molecule into wh it was formed by vegetables, it becomes less & less complex at every change.

Every change of them is a degladation they being finally converted into CO_2 & NH_3

The process of decay produces CO_2 & NH_3.



The substances of dead animals passes thro' the same change as the non-nitrogenous ~~parts~~ substances in their bodies The animal stands mid-way between the vegetable & mineral kingdoms. It has nothing to do with forming organic bodies

Mutual relation of plants & animals.

Animals derive nutrition from plants.

Plants truly feed animals but animals as truly feed plants.

It is certain that the atoms of wh. we are composed have passed thro' a succession of animals & men.

Perhaps the brain with wh. I (Professor Playfair) am now thinking once formed part of the liver of the Emperor of China.

There is the mineral kingdom as represented by air & soil.

The vegetable elaborating organic matter from the mineral.

The animal living on plants but breaking them down to mineral matter.

VII

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benzoin
caproic
cerotic
caprylic
cuminic
ethylic
hexylic (caproic)
laurylic
melissylic
methylic
octylic
price of
propylic
radicles
synthesis of
Alkoholic fermentation

17 Blank Leaves Not Scanned