tends to blacken, if not to injure, the teeth, to irritate the stomach, and constipate the bowels, while in large doses it may cause, in addition, headache and urino-genital irritation. Yet in the acute diseases mentioned above, in which large doses are so commonly prescribed, the medicine is remarkably well borne. The dose of the tincture ranges from ♏ ij. to x. or so, three times a day, in anæmia, to a teaspoonful, or more even, every hour or two, in the grave diseases requiring full dosage. The medicine must be well diluted, at least fourfold, with water, and the addition of some glycerin—about twenty-five per cent. of the potion as swallowed—remarkably disguises the harsh, unpleasant taste of the draught without affecting its efficiency. The dose should be sucked through a glass tube and the mouth well rinsed after the swallowing, and the administration should be preferably a while after meals rather than before. In anæmia good results often follow the giving of small and copiously diluted doses of the tincture—two drops diffused through a tumblerful of water. And thus administered, the medicine is practically freed from the objectionable taste and irritant action on the stomach which often preclude its use in larger dosage.

Basic Ferric Sulphate: $Fe_4O(SO_4)_5$.

This salt closely resembles the chloride in intense styptic quality, yet differs from the same in the advantageous way of being decidedly less irritant. It is official in the United States Pharmacopœia only in an original solution, as follows:

Liquor Ferri Subsulphatis, Solution of Ferric Subsulphate, "Monsel's Solution." Ferrous sulphate in a fixed proportion is added to a mixture in fixed proportion of sulphuric and nitric acids, at the boiling temperature. Conversion of the ferrous to the ferric sulphate results, but, by virtue of the proportion of sulphuric acid taken, it is the basic salt that forms. After the reaction is complete the solution is brought, by the addition of distilled water, to the standard strength—a strength "corresponding to about 13.6 per cent. of metallic iron" (U. S. P.). This solution is a deep ruby-red fluid, analogous in all general characteristics to the solution of the chloride. It is especially intended and used as a styptic, in which capacity it is pre-eminent.

Solution of the subsulphate may be applied clear to parts within reach; may be swallowed in ten-drop doses, well diluted, in hæmatemesis, and inhaled in atomized spray, in a two-per-cent. aqueous dilution, in hæmoptysis. The solution is also, of course, a possible chalybeate medicine, but, having no especial advantage over the tincture of the chloride, is rarely used for its medical virtues. The dose would be ten drops or so, largely diluted. This solution is the one formerly known as "solution of persulphate of iron"; and is dispensed whenever such solution is prescribed.

Normal Ferric Sulphate: $Fe_2(SO_4)_3$.

The normal sulphate differs, medicinally, from the basic only in being more irritant in its local effects. It is official in the United States Pharmacopœia for pharmaceutical purposes only, and in the following original solution:

Liquor Ferri Tersulphatis, Solution of Ferric Sulphate. This solution is made in precisely the same manner as the foregoing, only with such proportion of the ingredients as to yield the normal instead of the basic sulphate. It is of a strength "corresponding to about eight per cent. of metallic iron" (U. S. P.). It is important as being the preparation out of which ferric hydroxide is made, both when this compound is called for as an antidote to arsenic, and also when it is required for the making of the scale preparations of iron, as already seen. This solution is efficient as a chalybeate and as a hæmostatic, but, having no advantages for such application, is rarely so used.

Ferric Nitrate: $Fe_2(NO_3)_6$.

This salt is substantially an unnecessary duplicate of its congeners just considered. Like the ferric sulphates, it is official in the United States Pharmacopœia only in an original solution, as follows:

Liquor Ferri Nitratis, Solution of Ferric Nitrate. Fresh and moist ferric hydroxide is treated with nitric acid, and the resulting solution of ferric nitrate is brought to standard strength ("about 6.2 per cent. of the anhydrous salt") by the addition of distilled water. The solution is a clear, amber or reddish-colored liquid, sour and styptic in taste. It has been given as a chalybeate, in doses of from ten to twenty-five drops.

Ammonio-ferric Sulphate: $Fe_2(NH_4)_2(SO_4)_4.24H_2O$.

The salt is official under the title *Ferri et Ammonii Sulphas*, Ferric Ammonium Sulphate, "Iron Alum." It has the chemical structure and, physiologically, the peculiar strong astringency, without excessive irritation, of the true alums. It occurs in octahedral crystals of a delicate lilac or violet color, which dissolve freely in water, but are insoluble in alcohol. It is used in strong solution, as a styptic, or internally, as a combined astringent and chalybeate, in cases of anæmia with passive discharges. Dose, from 0.30 to 0.65 gm. (gr. v. to x.) three times a day.

Besides the foregoing official preparations there are numerous others, not official either because now dismissed from the Pharmacopœia as obsolete, or because not deemed worthy of recognition, or because newly proposed. Of the first class, two ferrous salts were dismissed in the last (1890) revision of the United States Pharmacopœia, namely, *ferrous bromide* and *oxalate*. The *bromide* used to be official in a syrup which was substantially a duplicate in all ways of the syrup of the iodide, and the oxalate was official as the salt itself. *Ferrous oxalate* is a lemon-yellow crystalline powder, practically insoluble in water. It was proposed for chalybeate use on the strength of an assertion that it does not constipate, but it never found favor. It may be given in doses of a few grains.

Dialyzed iron at one time had considerable vogue in medicine, although never recognized by the United States Pharmacopœia. As a chalybeate it is bland, but feeble, and as an antidote to arsenic—its other possible application—it is considered inferior to the "hydrated oxide with magnesia," on the score that the insoluble compound that it forms with the arsenical is less stable in the presence of acids.

Dialyzed iron is substantially a solution in water of ferric oxychloride, whose composition varies from Fe_2Cl_6, $12Fe_2O_3$ to $Fe_2Cl_6.95Fe_2O_3$. It is properly made by precipitating an aqueous solution of ferric chloride with water of ammonia, shaking until the precipitate redissolves (formation of oxychloride), and then dialyzing over water, continuing the dialysis, with frequent changing of the water, so long as any traces of hydrochloric acid appear. The product is then assayed, and, by addition of water, is brought to the standard strength of ten per cent. of dry oxychloride. Much of the dialyzed iron in market, however, is made not in this way, but simply by adding fresh ferric hydroxide to a solution of ferric chloride so long as it continues to dissolve, and then filtering. Such preparation is, of course, properly not *dialyzed* iron at all.

Genuine dialyzed iron is a clear, reddish-brown solution, odorless, practically tasteless, and perfectly bland and innocent. Any decidedly ferruginous or styptic taste probably means a sham specimen. The true article mixes in all proportions with distilled water, alcohol, glycerin, and simple syrup; but upon admixture with alkalies, many salts—notably sodium chloride—and most organic matters, it suddenly transforms itself into a soft gelatinous mass, in color and consistence much resembling clotted blood. Such reaction must inevitably ensue on swallowing, and in the colloidal state resulting the iron is incapable of absorption. What of dialyzed iron ever gets access to the blood must, therefore, be through some chemical attack upon it by the alimentary juices, with the development of new and soluble iron

compounds. The dose of dialyzed iron must be large if any effect at all is to be expected—at least a teaspoonful of the usual ten-per-cent. solution three times a day. As an antidote to arsenic, teaspoonful doses should be given every five minutes; and since now gelatinizing is of advantage, some common salt should follow each dose.

Dialyzed iron has been injected hypodermatically, but in some instances with the following of abscess at the site of puncture.

A distinct class of preparations is afforded by certain compounds of iron with *proteid* substances, designed to furnish iron in a condition allied to the "organic" iron of hæmoglobin, and this because of the notion that ordinary iron preparations are not capable of assimilation (see *ante*). Of these preparations the most important are those containing iron as an *albuminate* or a *peptonate*.

By reaction of solution of ferric chloride upon albumin *ferric albuminate* forms, which precipitates from the solution by addition of a solution of common salt. The precipitated albuminate, washed and dried, appears as a brown powder, soluble in water, especially under slight acidulation with hydrochloric acid. The preparation is bland, and may be prescribed as a chalybeate in doses of from 1.3 to 1.95 gm. (gr. xx. to xxx.), to be taken in pill or dissolved (freshly) in water. In this preparation the iron is not in the condition of "organic" iron, for a solution of the albuminate precipitates with alkaline sulphides the same as does a solution of an ordinary salt of iron.

Ferric peptonate can be obtained in the form of dried scales, resembling in character the scale preparations of ferric citrate (see *ante*). A solution of freshly peptonized albumin is treated with dialyzed iron under certain special pharmaceutical manipulations, and from the solution of ferric peptonate finally obtained scales are prepared in the usual way. These scales are brown in color, contain about one-quarter of their weight of iron, and dissolve slowly in cold water. They make a bland chalybeate, in which, however, as in the case of ferric albuminate, the iron is in "inorganic" and not "organic" condition.

Under the name of *ferratin* there has been offered a preparation of iron made to imitate the normal ferratin discovered by Schmiedeburg in the liver of the hog. Artificial ferratin is made by reaction of albumin with a double tartrate of iron and one of the alkali metals. The preparation is in the form of a brownish powder, almost insoluble in water but soluble in alkaline liquids. It contains from six to eight per cent. of iron. It is bland and may be given, as a chalybeate, in doses of a few grains several times daily. It is claimed that in ferratin the condition of the iron is certainly very near to that of natural "organic" iron, but yet the preparation reacts with the hæmatoxylon test, which true "organic" iron does not do.

Carniferrin is a preparation closely allied to ferratin in its properties and reactions. It is a compound of iron with phosphocarnic acid. It is in the form of powder, tasteless and bland; is soluble in alkaline fluids, and may be given as a chalybeate in doses of a few grains. It contains about thirty per cent. of iron.

Ferralbumose is another preparation in form of powder, obtained by precipitating with a solution of ferric chloride a solution of albumose derived from meat by treatment with artificial gastric juice.

The various proteid preparations of iron have the certain merit that they do not upset the stomach and that they are readily absorbed. They are, however, comparatively expensive, and it is not demonstrated that they cure chlorosis any more effectively than well-selected preparations from among the pharmacopœial list.

III. General Therapeutics of Iron Compounds.—Excepting certain special applications of individual compounds, the therapeutics of iron comprises the internal use for the cure of anæmic conditions, and the local employment for astringent or styptic purpose. Concerning the two applications, the following practical points are to be made:

Anæmia.—1. Except in pernicious anæmia, iron proves so serviceable that, given an anæmic state, the medicine is commonly held to be indicated, unless there be either fever or a tendency to active hemorrhage—conditions apt to be aggravated by iron. 2. In the matter of choice of preparations, in general, the astringent chalybeates are more powerful than the bland, but yet it will be wiser to try the latter kind first if either the stomach be over-irritable, the bowels strongly prone to constipation, the teeth fragile, or the patient of careless habits; or if, as with children, the disagreeable taste of the astringent preparations be particularly obnoxious. On the other hand, the astringent chalybeates are especially advantageous when the appetite is poor and yet the stomach is not unduly sensitive, or when there is general laxity of tissue, or a tendency to passive fluxes or hemorrhages. 3. In particular, concerning the preparations, if an astringent be wanted, the tincture of the chloride answers every purpose as a fluid form, and the dried sulphate (ferrous) as one for giving in solid form in pill. If a bland compound be required, there may be prescribed, in powder, reduced iron and the saccharated carbonate; in pill, reduced iron, pills of the carbonate, "Blaud's pills," and the citrate; and in solution, the potassio-tartrate or the pyrophosphate, with the others of the scaled preparations as substitutes. For the rest, the various compound salts and the fancy pharmaceutical preparations are often convenient, but are never indispensable. 4. The frequency of dosage is most conveniently fixed at three times a day, and the doses, as already given, are intended for such frequency. But in exceptional uses of iron, as of the tincture of the chloride in diphtheria, the frequency will be far different—according to the severity of the case, even to hourly administration, day and night. 5. The timing of the doses is best arranged to be at meal-hours, the administration to be rather after than before eating. This certainly with the astringent chalybeates, but with the very bland the rule need not be enforced.

To Arrest Hemorrhage.—1. In general, it must be remembered that arterial hemorrhage belongs by right to the domain of surgery, and that medicinal hæmostatics are only proper when the vessel is either too small for mechanical measures or is inaccessible. This rule needs especial observance in connection with the iron styptics, for if they fail to stop the bleeding the surgical search for the bleeding point, through the indiscriminately slough-obscured tissue resulting from the styptic application, is made exasperatingly difficult. Furthermore, this same slough caused by the styptic seriously interferes with speedy healing of the wound. 2. Of the styptic preparations the official solution of the subsulphate is generally the best, because the least irritant; but if extreme power be required, and the area to be subjected to the application is small, a drop or two of the deliquesced chloride may be allowed.

The individualized applications of iron compounds are of the hydroxide, as an antidote to arsenic; of ferrous sulphate, as a disinfectant; of the tincture of the chloride as a medicine of peculiar virtues; of the solution of ferric sulphate for purposes of pharmacy, and of the ammonio-sulphate as a pure astringent.

Edward Curtis.

[1] Willcocks: The Practitioner, vol. xxxi., pp. 7 and 94.

IRONDALE SPRINGS.—Preston County, West Virginia.

Post-Office.—Independence.

Access.—Viâ Baltimore and Ohio Railroad to Hardman's Siding, one and one-half miles west of Independence, thence by the Iron Valley Railroad three and one-half miles to the springs.

The Irondale Springs occupy a very attractive location about 1,200 feet above the sea-level, but the place is not at present used as a resort. The water is bottled and used commercially, being recommended by physicians in many of the large Eastern cities. It has been analyzed

by Prof. A. A. Breneman, formerly of Cornell University, with the following results:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium sulphate	60.42
Magnesium sulphate	4.34
Potassium sulphate	6.76
Aluminum sulphate	11.34
Manganese sulphate	2.86
Iron sulphate with cobalt and nitric acid	Trace.
Sodium chloride	1.36
Silica	1.44
Iodine with sodium	Trace.
Vegetable and volatile substances	8.24
Total	96.76

This water, as shown by the analysis, is exceptionally rich in manganese, besides containing a large amount of alum. The following facts relating to its therapeutic effects are gathered from an article contributed to the New York *Medical Times* by Dr. Samuel Swift. This water, he says, possesses undoubted tonic and diuretic properties. It also acts as a sedative to the gastric mucous membrane, and in virtue of this fact it is highly extolled in cases of gastric irritability. It acts well in the nausea and vomiting of pregnancy, and has been found useful in chronic diarrhœa. In Bright's disease and in anæmia and chlorosis it has seemed to possess decided remedial value. The water is not unpleasant to the taste, and has no disagreeable after-effects. The Irondale Spring salts, made by evaporating the water, are also on the market. *James K. Crook.*

IRON LITHIA SPRINGS.—Tazewell County, Virginia.

POST-OFFICE.—Tazewell. Hotel.

ACCESS.—Viâ Clinch Valley Division of the Norfolk and Western Railroad to Tip-Top Station, thence by private conveyance two miles to the springs.

These springs are charmingly located in the Alleghany Mountains at an elevation of 2,700 feet above the sea-level. They were but recently discovered, but have already become well known. A hotel has been erected capable of accommodating fifty guests. The many advantages of climate, mineral springs, scenery, etc., which are found here will doubtless bring the place into prominence in the near future. The springs are five in number and discharge about 1,000 gallons of water per day. An analysis by Dr. Henry Froehling, of Richmond, in 1890, shows the following ingredients:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Magnesium sulphate	4.71
Calcium sulphate	1.71
Barium sulphate	.09
Strontium sulphate	Trace.
Iron sulphate	5.08
Manganese sulphate	.36
Aluminum sulphate	8.05
Potassium sulphate	.51
Sodium sulphate	.25
Lithium chloride	.18
Sodium	.39
Sodium iodide	Trace.
Aluminum phosphate	.11
Sulphuric acid (free)	.51
Silicic acid	1.60
Total	23.55

Carbonic acid gas, 5.20 cubic inches.

This water is distinguished by the not inconsiderable quantity of manganese which it contains. This remedy has been found valuable in certain female complaints, especially in functional amenorrhœa. In addition it contains a very large proportion of iron and alum, and a considerable amount of sulphate of magnesia. Taken altogether, it may be pronounced a very valuable mineral water, and will be found useful in a large class of cases requiring a local astringent, a general ferruginous tonic, or a uterine detergent. *James K. Crook.*

IRON, ORGANIC COMPOUNDS OF.—The following preparations are used to replace the inorganic salts of iron, as many believe that these organic combinations are better borne by the stomach and more certainly absorbed.

Carniferrin is the iron compound of phospho-carnic acid prepared from meat. It contains thirty per cent. of iron and is compatible with acids or alkalies. Dose 0.2–0.5 gm. (gr. iij.–viij).

Carniferrol is a liquid preparation of iron and meat peptone.

Ferratin is an artificial ferrated albuminic acid designed to represent the natural iron compound of the hog's liver. It contains about seven per cent. of iron and its dose is 0.3 to 1 gm. (gr. v.–xv.).

Ferratin-sodium is a soluble form of ferratin which may be added to milk or other liquid foods.

Ferratogen is an insoluble yellowish powder made as follows: yeast is grown on a medium containing iron, the nuclein thus formed being isolated and digested with gastric juice, then washed with alcohol containing hydrochloric acid. It represents one per cent. of iron and is said not to be affected by the gastric juice, and to be well absorbed in the intestine.

Ferrinol is an iron nucleid containing about six per cent. of iron.

Ferropyrin is an orange-colored powder made by acting on antipyrin with ferric chloride. It contains 64 per cent. of antipyrin and 12 per cent. of iron, is soluble in water and alcohol, and is said to have remarkable styptic properties without caustic effects. It is used in 20 per cent. to full strength as styptic in uterine and other hemorrhages, in 1- to 3-per-cent. solution as an astringent in gonorrhœa, and in dose of 0.3 to 1 gm. (gr. v.–xv.) internally for anæmia and chlorosis.

Ferrosol is a saccharated ferrous oxide with sodium chloride.

Fersan is an acid albumin obtained from blood corpuscles, and is a ferruginous nutritive containing a high percentage of phosphorus. It is said to rank high as a hæmatinic and as an albuminoid food. Dose 1 to 2 gm. (gr. xv.–xxx.) three times a day.

Hæmalbumin (*Dahmen*) contains hæmatin, hæmoglobulin, paraglobulin, serum albumin, and the inorganic constituents of blood.

Hæmaticum is a red-brown, clear hydroalcoholic liquid containing indifferent compounds of iron.

Hæmatogen (*Bunge*) is a nucleo-albuminoid preparation.

Hæmatogen (*Hommel*) is defibrinated blood from which the serum has been removed and a minute quantity of creosote added.

Hæmatogen (*Marfori*) is a soluble ferrated albuminic acid similar to ferratin and containing 0.7 per cent. of iron.

Hæmatol is a sterilized hæmoglobin containing glycerin and brandy.

Hæmogallol is an indifferent preparation of iron obtained by the reducing action of pyrogallol on the hæmoglobin of ox-blood. It is a red-brown powder the iron of which is not changed to chloride by the gastric juice. Dose 0.3 to 1 gm. (gr. v.–xv.).

Hæmol, a congener of hæmogallol, is obtained by the reduction of hæmoglobin with zinc dust. This substance has been combined with various metals forming:

Arseno-hæmol containing one per cent. of arsenous acid.

Bromo-hæmol containing 2.7 per cent. of bromine.

Copper-hæmol containing two per cent. of copper.

Hydrargyro-iodo-hæmol containing 12.35 per cent. of mercury and 28 per cent. of iodine.

Iodo-hæmol containing 16.6 per cent. of iodine.

Zinc-hæmol containing one per cent. of zinc.

Triferrin is a compound introduced by Salkowski, containing iron, phosphorus, and paranucleinic acid obtained from the casein of cow's milk. It contains about 2.5 per cent. of phosphorus and 22 per cent. of iron, is insoluble in acids (gastric juice) and soluble in solution of sodium bicarbonate. With doses of 0.3 gm. (gr. v.) three times a day, Klemperer had good results in twenty-one cases of anæmia.

Other organic iron preparations are the albuminate, peptonized albuminate, ammonium arseno-citrate, caseinate (nucleo-albuminate), dextrinate, glycero-phosphate, inulate, peptonate, and vitellinate (iron and egg yolk) of iron, iron and sodium albuminate and citro-albuminate, hæmatin-albumin, hæmochromogen, hæmoferrum, hæmoglobin, methæmoglobin, pepto-ferro-mangan, and ferrosomatose (two per cent. iron). *W. A. Bastedo.*

IRON, POISONING BY.—Metallic iron and those compounds of iron which are insoluble in water are not poisons. The soluble salts, however, though not active poisons, have an irritant action, and are capable of destroying life when taken in large doses and in a concentrated state. The continued administration of even medicinal doses produces, after a time, decided gastric disturbance. It is probable that all the soluble preparations may act as irritant poisons when administered in large doses. The most important, however, from a medico-legal point of view, are ferrous sulphate (copperas, green vitriol), ferric chloride (perchloride), which is used medicinally in the form of tincture, and the tannate in the form of ink.

The salts of iron are rarely administered for criminal purposes. Most of the reported cases of poisoning have been the result of accident, or of the use of the sulphate or the tincture of the chloride of iron in attempts at abortion. The symptoms which follow the administration of large doses of the preparations named are essentially similar to those produced by the irritants in general. There are a styptic taste in the mouth, nausea, vomiting, pain in the stomach and intestines, and purging. The evacuations are black, owing to the conversion of the iron salt into a tannate by the tannic acid of the food, or into a sulphide by the sulphureted hydrogen resulting from decomposition in the intestines. Irritation of the genito-urinary passages is sometimes observed. The tincture of the chloride of iron is more corrosive in its action than the sulphate, by reason, apparently, of the free hydrochloric acid which it frequently contains. Its injection into the cavities of the body, for the purpose of arresting hemorrhage, has proved fatal.

The amount of any of the preparations of iron required to endanger life is not accurately known, but appears to be quite large. In most of the cases in which the sulphate has been taken the amount was unknown. Recovery has taken place after a dose of 31 gm. (℥ i.) of the sulphate (Christison). A case is reported in which 48 gm. (℥ iss.) of the tincture of the chloride of iron proved fatal in about five weeks (Christison). Recovery has taken place after doses of 32 to 96 gm. of this preparation. The favorable issue is probably due, in many cases, to the early occurrence of vomiting.

The results of experiments on animals are not uniform. Gmelin states that 7.7 gm. (℥ ij.) of the sulphate of iron administered to dogs by the mouth caused vomiting only; that 2.6 gm. (gr. xl.) administered to rabbits produced no injury; and that 1.3 gm. (gr. xx.) injected into the veins of a dog produced no symptom whatever. Dr. Smith, however, states that 7.7 gm. will prove fatal to dogs when administered by the mouth or applied to a wound.

The post-mortem appearances are those of a simple irritant, and are confined, so far as has been observed, to the stomach and upper part of the intestines. In acute cases the contents of the intestines will probably present a black appearance, owing to the presence of the tannate or the sulphide of iron.

Iron is eliminated to some extent in the urine. A small amount only is absorbed in any event, the greater part escaping in an insoluble form with the fæces.

Treatment consists in the use of the stomach pump, or of emetics, if necessary. Magnesia or dilute solutions of alkaline carbonates should be administered as antidotes, and these should be followed by demulcents.

William B. Hills.

IRRADIATION is the diffusion or, as one might say, "the overflowing" of the nerve impulse over the boundaries of the pathway within which it usually travels.

If a local cardiac condition gives rise to pain not only in the region of the heart but also in the arm, the latter pain is an irradiated one, belonging as it does to quite another territory than that supplied by the nerves of the heart. This irradiation of visceral pains into cutaneous areas follows definite laws which have been laid down by Head in his classical researches on this subject.

But a pain may irradiate not only from a visceral or sympathetic to a cutaneous or other cerebro-spinal nerve territory; it may also irradiate from one nerve to the other or from one branch of a nerve to the other *within* the cerebro-spinal system. For instance, pain arising from a partial lesion of the second branch of the fifth nerve (toothache) may spread not only over the entire second branch, but even over the third branch of that nerve. A pain may also irradiate from one side to a (usually symmetrical) point on the other side of the body.

While it has thus been customary to apply the term irradiation to conscious sensory impressions, which need not necessarily be painful, there is no reason why it should not be applied to motor and reflex innervation as well, the physiological process and its anatomical basis being probably the same. For instance, if tapping of the patellar tendon which normally causes a contraction only of the quadriceps muscle of the same side, produces also muscular contractions in the other lower extremity, as is the case in many organic cerebral and particularly spinal lesions, we certainly have the right to speak of it as irradiation.

Similarly the associated movements often accompanying motor acts, for instance, movements of the jaw accompanying the act of cutting with scissors or of cracking nuts, should also be classed under the heading of irradiation.

The small space allotted to this article does not allow us to enter on the mechanism of irradiation further than to say that it must take place at the points of passage from one neuron to another, the multiplicity of connections of each neuron giving a wide range of possibilities in this direction, especially if it is considered that in every case a chain of at least two neurons must be passed before the stimulus reaches its final destiny.

B. Onuf (Onufrowicz).

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IRRITABILITY.—Irritability may be defined as the quality possessed by living tissues, animal as well as vegetable, of reacting toward stimuli* with manifest dynamic changes. These changes† may become apparent directly or indirectly, in the form of muscular contraction, glandular function, sensory perception, amœboid movements, flagellate movements, or streaming of protoplasm, or in other ways.

The dynamic changes produced by the stimulation may manifest themselves in the stimulated tissue itself or be inferred indirectly by the effects upon other tissue. For example, the dynamic alterations wrought by stimulation of a motor nerve may find an indirect expression in the form of a muscular contraction; but their presence in the nerve may be demonstrated also directly by the so-called "current of action" or "negative variation," produced in the nerve by the stimulation, and demonstrable with a galvanometer.

This latter direct method is the more accurate one, giving a truer measure of the irritability of the stimulated

* A definition of *stimulus* is given in a later section of this article.

† The nature of these changes in the case of the nerve protoplasm has been made a subject of special study by A. F. Mathews, the result of whose researches was published in the New York Sun. He concludes that "nerve protoplasm" is stimulated (*i.e.*, excited) by the passage of colloidal particles from a condition of solution to that of gelatination. The irritability of a nerve is diminished whenever the solution of the colloids is rendered more permanent. It increases as the nerve approaches the state of gelatination.