you that, notwithstanding the opposition which we have been called to witness against bleeding in all its forms, and the decadence into which it has fallen, it ought not to be completely abandoned.

In the next lecture I shall treat of one of the consequences of bloodletting; I refer to anæmia and its treatment.

ON THE TREATMENT OF ANÆMIA.

SUMMARY:—History—Anæmia and Chlorosis—Different Kinds of Anæmia—Alteration of the Blood in Anæmia—Red Blood-Corpuscles, Their Composition—Oxy-Hæmoglobin—Evolution of the Globules—Essential and Symptomatic Anæmia—Chlorosis—The Importance of Enumeration of the Globules, and Dosage of the Hæmoglobin—Treatment of the Anæmias—Pharmaceutical Treatment—Iron—History—The Action of Iron—Absorption of Iron—Elimination of Iron—Mode of Introduction of Iron—Ferruginous Preparations—Reduced Iron—Oxides of Iron—Dialyzed Iron—Ferrous and Ferric Salts—Ferruginous Preparations in General—Ferruginous Waters—Artificial Ferruginous Waters—Choice of Ferruginous Preparations—Inconveniences of Iron Medication—Constipation—Blackening of the Teeth—Gastric Pains—Quantities of Iron Absorbed per Day—The Specific Action of Iron—Adjuvant Medications—Manganese—Arsenic—Hydrotherapy—Ærotherapy—Hygienic Treatment—Alimentation—Must We Treat All Cases of Chlorosis?—Pernicious Anæmia, Its Treatment.

GENTLEMEN: There are no diseases more common than the various forms of anæmia, and this age of ours is especially the age of anæmic patients. The treatment of anæmia is, therefore, worthy of your serious, earnest study.

Ever since Varandal, professor of the faculty of Montpellier, in 1620, introduced the term chlorosis into pathology, and Daumius, a century later, wrote the word anæmia, these two affections have been the subject of long discussions, some authorities making them two distinct diseases, others including them in the same description, and successive attempts have been made to found these opposing views on arguments drawn from clinical medicine and on arguments drawn from the chemical examination of the blood.[1]

[1] If the ancients understood anæmia, they have said little about it in their writings. In Hippocrates indeed the word *anaima* is found, and is applied to persons in a miserable exsanguinated condition. Galen makes no mention of anæmia.

In 1620 Varandal in his treatise on Diseases of Women, made mention of the pale color of certain patients, and proposed for this condition the word chlorosis. In 1706 Euth proposed the name oligæmia to characterize the lack of blood. In 1732 for the first time we find the word *anæmia* in the inaugural thesis of Daumius, Mich. Alberti being dean of the faculty. Then a few years later appeared the theses of Kutter and Behr on anæmia. Notwithstanding these works, anæmia was exceptionally admitted in France. Bouillaud in 1833 pointed out the anæmic souffles of the heart and blood vessels. Piorry called attention to local and general anæmias; finally the labors of modern hæmatology enabled us better to understand anæmia.

Then came the numerous divisions corresponding to the varieties of anæmia which were being studied, and an attempt was made to establish between anæmia and chlorosis distinctions more or less precise, and based more particularly on the alterations of the serum and the alterations of the globules. Thus Germain Sée admits four types of chronic anæmia: oligæmia corresponding to a diminution in the whole mass of the blood; globular anæmia; hydræmia, characterized by augmentation of the watery principles of the serum; disalbuminæmia in which there is diminution in the proportion of albumen. Moreover he establishes a distinction between chlorosis and anæmia. He regards chlorosis as a globular anæmia, resulting from nutritive impoverishment entailed by the demands of the reproductive functions and of growth. Jaccoud thus distinguishes anæmia from chlorosis: In

The incessant progress which the physical sciences and chemistry have made in the study of the blood, enables us at the present day to know the veritable nature of the anæmias. At first characterized and described as a diminution in the whole mass of the blood, the anæmias were subsequently considered as resulting from modifications in the divers constituent elements of that fluid. Hence in correspondence with the ingredient lacking, or in excess, different varieties of anæmia were established; essential globular anæmia, hydræmic anæmia, polyæmic anæmia (poly-anæmia) according as the globules alone were diminished in number or as there was predominance of the serous elements or even diminution in the proportion of albumen, such deficiency being indicated by the word disalbuminæmia, coined by Germain Sée.

To-day these distinctions ought to be abandoned, not because, irrespective of globular deficiency, these alterations in the constituent elements of the blood do not exist, but because they are variable and are not based on any very positive mathematical data. On the other hand, by reason of the discovery of processes which enable us not only to number the globules,[2] but to judge of

chlorosis the blood alteration is purely globular; it is an essential globular anæmia. In anæmia proper there is modification of the other constituent elements of the blood.

Under the head of anæmia we distinguish:

1. True or post hæmorrhagic anæmia.
2. Serous or polyæmic anæmia.
3. Albuminous or hydræmic anæmia.
4. Globular anæmia, or chlorosis.

Hayem has shown that in chlorosis the trouble is with the evolution and complete development of the red globules. (*a*)

[2] The discovery of the blood globules was one of the first triumphs of the microscope. It was in 1661 that Malphigi perceived in the blood of a hedge-hog certain red and spherical corpuscles which he considered to be globules of fat. Swamnerdam had, however, several years before, namely in 1658, made the discovery of these globules in the blood of a frog, but these investigations had not been published. In 1673, Leuwenhoek showed that the blood globules exist in the blood of all animals and that it is to them that the red color is due. Finally in 1770 Hewson completed this discovery and studied the structure of these bodies, their form, their dimensions, and published a very important work on the solid particles of the blood.

To-day we know the precise constitution of these corpuscles. In man the globules have the form of circular discs flattened in the centre. They are oval and elliptic in birds, fishes and reptiles.

Their dimensions vary according to the species and conform to the two great laws laid down by Milne Edwards: 1. Throughout the entire animal scale, in proportion as the organism progresses towards perfection of type, the globules decrease in size. 2. In animals belonging to the same zoological group, the more active the respiration the smaller the globules.

In man these dimensions according to Hayem vary from 5 m 5 to 8 m 6 (m = 1-1000 millimetre).

(*a*) Varandœus. De Morbis Mulierum, 1620, Lib. 1, ch. 1. Daumius, Diss. Inaug. Med. de Anæmia, 1732. Kutter and Behr, Opera, 1766. Bouillaud, Jour. hebd., 1833, t. ix., p. 578. Piorry, Traités des Alterations du Sang., Paris, 1836, p. 21. G. Sée, Leçons de Path. Experiment, Paris, 1867, pp. 38 and 244. Jaccoud, Path. Int., 1871, t. ii., p. 819. Hayem, On the Anatomical Characteristics of the Blood in the Anæmias, Compt. Rend. de l'Acad. des Sc., July, 1876. Moriez, De la Chlorose (th. d. agrégation, 1880).

their quality, we can by this very examination of the globules find a basis for the entire study of the anæmias. Here, moreover, it is to Professor Hayem that we are under obligations for the most important and decisive investigations on the characters of the blood in anæmic persons.[1]

Constituted by a solid organic frame-work provided even, if we may accept the latest researches of Ranvier, with a spherical membrane, the red corpuscles circulate in large numbers in the blood current. Deprived of nuclei, at least, as a rule, except in the fœtus, having a distinct form with which you are all familiar, these red corpuscles have a chemical composition to-day well known. They are constituted by an albuminoid matter, globuline, and contain also lecithine, cholesterine and animal matters, but that which especially characterizes them is the presence of a complex azotized matter colored red, crystallizable, containing a notable proportion of iron, the oxyhæmoglobin.

This oxyhæmoglobin is the veritable factor of the respiratory power of the blood; it presents to spectral examination certain characteristic rays which I here show you in this drawing, and when it is deprived of its oxygen, it constitutes what is called hæmoglobin reduced, which offers (and this is an important point) a spectral appearance quite different, as you can judge on comparing the two figures which I place before you. Apart from this reduced hæmoglobin, oxyhæmoglobin gives rise to other products of decomposition, such as hæmatin, hæmochromogen, hæmin, and hæmatodin.

You know from what I told you in a previous lecture, the methods in vogue for ascertaining approximately the amount of hæmoglobin in a given quantity of blood.

Anæmia of every kind, resulting as it must from an affection localized in the red globules, it is absolutely necessary that you chould have precise knowledge of the constitution of these globules and their evolution. Having finished the first part of my task, I come to the second, which concerns the evolution of the blood-corpuscles.

Here, unfortunately, our data are less conclusive, and we are obliged to resort to conjectures.[2] At the same time we know, according to Professor

[1] The number of these globules in the blood is estimated by Hayem as 5,000,000 per cubic millimetre. Their structure has been the subject of numerous researches, the most important of which are those of Rollet and Ranvier. Rollet maintains that the corpuscles are deprived of envelop, and are constructed of a solid organic frame-work, soft and uncolored, which he calls stroma, and which imbibes hæmoglobin like a sponge. Ranvier insists that there is a membrane around them. Sappey affirms the existence of a nucleus in the human blood globule. Hayem has found this to exist exceptionally, and in particular in cases of leucocythæmia. To detect these nuclei you must have a special staining fluid, either iodo-ioduretted water or hæmatoxylin. (*a*)

[2] It has till quite lately been supposed that the red globules come from the lymph and chyle, and that it is in the blood itself that the transformation from lymph globules into blood globules is effected. Within a few years, the tendency has been to assign to certain organs the function of transformation of the leucocytes into red globules. The red corpus-

(*a*) Rollet, Sitzunsbér der Wiener, Akad. der Wissensch., t. xlvi, May, 1862. Ranvier, Researches on the Elements of the Blood, Arch. de Physiol., 1874, p. 790. Hayem, Nucleated Red Globules in the Blood of the Adult, Arch. de Phys., t. i., March 1st, 1883.

Hayem, that the red corpuscles come from those little brilliant bodies which you see in microscopical preparations of blood, and to which the name of hæmatoblasts has been given. But what is the source of these hæmatoblasts? Do they come, as Hayem thinks, from the lymphatic net-work? Or from the marrow of bones, as the German and Italian schools maintain? Or are they engendered in the interior of certain glands, as the liver and the spleen? We are quite ignorant, and while recognizing the fact that there must be hæmato-poietic centres, we cannot at present definitely localize them. It is probable that the entire economy participates in the formation of hæmatoblasts.

The want of precise data concerning the origin of the blood globules, is a misfortune as far as therapeutics is concerned. In fact, the production of these hæmatoblasts is at the core of this whole question of the etiological treatment of anæmias, and if we could know the exact point where the hæmatoblasts originate, it is to this point that all our therapeutic endeavors should be directed.

What we do know is that under the influence of bad conditions of alimentation, or by reason of deprivation of a plentiful supply of oxygen in the air of respiration, or even as a result of the absence of sunlight, the production of

cles issue fully formed from these organs, and among these hæmato-poietic organs appear in the first rank, the liver and the spleen. The labors of Neumann, Bizzozero, and Rindfleisch, have added the marrow of bones. Bizzozero's conclusions are as follows:

1. The marrow of bones serves for the formation of white globules and lymphatic elements.

2. It is an organ of destruction of the red globules.

3. It is an organ productive of the red globules in the ratio of the transformations which the white globules undergo in its interior.

These views are based on patho-anatomical data and on experimental facts. After abundant hemorrhages in animals the medulla of bones contains a large number of nucleated red globules. Litten and Orth even found in the blood of anæmiated dogs nucleated globules.

In pernicious anæmia the marrow of the bones has been found red and altered.

The spleen has long been regarded as a hematopoietic organ. Bizzozero, Salvioli, and Foa affirm that in animals, during the first period of their life it is the spleen and the liver which form the globules.

According to Neumann and Bizzozero, the successive stages in the evolution of the red globules are as follows: The first stage is represented by the white globules and the uncolored cells of the marrow. In the second stage appear the nucleated hæmotoblasts. In the third the nucleus disappears, and the red globule is fully formed. Rindfleisch adds that it is the expulsion of the nucleus that gives to the red corpuscle its bi-concavity.

Hayem, who has reproduced the greater part of these experiments, does not share these views of the German and Italian authorities, and while admitting that in the fœtus the nucleated corpuscles may have multiple origins, he believes that the red globules always come from the hæmatoblasts. (a)

(a) Neumann, *Ueber die beudeutung des knochenmarkes fur die blutbildung* (*Arch. d. heilk.*, Bd X, s. 68–102, 1869).—*Neue beiträge zur kenntniss der blutbildung* (*Arch. d. heilk.*, 1874, s. 441).—*Knochenmark und blutkörperchen* (*Arch. f. mikr. anat.*, Bd XII, s. 793).—Litten et Orth, *Ueber veränderungen des markes in röhrenknochen unter verschiedenen patholog schen vehralenissen* (*Berl. kl n. Woch.*, s. 743, 1877).—Bizzozero, *Sulla funzione amatopoetica del midollo della ossa* (*Gaz. hebd. Lombard a*, n° 46, 1868).—*Centralbl. f. med. Wiss.*, s. 885, 1868, n. s. 149, 1869).—*Sul. midollo della ossa*, Napoli; 1869.—Rindfleisch, *Ueber knochenmark und blutbildung* (*Arch. f. mikr. anat.*, Bd XVII, s. 1, n. s. *f.* 21).—Bizzozero et Salvioli, *Blukorperthen in der milz* (*Centralbl. die med. Wissens.*, s. 273, 1879).—Foa et Salvioli, *Sull' origine dei globulirossi detisangus* (*Arch. per le sc. mediche*, vol. IV, n° 1.

blood corpuscles diminishes, and the corpuscles, touched in their vitality, do not attain their complete development.[1] In other circumstances the original cause escapes us, and we see develop at certain periods of life those essential anæmias described under the name of chlorosis, and in which the hæmatopoietic centres seem primitively to have undergone some lesion. Oftener these troubles in the evolution of globules are temporary, but there are others which are permanent; we give the name malignant or pernicious to these anæmias, and all our therapeutic efforts are impotent in these cases to communicate a new activity to the production of hæmatoblasts.

Whether we are concerned with symptomatic anæmia, with essential anæmia, or pernicious anæmia, it is always in the evolution of the corpuscles that we must place the first cause of the trouble, and to serve as a basis for our diagnosis of anæmia, and to measure the intensity of the evil, we ought always to refer ourselves to the three following particulars, as Hayem has shown:— What alterations have the globules undergone? What is their real number? what is their individual value?[2]

[1] Hayem affirms that in all kinds of anæmia you will find abnormal forms of globules, and in particular, giant corpuscles with a diameter of 12′ m. There are other globules which are very minute. With these alterations in size there are alterations in shape, due to the abnormal softness of the globules in chlorotic patients; it is, however, worthy of note that the corpuscles never lose their disk shape.

Moriez considers the theories which have been advanced respecting chlorosis under five heads:

1. Chlorosis due to disturbances of menstruation.
2. Chlorosis due to dyscrasia.
3. Chlorosis due to disease of the nervous system.
4. Chlorosis due to inflammatory or organic disease.
5. Chlorosis due to faulty evolution.

1. *Chlorosis is due to menstrual disorders.*—This is the view sustained by the ancient fathers of medicine, and multitudes of modern authorities, who have attributed to uterine troubles the first cause of chlorosis.

2. *Chlorosis is a cachexia, a dyscrasia.*—This is the opinion the most generally adopted, and a great number of hypotheses have been advanced with regard to it. Some see in chlorosis nothing but alterations in the red globules, others alterations in the plasma as well.

3. *Chlorosis is a disease of the nervous system.*—Sydenham compared chlorosis to hysteria, regarding them as akin. Trousseau placed the disorders of the nervous system in the first rank, and before the anæmic troubles. Copland attributes chlorosis to asthenia of the great sympathetic. Hoefer, Cocchi and Braxton Hicks attribute it to neurosis of the ganglionic nervous system; Putegnat to a neurosis of the trisplanchnic nerve.

4. *Chlorosis is an inflammatory or organic disease.*—Broussais considered chlorosis as a visceral irritation. Rasori, Giacomini, and Tommasini invoke a slow arteritis, while Hoffmann, Beau, and Suton place in alteration or functional troubles of the digestive tube, the point of origin of chlorosis.

5. *Chlorosis is a disease of evolution.*—This is the opinion sustained by Germain Sée. According to him, whenever there is disproportion between the developmental forces and the reparatory forces, chlorosis may arise.

[2] Hayem has studied the anæmias from the standpoint of numeration of the globules, and of colorimetry. According to him, the elements of appreciation of the degrees of anæmia are in order of importance:

This examination will be very easy for you if you follow the rules which I gave you in a previous lecture, and all that you have need of in order to carry them out, is a drop of your patient's blood. You will see then by the microscopic examination of the preparation, the form of the corpuscles, their number, and that of the hæmatoblasts; you will appreciate by this examination, which should be a very thorough one, how important it is to combine the numerical examination of the globules with the qualitative estimation of the hæmoglobin, and always to compare the corpuscles under inspection with healthy corpuscles, that you may know their real value.

There exist, in fact, anæmias in which the number of globules is not diminished, and this shows that the word globular anæmia, taken in its most rigorous acceptation, is not always an appropriate word to designate impoverishment of the blood. But if by means of the hæmacytometer you are able to compare these globules with healthy globules, you will find a marked difference in their number.[3] We have now in our hospital wards anæmic individuals (advanced cases), who, by the simple enumeration of the globules, have from four to five millions, a figure almost normal, but which amounts to only two or three millions when the comparison is made with well-developed healthy globules. So that it is not enough to have a normal quantity, they must be healthy as well.

1. The richness of the blood in hemo-globin, expressed in the number of healthy globules.
2. The alteration of the globules.
3. The real number of the globules.
4. The individual value of the globules.

Basing himself on these characters, he establishes four degrees of anæmia:

1. The mild degree of globular deficiency, characterized by alterations nil or feeble, by a globular richness expressed in healthy globules varying between three and four millions. Corpuscular value varying from 1 to 0.70.
2. Globular deficiency of medium intensity, characterized by pronounced globular alterations with diminutions in the dimension of the globules; a richness varying from two to three millions. Individual corpuscular value varying between 0.30 and 0.80.
3. Intense globular deficiency; having also for characteristics altered globules, but of very unequal dimensions, of which the medium approaches the normal by reason of the great proportion of giant globules; a globular richness varying from two million to eight hundred thousand. Individual corpuscular value oscillating between 0.40 and 1.
4. Extreme globular deficiency, characterized by altered globules of very unequal dimensions, but whose medium approaches the normal, and may even exceed it; a richness varying from 800,000 to 450,000. An individual corpuscular value approaching the normal.

[3] According to the researches of Quinquaud, researches based on the dosage of hæmoglobin by the process of Schutzenburger, in the blood of chlorotics there is a double alteration: diminution in the figure of hæmoglobin, and lowering of the maximum of saturation of the blood by oxygen. The hæmoglobin is diminished ½ in chloroses of medium intensity. In the normal state in 1000 grammes of blood the hæmoglobin is 125 grammes; it falls to 70 and even 30 grammes in chlorotics. As for the absorbent power of the blood for oxygen, it is normally in the ratio of 240 cu. centimetres to every 1000 grammes of blood; it falls to 80 cu. centimeters in chlorotics. Quinquaud has also found a diminution in the salts of potash and chlorides which enter into the composition of the blood. (*a*)

(*a*) Quinquaud—Researches on Clinical Hæmotology, Paris. 1880.

This microscopical examination will give you a good basis for prognosis. Whenever you see the hæmatoblasts in sufficient abundance, be persuaded that by reason of the conservation of the hæmatopoietic functions, you will be enabled easily to cure your patient. If there be paucity of hæmatoblasts, you will have difficulty in bringing about restoration, and the difficulty will be insuperable if the hæmatoblasts be very few.

You will pardon these somewhat lengthy details on account of the importance of such investigations as these, investigations which, though as yet little known and employed, have completely modified the study of anæmia. I come now to the practical question before us, the treatment of the various forms of anæmia. The treatment of anæmia is, first, pharmaceutical; second, hygienic.

1. In the first rank of therapeutic agents we place iron, and this question of ferruginous preparations in the treatment of anæmia is one of the most interesting in therapeutics, and one which has awakened the most ardent discussions.

The first physicians who employed iron in anæmia were probably guided by the therapeutic rule called the law of similitudes, and selecting iron as the representative of force—placed, as it had been, under the patronage of Mars—they judged this metal to be indicated in diseases characterized by great depression of the vital forces.

In the middle of the seventeenth century Ferrein thus characterized the therapeutic properties of the ferruginous preparations: 1. Sunt temperantes; 2, Diluentes; 3, Solvunt et aperiunt; 4, Vi stomatica donantur; 5, Vi cathartica; 6, Vi astringente; 7, Diureticæ sunt.

These multiple properties were based only on observation, but an important discovery which had just been made at Bologna and at Venice by Galatti, by Menghini and by Badia, gave a much more powerful support to this ferruginous medication, since these physicians had just recognized the existence of iron in the blood;[1] then more precise investigations proved the presence of iron in the red corpuscles, and in the oxy-hæmoglobin, which constitutes the

[1] The following, according to Pelouze, are the quantities of iron contained in 100 parts of blood of different kinds:

	MAXIMUM.	MINIMUM.
Man	0g.0537.	0g.0506.
Ox	0 .0540.	0 .0480.
Hog	0 .0595.	0 .0506.
Goose	0 .0358.	0 .0347.
Chicken	0 .0357.	"
Frog	0 .0425.	"

Boussingault has given the following figures:

100 grammes of human blood contain of iron.......... 0gr.051.
100 grammes of beef's blood contain.................. 0gr.048.

most important part of these globules.[1] As a result of this discovery iron came into such general use in anæmia that not a mother of family but of her own accord gave ferruginous preparations to her daughters when the appearance of pallor in the countenance indicated this medication—a custom which has prevailed to the present time.

At the same time, despite the popularity of the ferruginous medication, despite the constant multiplication of new preparations of iron, this question of efficacy, and especially of the action of chalybeates, is far from being solved, and there are two ways of regarding the subject. Certain physiologists, emphasizing the fact of the presence of iron in the hæmoglobin, and deriving support from the labors of Prof. Hayem, insist that a course of iron preparations is essential to the cure of globular anæmia. Clinicians, on the other hand, reply that while fully recognizing the utility in certain cases of martial remedies, the latter, nevertheless, have no direct local action on the globules, and what action they have results from stimulation of the entire organism; that all hygienic and other means which improve nutrition and arouse the hæmatopoietic forces, arrive at the same result. In support of this view clinicians appeal to the numerous facts of chlorotic patients where martial preparations, continued for several years, have produced no effect, and where cure has at last been brought about by hydrotherapy, gymnastics, and especially by country air.

Till recently I have ranged myself on the side of the clinicians, but I acknowledge that since I have employed in the study of therapeutic results obtained, the scientific method of the enumeration of the globules, my opinion has been shaken, and within certain limits, which I shall fix presently, I am ready to endorse the claims of the partisans of the ferruginous medication.

What renders obscure this mode of operation of chalybeates is that we are still ignorant of the pharmaco-dynamic action of this remedy daily employed,

[1] Hæmoglobin is the most important part of the chemical composition of blood globules. According to Wurtz, it ought not to be reckoned among the albuminoid matters. It is constituted essentially by a crystallizable matter to which has been given the name of oxy-hæmoglobin. The form of these crystals varies according to the blood from which they are derived, whether venous or arterial and according to the animal species from which it is obtained. Submitted to spectrum analysis, it presents two absorption bands situated between the rays D and E of the solar spectrum and separated by a luminous ray colored greenish-yellow.

When you put oxy-hæmoglobin in contact with a body that has a great affinity for oxygen, you obtain hæmoglobin reduced, which is distinguished from the former in that it is no longer crystallizable and that instead of presenting two absorption bands it has but one, and this in the place of the greenish-yellow band which separates the two absorption bands of the spectrum of oxy-hæmoglobin.

In the presence of acids and of alkalies, hæmoglobin breaks up into albuminoid coagulable substance, and an iron pigment, hematosin (which Lacanut described under that name); this hematosin is capable of combining with sulphuric acid and giving rise to a new body to which has been given the name of hematoporphyrine. It combines also with hydrochloric acid and forms chlorhydrate of hematine, (Wurtz, Treatise on Biological Chemistry, p. 297).

and that on many points relative to the absorption and elimination of this medicament, we are reduced to hypotheses.

As for absorption, the hypothesis of Scherpf is the most probable, who affirms that ferruginous preparations enter the blood under the form of a double salt.[1] First they may be taken up by the stomach as a chloride, which on entering the serum is changed to an insoluble albuminate, which is then rendered soluble by an excess of soda, constituting a double albuminate of iron and of soda. Or on the other hand this transformation into a soluble albuminate or peptonate may be effected in the intestine under the influence of the digestive fluids, and in this state it may be absorbed. But what has given place to the most controversy is the question relative to the elimination of iron.[2]

In fact the whole of the iron ingested seems to appear in the fæcal matters, and this has led the opponents of the ferruginous medication to affirm that iron does not undergo any change in the economy.[3]

At the same time, when we examine the question a little more carefully, we perceive that the iron which is found in the dejections comes not only from the iron introduced directly by the stomach, but also from the different intestinal secretions, the gastric juice, and especially from the bile, which con-

[1] To explain the absorption of iron, three hypotheses have been admitted: 1. Direct penetration of the iron into the blood under the form of an inorganic salt and combination of this salt with the albuminoids of the blood.

2. Combination of the iron and the albuminoids directly in the stomach and intestine.

3. Absorption by these two processes at once.

It is this last theory which has received the support of Scherpf, of Mitscherlich, of Buchkeim and Ditts. The theory more explicitly stated is as follows: The assimilation of iron is brought about in two ways—in the blood and in the intestine. In the blood, the iron penetrates in the state of an inorganic salt and combines with the inorganic substances of the serum; in the intestine there is also, before absorption, a combination of iron with the albuminoid matters, forming veritable ferruginous peptonates. It is probably in the the state of chloride that iron enters the blood. This chloride of iron, introduced into the blood, is transformed into albuminate of iron, at first insoluble and afterwards changed by the alkali of the blood into a double albuminate of iron and soda. These double albuminates of iron and soda and the peptonates of iron are absolutely innoxious to the blood. (*a*)

[2] Scherpf, On the Absorption and Elimination of Iron, Wurtzburg, 1878.

[3] Tiedmann and Gmelin found, so to speak, the whole of the iron administered to subjects under experimentation, in the stools. Most of the secretions contain iron; the tears, saliva, the milk, the digestive and intestinal secretion, the bile, etc. The gastric juice of a man, according to Schmidt, excretes three centigrams a day of iron, the bile four centigrams. Paganuzzi maintained that iron absorbed in the intestines penetrated to the cells of the liver, there stimulated the hæmatopoietic functions of this gland, and was eliminated by the bile to be again taken up by the intestine. Hayem affirms on the contrary that the iron which is found in the excretions does not find its way there till it has been made a part of the blood globules, and that it undergoes an incessant renewal in the economy. In dogs, nourished on aliments deprived of iron, this metal was found in notable quantity in the fæcal matters (*b*)

(*a*) Scherpf, On the Resorption and Assimilation of Iron. Wurtzburg, 1878. Hayem, loc. cit.
(*b*) Hayem, Leçons sur les Modifications du Sang., p. 507.

tains iron in notable proportions. *A propos* of the presence of iron in the bile, I showed you, when addressing you on the functions of the liver, that Paganuzzi and Lussana had based on this fact a particular theory of the action of iron on the hæmatopoietic functions of that organ.

It is, then, probable that the iron which is found in such abundance in the stools and in the intestinal secretions, comes not only from that which has been taken as medicine, and from the food, but also from the incessant modifications which the blood corpuscles undergo in the organism. But what is quite inexplicable, and altogether different from what we observe in the case of other medicaments, the quantity of iron found in the urine is little if at all increased, in whatever form the chalybeate may be administered, that is if we may rely on the experiments of Hamburger.[1]

The method of administration of ferruginous medicines is almost exclusively by the alimentary canal. Nevertheless the past few years attempts have been made to introduce soluble iron preparations hypodermically, and even by the rectum. Neuss has recently experimented with subcutaneous injections of the pyrophosphate in solution of citrate of soda. Luton and J. M. Da Costa have administered the dialyzed iron in the same way, the quantity for hypodermic injection being fifteen to twenty drops. This preparation is said to cause no local irritation whatever. Chiamarelli has employed to advantage the ammonio-citrate, one grain to about fifteen drops of water, and claims that this is a good and safe preparation for hypodermic use.

Jaillet has recommended lavements of peptonate of iron, and I have myself practiced subcutaneous injections of the peptonates. These tentatives ought to be encouraged, for there are persons whose stomachs cannot support the martial preparations, and in these cases there will be an advantage in using the hypodermic or rectal method. At the same time it must be borne in mind that subcutaneous injections of the peptonate of iron are painful, without however being attended with the risk of grave local lesions.[2]

As for the preparations of iron which are administered by mouth, they are innumerable, and their number increases every day. They may be divided into the martial preparations properly so called, and the ferruginous waters.

[1] Hamburger has studied the elimination of iron and affirms that one will always find iron in the normal state in the urine, and when iron is administered to animals, for instance in the dose of five grammes of the sulphate per diem, this dose does not augment more than from one to two milligrammes the quantity of iron contained in the urine. (*a*)

[2] Jaillet's solution of the peptonate is as follows: Take of sublimated perchloride of iron, 1 gramme. Distilled water, 60 grammes. Dried peptone, 2 grammes. Pure glycerine, 40 grammes. Dissolve the peptone in a little water and add the glycerine; dissolve the ferrum perchloride in the rest of the water, and mix the two solutions, add finely pulverized carbonate of soda to saturation, and filter the solution; (see that the solution measures 100 cubic centimeters before filtration). (*b*)

(*a*) Hamburger, Ueber die aufnah me ausscheidung deseiseus. (Zeitschrift f. physiologische chemie, Bd. 11, p. 119, 1878.)

(*b*) Jaillet, Physiological and Chemical Studies on the Chloropeptonate of Iron.

The martial preparations are both soluble and insoluble, simple or compound. I cannot enumerate all. I will only mention the principal. Iron in substance has been used, the oxides and the sesqui-oxides, the ferrous as well as the ferric salts.

Iron in fine powder, iron filings, porphyrized or not, and the *ferrum redactum* (or iron reduced by hydrogen or by electricity), represent the type of the insoluble preparations. Introduced into therapeutics by Quevenne, who recognized its ready solution in the gastric juice, this reduced iron has had and still has a great repute. [It was a favorite preparation with the late Dr. C. D. Meigs, of Philadelphia.—TRANS.] Iron filings are also given in the form of powder, pills, dragees, or as iron chocolate.

Under the name of ethiops martial, and under that of aperient saffron of Mars, therapeutics utilizes the dark ferric oxide, and the hydrated sesqui-oxide, which serves as the basis of numerous complex preparations. Of these oxides there is one which enjoys great repute, at least on the advertising pages of medical journals; I allude to the dialyzed iron, which is a very unreliable preparation, if we may trust the conclusive experience of Bouchardt.[1]

Then comes the long series of ferrous and ferric salts. At their head we have the ferrous carbonate (the old proto-carbonate), two preparations of which, quite complex, are well known—Vallet's and Blaud's pills. Quite recently, too, under the name of the sucro-carbonate of iron, Tanret has put in the market a preparation very agreeable to the taste, which is a combination of ferrous carbonate with sugar.[2]

Next in order is the iodide of iron, which serves as basis of the pills of

[1] The following useful formulas are worthy of mention in this connection:

Iron Chocolate.—Take of chocolate 50 parts, porphyrized iron filings 1 part. Mix. 25 grammes represents 25 centigrammes of iron.

Chalybeate Pill—(Each pill contains 1 grain porphyrized iron filings, with about ⅙ grain socotrine aloes and pulv. canella, made into a pill with a little powdered licorice root and honey.)

Compound Iron Pills.—℞

		GRAMMES.	
For one pill.	Quevenne's iron	0	16
	Sulph. quinine	0	01
	Pulv. zingib	0	01
	Ext. cinchon. flav	0	03
Dose, from one to six.	Ext. rhei co	0	03
	Aloes soc	0	005

Mist. Fer. Aromatic.—(Dublin Ph.)

℞ Iron filings, 15 grammes (gr. ccxxv).
Yellow calisaya bark, 30 grammes (℥ i).
Columbo root, 12 grammes (ʒ iij).
Cloves, 8 grammes (ʒ ij).
Peppermint water, 200 grammes (℥ vi and ʒ v).

M. Macerate three days, shake and filter, then add enough tincture orange peel to flavor. Dose, two to three teaspoonfuls a day.

[2] The formula of Vallet's pills is as follows: