membrane permeable, or reduce it to the condition of a filter, is without sufficient foundation.

2. That the power of endosmose of different substances is not regulated entirely by their density, as already observed by Dutrochet.

3. That the purgative salts generally have an energetic power of endosmose, and that this is exerted with more steadiness and uniformity by those which medical experience has selected as the most useful in ordinary cases.

4. That some of the other substances examined have marked peculiarities with regard to endosmose, which will probably assist towards explaining their mode of action on the system.

London, December 1851.

THE LIVER THE REGENERATOR OR HYDROGENATOR IN ANIMALS; OR THE ANTAGONISM BETWEEN THE LUNGS AND THE LIVER.

By GEORGE WYLD, M.D.

THE object of this paper is to disprove the doctrine, so universally prevalent, of the liver being mainly an organ for the excretion of the waste of the tissues, and thus *vicarious* with the lungs; and to propound the idea of the writer, that the liver is essentially a *secreting* organ in *antagonism* with the lungs. Or, that, as the lungs are mainly for the *oxydation* of the system and destruction of the tissues, so the liver is mainly for the *hydrogenation* of the system and regeneration of the tissues.

The following (abbreviated) quotations will fully exhibit the prevalent doctrine concerning the function of the liver to be as above stated.

Müller says the liver *frees the blood* from an excess of matters containing carbon and hydrogen, as the kidneys remove the superabundance of those materials, which contain a large proportion of nitrogen. (pp. 164, 165.)

Tiedemann and Gmelin say that the excess of bile secreted in the tropics is required to compensate for the diminished purification of the blood in the lungs, on account of the rarification of the air. (Müller, p. 166.)

Carpenter, in his *Physiology*, 1842, says: "The rudimentary structure of the liver in insects is compensated for by the extremely active respiration of these beings, while in molluscs the liver attains a greater development; and we are at once struck with the fact that the liver bears an inverse proportion to the opportunity afforded by the respiratory organs for the aëration of the blood. In fishes and reptiles the liver is of considerable size, and seems to perform a very important part in the decarbonisation of the blood. In birds, on the other hand, where respiration is so much more active, the liver is smaller." (pp. 439, 440.)

"Before birth, the lungs not acting, the liver is the only *decarbonising organ*." (p. 449.)

"It is uncertain whether the bile does not act entirely as a precipitant, and is *altogether cast out* of the system. There can be *no question*, however, that by *far the largest* part of the secretion is destined to be *entirely thrown off*, and thus *free the system of superfluous hydro-carbon*."

Again, Carpenter, in his *Manual*, 1844, says "that a large part of the bile is purely *excrementitious*, and is poured into the intestinal tube for the purpose of being carried out of the body, can scarcely be questioned. We may regard it as one office of the liver to remove from the blood such products of the disintegration of the tissues as are rich in carbon and hydrogen."

"That the less hydro-carbon is separated from the blood by respiration, the more is eliminated from it by the biliary secretion, seems to be a great principle throughout the animal kingdom." (pp. 420, 421.)

Liebig, 1842, says: "The elements of the bile, viz., carbon and hydrogen, serve for respiration, and for the production of animal heat."

Prout speaks of the liver as a *depurator* of the blood.

Gregory, 1845, says: "The bilious product of the destruction of the tissues is oxydised into carbonic acid and water, thus contributing to keep up animal heat." (p. 562.)

Erasmus Wilson speaks of "the two great *depurating* organs, the lungs and the liver"; and "the necessity of removing carbon and hydrogen from the blood."

Budd, 1845, observes: "It is clear enough that a large proportion of the proper principles of the bile are derived from the waste of the body. The liver, lungs, and kidney, are the three principal outlets for the *waste of the tissues*." (p. 28.)

Kirkes and Paget, 1848: "In the foetus there is no respiration, but the liver is proportionally larger than after birth. In the foetus, therefore, the main purpose of the secretion of bile must be the purification of the blood by direct excretion; the intestines at birth being full of thick bile (probably all that is secreted in foetal life) and miconium. Thus the liver may be said to discharge a function vicarious with the lungs. This makes it highly probable that the bile in extra-uterine life is also, at least for the *most part*, destined to be *discharged as excrement*, viz., in the form of water and carbonic acid gas." (p. 442-6.)

Liebig's *Letters*, 1851. "The liver roughly sketched is the magazine for the matters destined for respiration; it is the workshop in which they receive the shape and quality fitted for the production of animal heat." (p. 327.)

Carpenter, 1851, inculcates the same doctrines concerning the function of the liver as he teaches in the extracts we have already given from his earlier works.

It is thus rendered sufficiently evident, that the grand function of the liver is understood to be "to free the system from an excess of hydro-carbonaceous matters, the result of the waste of the tissues." Beyond the above quotations, physiologists certainly maintain that the bile serves certain purposes in digestion, such as converting chyme into chyle; and further, that bile is an antiseptic and an exciter of the

peristaltic action in the intestines, and a saponifier of fats, while Meckel says that it converts sugar into fat. These offices of the bile, however, are generally spoken of as subjects of doubt and difficulty. For instance, Müller, in alluding to certain experiments of Tiedemann and Gmelin, says, that "they afford no satisfactory information relative to the office of the bile in chymification." (p. 602-3.) Carpenter says in his *Manual*, that "the destination of bile is still a matter of doubt." (p. 277.) Dr. Budd observes, "when we come to details concerning the purposes of the bile, our knowledge is found to be much wanting in precision" (p. 28); while Kirkes and Paget say, "respecting the nature of the influence of the bile in digestion, little is known." (p. 446.) These confessions appear to me sufficiently to justify the proposal of a new theory concerning the functions of the liver: but let us first inquire into the arguments in favour of the current theory of the day. The arguments produced in favour of the excretory and vicarious functions of the lungs and liver are mainly three.

First. "If bile be not excreted, there is jaundice, which may be fatal; therefore the bile is mainly excrementitious."

Now although we know that the suppression of any excretion has a poisonous effect upon the system, yet there is no proof that the fatality spoken of in certain kinds of jaundice arises from the presence of those matters in the blood which should have been excreted as bile, because in these cases there is generally urea also found in the blood, a sufficient cause for the effect produced, viz., death. But, granting that this poisoning does arise from the presence of matters which should have been excreted *as* or *in* bile, this by no means proves that *all* the matters going to form bile are poisonous, but merely a certain number of such. But, lastly, granting that all such retained and *non-secreted* matters are the source of this poisoning, this does not prove that *secreted* bile is an excrement; for, as Dr. Alison has shown, if bile be once secreted and again reabsorbed, the aforesaid fatal jaundice does not occur. Therefore the poisoning is not in the bile *per se*, and therefore, we might add, bile is not an excrement.

Second. It is said, "In hot climates, where from rarity of the air oxygen is deficient, there is a deficient oxygenation and excretion of hydro-carbonaceous matters from the lungs, and a consequent biliousness; hence an additional call is made upon the liver to excrete such superfluous hydrocarbonaceous products; hence diarrhoea and bilious vomiting. Therefore the lungs and the liver are vicarious in function, and that function is the excretion of hydrocarbonaceous matters."

In answer to this, we observe that this doubtless occurs where from indolence, induced by heat and excessive indulgence, there is a deficient muscular exertion maintained, and a consequent deficient respiration and oxygenation of the tissues and excretion of such by the lungs, and a consequent biliousness; yet, with sufficient exercise and temperance, there is in hot climates, as in cold, an immunity from this biliousness. Again, as to excessive discharge of bile with diarrhoea in hot climates, there is nothing to prove that this arises from a deficiency of oxygen in the air, and not rather from the presence in *excess* of that natural stimulus of the liver, viz., *heat*; for in temperate climates the indolent are constantly liable to what is called biliousness, but not often, as in hot climates, to diseases of the liver, except, as with cooks, there be

exposure to great heat, together with that intestinal and consequently hepatic irritation produced by the over-excitement of rich food and spirituous liquors.

Third. It is said, "This vicarious function is further illustrated by the law of inverse ratio which subsists between the development of the lungs and the liver in the animal series; and further, by the immense development of the foetal liver, the lungs being in this case undeveloped and unemployed." Hence, as Messrs. Kirkes and Paget say, "In the foetus, probably all the bile formed is excreted into the intestinal canal, to be there found at birth with the meconium; therefore it is probable that in extra uterine life also the bile is mainly excrementitious."

To this I would in the first place answer, in the words of Dr. Budd, "It is a formidable objection to the vicarious theory between the lungs and the liver, in separating hydro-carbon, that in the serpent, whose respiration is extremely feeble, the excrement does not contain a particle of bile." (p. 32.) And in answer to the arguments of Messrs. Kirkes and Paget, I would observe, that we know that the adult human liver secretes from twelve to twenty fluid ounces of bile daily, say fifteen ounces; that is, the liver being from forty to fifty ounces in weight, secretes daily one-third of its own weight of bile. The foetal liver at birth is about eight ounces in weight; and if we calculate its average weight from the fifth month inclusive, up to the full period, we obtain an average of fully three ounces as the weight of the foetal liver, extending over a period of six lunar months. Now this liver, at the admitted action of the adult gland, should furnish one fluid ounce of bile per day; and, therefore, at the birth of the infant, we should find 168 fluid ounces of bile in the intestinal canal. But what do we find? Why, only about two ounces of meconium, viz., mucus and bile mixed; that is, about one fluid ounce of bile, instead of the 168 ounces promised to us! If it be objected that we should only look for solid bile, (the fluid part being reabsorbed,) still we should find seventeen ounces; instead of which, we shall find probably not more than a quarter of an ounce of solid bile, or about the sixty-eighth part of what we should demand, if the theory propounded were true.

We have thus endeavoured to show, *first*, that the fatal jaundice, accompanying the non-secretion of bile, does not prove bile to be an excrement; *second*, that there is no proof that the deficiency of oxygen in the air is the cause in hot climates of a superfluity of bile in the duodenum; *third*, that the doctrine of a vicariousness, as subsisting between the lungs and the liver, rests only on an hypothesis which is, with regard to the foetus, easily shown to be most untenable.

If we now proceed from the negative to the more positive side of the argument, we shall find the strongest reasons against the doctrine of the liver being *mainly* an excretory organ.

1. The immense size of the gland, its most beautiful and complicated structure, together with the fact of its nucleated hepatic cells, is *a priori* a strong argument against the doctrine of its main function being for excretion.

2. The immense relative size of the liver in the foetus, contrasted with the extremely small amount of excretion, is a further argument in the same direction.

3. The fact of only about one-fortieth part (*see* Budd and Liebig) of the secreted bile of the adult being found in the *fæces* (the true intestinal excrements), is a still further and stronger argument in favour of the bile not being mainly an excrement.¹

4. The amount of supposed excrement daily produced, viz., about one and one-fifth of an ounce of solid hydro-carbonaceous matter, is a most inadequate result to be purchased at the expense of so large and complicated a gland, seeing that the lungs and the skin daily excrete about fourteen ounces of solid carbonaceous matter.

5. There appears little necessity for the elimination of this hydro-carbonaceous matter, seeing that if, as it is said, it be reabsorbed for the purpose of burning, it could furnish only about one-twelfth part of the daily-required animal heat. (*See* Dr. Budd, p. 32.)

6. Although, most bountiful, nature ever scatters her gifts with the utmost luxuriousness of hand, yet, in so doing, she ever employs the utmost economy of means, producing from the smallest possible expenditure of power, the largest possible results. If, then, all that is required be the excretion of the effete hydrocarbonaceous matter from the blood, then there exists no necessity for the liver at all, because the lungs are the admitted natural emunctory of such products; and to say that these products are, first, excreted by the liver; second, reabsorbed by the lacteals; third, again excreted by the lungs, is to attribute to nature a process of involution and supererogation such as she is never guilty of.

7. As Dr. Alison has shewn, if bile be secreted and then reabsorbed, the effects on the system are not poisonous, as they probably are if the elements of the bile are not first separated from the blood by the liver. This proves, *first*, that the lungs cannot separate these elements from the blood; for, if so, why jaundice, and why poisoning? *second*, that therefore these elements are not merely waste hydrocarbonaceous matters; *third*, that the bile, being neither *per se* poisonous, nor capable of elimination by the lungs, is therefore a new and chemical product, created by the liver.

8. The fact of bile not being discoverable in the blood, even after extirpation of the liver, as tested by Hernde, is a further corroboration of the idea that the bile is not *excreted*, but *created* by the liver.

9. From the fact that in the lower animals, as in the echinodermata, myriapoda, and conchifera, the bile is poured into the stomach; while in the higher animals, as from the fish up to man, it is *not* poured into the colon or rectum, but into the duodenum; and from the fact that there is no gall-bladder in those animals most constantly ingesting food; and from the fact that the presence of chyme in the duodenum is a necessary stimulus to the flow of bile into that cavity; and from the converse fact that, when this stimulus does not exist, the bile is hoarded up in the gall-bladder, to be poured out only when chyme reaches the duodenum;—from these facts, we say, it seems impossible to resist the conclusion that the bile is *not* an excrement, but that the *grand* function of the liver is to assist in the maturation of the chyme.

10. And further, from the fact of no true chyle being formed, if the

¹ Dr. Sharpey says, that a larger amount is excreted by the intestines than Liebig has calculated.

bile be by a ligature, as in Sir Benjamin Brodie's experiment, or by a fistulous opening, as in Schwann's experiment, prevented from reaching the chyme—death resulting as a consequence of slow starvation—we attain to something like a demonstration that the bile is not an excrement, but that its presence is absolutely essential to the digestive and assimilative processes, and to the life of the animal.

11. The skin and the lungs are, in hot and in cold climates, most cordially vicarious in function, and relieve each other with the utmost good will, and without any derangement to the system, as a result of the one being plus and the other minus in its action. But no sooner is the liver called upon for a little vicarious work, as is supposed, than it and the system generally manifest great disturbance and dissatisfaction; and truly with a bad grace does it perform the duties of its vicarage. But, indeed, this is a sufficient proof that its normal function is not one vicarious with the lungs.

12. But, lastly, this doctrine of a supposed vicariousness existing between the lungs and the liver, as a chief function, seems to be in part founded upon a curious oversight; for what is the chief function of the lungs? Evidently not merely to excrete hydrocarbonaceous matters, but to absorb oxygen as a vital stimulus. If, then, a vicariousness subsist, the chief function of the liver should also be to absorb oxygen—which no one says that it does. Therefore, the doctrine of a true vicariousness is not founded on, but is contrary to, fact.

What, then, is the grand function of the liver? It appears to me, that the question, beyond the power of the bile as a purgative, antiseptic, etc., has been already answered, by shewing that the presence of bile is essential to the conversion of chyme into chyle. And it certainly does strike me as being somewhat curious that physiologists, instead of enforcing this view, should have chosen rather to establish the doctrine of an *excretory vicariousness*.

According to Dr. Beaumont, if bile and pancreatic juice be mixed with chyme out of the body, it separates into a sediment at the bottom, a whey-like fluid in the centre, and a creamy pellicle at the top.

Tiedemann and Gmelin, as quoted by Müller, say that the milkiness of the chyle is owing to minute particles of fat being held in minute divisions, which divisions they believe to have been accomplished by the bile. And Müller says, that he himself observed numerous *globules of oil* in a drop taken from the thoracic duct and placed under the microscope; and he adds, "these oil-globules evidently caused the milkiness of the chyle". According to Sharpey, chyle consists of 1. Chyle corpuscles; 2. Molecules, $\frac{1}{3,600}$ to $\frac{1}{2,400}$ in., called by Mr. Gulliver the molecular base of the chyle, being opaque bodies instantly soluble in ether, and therefore presumed to be fatty matter, chyle becoming nearly transparent on their solution; 3. Oil globules; 4. Minute spherules, probably albuminous.

According to Dr. Rees, the chyle of an ass consists of—

Water	90·237
Albuminous matter	3·516
Fibrinous matter	·370
Extractives, soluble in water and alcohol	·322
Ditto, soluble only in water	1·233
Fatty matter	3·601
Alkaline, chloride, etc.	·711—100·000

The grand function, then, of the liver appears to be, to convert chyme into chyle; that is, to create the fatty molecules and oil-globules of the chyle, without which it would appear that the nutrition of the animal is impossible.

As to the method by which the bile performs this most important office, we do not pretend to divine. It may be that bile, being a saponific of fatty matter, merely separates, breaks down, and in some way alters the fatty matter contained in the food, so that it assumes the form of molecules and oil-globules; or it may be that the bile, by precipitating certain equivalents of oxygen, thus converts starchy matters into fat and oil; or it may be that the bile, being a rich hydrocarbon, thus, as it were, raises the low hydrocarbons of the chyme to fatty and oily matter, as thus:

We have no formula for chyme; but, accepting of that for blood as probably not far from the truth, then we have—

Chyme (blood)	C 48	H 36	O 14	N 6
Add the formula of bile	76	66	22	2
And divide by common divisor 5.1)	124	102	36	8
We obtain (nearly).....	C 24	H 20	O 7	N 1.5
viz., a very close approximation to fat, viz.,	C 24	H 20	O 2	

Of course it is not pretended that the manner of this calculation is strictly scientific, or the result extremely satisfactory; still, it appears to us sufficiently so to merit some attention. Nor is it difficult to suppose, nor do we perhaps ask too much in supposing, that the extra oxygen and nitrogen may be of those parts of the bile which are cast out of the body with the fæces. But, whatever be the process by which bile creates fat and oil from the chyme, of this we are at least certain, that fatty molecules and oil-globules do result on the bile being added to the chyme.

Now, if we accept of the suggestions of Ascherson and of Dr. Bennett, as illustrated by Dr. C. J. B. Williams, with reference to cod-liver oil, in the first number of the LONDON JOURNAL OF MEDICINE, it appears scarcely possible to over-estimate the value of the aforesaid fatty molecules and oil-globules of the chyle. Dr. Williams, after quoting several illustrations of the almost miraculous benefits derived from the exhibition of cod-liver oil, and mentioning one instance in which a patient, by the consumption of eight pounds of the oil, gained forty pounds in weight, adds: "The effect of the oil seems to be, to increase the healthy function of the liver, and thus to add to the general health and vigour of the system." He says also: "There is much reason to believe that cod-liver oil proves serviceable in supplying the fat molecules which appear to be essential to healthy nutrition, as forming the nuclei of the primary cells or rudiments of tissues."

Now, although we cannot say that we altogether subscribe to the opinion of Ascherson and Dr. Williams, yet, with reference to the fact that no other oils yet tested, whether pure or medicated, act so beneficially in phthisis as oils got from the livers of fishes, it certainly does appear to us extremely probable that the liver not only has the power of creating oil by its secreting the bile, but that it has also the power of creating a certain *specific oil*, which would seem to be essen-

tial to the operations of the nutritive and formative powers. This, then, we consider to be the grand function of the liver.

Again, this formative and regenerative power possessed by the liver is further illustrated by the most significant fact, that in those animals in which the liver is strikingly large, the power of formation and of reproduction or regeneration is most wonderfully developed. For instance, the crustacea, which have immense livers, have also the power of regenerating amputated limbs. In the salamander, the liver is relatively immense; and, as pointed out by Spallanzani and others, the salamander has the power of regenerating its amputated tail; also of regenerating amputated limbs; also regenerating its under jaw; and has even the power of regenerating the spinal cord along with the tail. In the triton, also, Blumenbach has observed the regeneration of an extirpated eye. The molluscs, also, have immense livers; and the snail, in which the liver is about one-third of the entire animal, has the power of regenerating her amputated face. Again, the younger the animal, the larger relatively is the liver, and the greater is its formative and growing power. And it is in the very early human foetus, when the liver is at its largest, namely, about one-third of the entire weight of the being, that the formative power has attained its climacteric.

So strong, indeed, is this regenerative power, that if an early foetus by some intra-uterine stricture should get its arm amputated, nature will make an attempt to reproduce the lost limb, and the rudiments of fingers and nails will appear on the stump.¹ In short, it appears to me, that just in direct proportion to the relative size of the liver in the animal series, will be found the force of the formative and regenerative powers. It may be objected, that the regenerative power is generally in the ratio of the simplicity of structure in the animal. Granting that it may be so, this does not prove that the liver is not the source of that power; while in the human foetus the objection will not apply, for here we have a being of as complicated a structure as the fully-grown adult man, and yet this enormous plastic power exists, viz., a power in direct relation to the immense size of the liver.

If, then, it be granted, that the main office of the liver is to regenerate the tissues, so also must it be granted that this function of the liver must be, *not vicarious with, but in antagonism to that grand function of the lungs*, which consists in the oxydation, or combustion and elimination from the system, of those effete products consequent upon the life and growth and action of the animal.

Of course we do not overlook the fact, that one grand office of oxygen is to stimulate the vital force. Perhaps it may be also allowed that the pathology of the lungs and that of the liver still further illustrate some kind of antagonism. For instance, it is in *cold* climates where dense air, viz., oxygen, is plus, that phthisis prevails; and it is in the tropics, where heat is plus, that hepatitis prevails. Again, hepatitis is accompanied by a dry and itching skin, a dull eye, and a sour temper, while phthisis is accompanied by the reverse, viz., a moist and perspiring skin, an abnormally clear eye, and a temper greatly tending towards joy and hopefulness. It is further a curious circumstance, that disease of the liver is much more prevalent among men than

¹ DR. SIMPSON in Edinburgh Month. Journal of Med. Science, vol. for 1848.

among women, as is illustrated by the condition of our British troops in India and their attendant wives, and this independent of an equal amount of dram drinking on both sides. And it is again a strange fact, that immensely fatty and enlarged liver is a frequent accompaniment of phthisis; but it is much more common in the female than in the male.

In chemistry, we believe that a certain antagonism exists between oxygen and hydrogen; and, believing as we do, that a strong antagonism subsists between the functions of the lungs and the liver, and it being granted that the lungs are the oxygenators in animals, so we have ventured to name the liver "the *hydrogenator* in animals". Between oxygen and hydrogen there exists the antagonism, that oxygen is magnetic, as shown by Faraday, and hydrogen is believed to be diamagnetic. In the decomposition of water by the battery, oxygen appears at the positive pole, and hydrogen at the negative pole.

Again, oxygen eats into and corrodes all substances, even the metals, and hardens in so doing. In short, oxygen, although necessary to life, is yet the cause of death; while hydrogen, in that union in which we know it best, viz., in water, is the most universal solvent of matter, and in man water constitutes seven-eighths of the entire animal.

If, then, this antagonism subsists between oxygen and hydrogen on the one hand, and between the lungs and the liver on the other, we might, *a priori*, conclude, that as oxygen, viz., air, was the true stimulus of the lungs, so hydrogen, that is, water, should be the true stimulus of the liver; and accordingly we find that it is so, for water is an excellent cholagogue. And so also as nitrous oxide, viz., excess of oxygen is an inflammatory stimulant to the lungs, so alcohol, that is, excess of hydrogen, is a deadly enemy to the liver, either by the production of hepatitis, or excessive fattiness, viz., abnormal nutrition.

As by the lungs, then, the animal is oxygenated, so by the liver the animal is hydrogenated. The oxygen is carried into the system by the red corpuscles, and the hydrogen is circulated in the fluid fat of the blood. The source of this oxygen is in the air we breathe; and the source of this hydrogen is in the water and fluids we drink. The water being carried by the mesenteric veins to the liver, is there decomposed by the nucleated hepatic cells.¹ Hydrogen, being thus liberated, unites with the carbonaceous matters also present, and is thus passed out in the form of bile, viz., a substance, the characteristic of which is, its being a rich hydro-carbon, analogous to fat.

I seem to be further justified in this theory of the *creation* of bile,

¹ This has been my opinion since April 1847, when the general idea of this paper was first suggested to me by my friend Mr. Dove. This idea I submitted in writing to the consideration of my friends on the 31st March, 1851. About two months afterwards, the new edition of Liebig's *Letters on Chemistry* appeared, in which, at page 378, I find the following note. "When a fresh calf's liver is cut in pieces and covered with water, and exposed to a temperature of 98° 6' to 104° F., a remarkable fermentation begins after a few hours. The liver becomes covered with a number of gas bubbles, chiefly of *hydrogen*. Each bubble as it rises may be kindled at the surface. In an open vessel, during the first hours of fermentation, no putrid smell is observed. It is hence obvious, that the liver contains a substance which, in a certain state of decomposition, becomes a ferment powerful enough to decompose water, the oxygen of which is taken up by the elements of the ferment."

by the fact of no bile being detectable in the blood, even after the liver has been extirpated, as tested by Hernde. We have already seen that bile is essential to the formation of chyle, that is, essential to the life of the animal; and that the characteristic of chyle as distinguished from chyme, is the presence of oil globules and molecules of fat. Do we, then, push our argument too far in saying, that hydrogen is the peculiarly essential element in oil necessary to the nutritive and regenerative powers, seeing that the grand characteristic of oil is, that it is of all animal substances the *richest in hydrogen*.

We have thus endeavoured to show;—

1. That the main office of the liver is not to excrete hydrocarbonaceous matters, the result of the waste of the tissues; and therefore that its function is not vicarious with that of the lungs.

2. That the grand function of the liver is to *create* bile, without which bile the *nutrition* of the animal is impossible.

3. That the grand office of the bile is to create the oil globules and fat molecules, as they are found in the chyle.

4. That this oil is of a character different from ordinary oils, inasmuch as it is not only the most nutritious of all oils hitherto tested (cod-liver oil), but is, in short, an oil essential to the formative and regenerative processes (oil of chyle).

5. That in proportion to the relative size of the liver in the animal series, will be found the force of the formative and regenerative powers.

6. That although oxygen is essential to the vital force, yet one of its grand offices is to destroy tissues; and thus an *antagonism* may be said to subsist between the functions of the lungs and the liver.

7. That the liver has the power of decomposing water, and using the hydrogen thus set free for the creation of bile.

8. That, therefore, as the lungs may be called the oxygenators in animals, so *the liver may be called the hydrogenator in animals*.

ON THE RELATIONS OF UTERINE TO CONSTITUTIONAL DISORDER.

By F. W. MACKENZIE, M.D., Physician to the Paddington Free Dispensary for the Diseases of Women and Children, Fellow of University College, etc.

(Continued from p. 135.)

SECOND GROUP. CASES OF UTERINE DERANGEMENT MORE ESPECIALLY MANIFESTED BY MENSTRUAL DISORDERS.

IN this series, I have more particularly included cases of amenorrhœa, irregular menstruation, and menorrhagia; but, in doing so, I have felt some difficulty in determining the exact nosological position of various cases which I have met with. Thus the term amenorrhœa comprehends at least three varieties. Firstly, those known under the appellation of *emansio mensium*, where the discharge has not appeared at the ordinary period of puberty; secondly, those of *retentio mensium*, where the