ing the existence of reducing division in plants appears to have been removed. Moreover, the similarity is so close at this stage that many of the figures drawn by Strasburger, Miss Sargant, and Schniewind-Thies to illustrate forms of chromosomes in plants might be substituted for some of Paulmier's or Montgomery's figures, representing corresponding stages, with very little change.

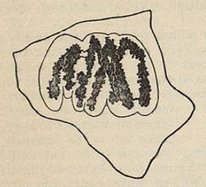

FIG. 3938.—Primary Spermatocyte of Lubber Grasshopper in Synapsis (telophase of spermatogonium). Only a few of the chromosomes are shown. (After Sutton.)

Synapsis, Reduction, and Heredity.—As stated in the introduction, the conception "reducing division" had its origin in an attempt to satisfy the requirements of a theory of heredity. The conception has very recently gained new interest and importance through an announcement made by E. B. Wilson (1902) and the publication of preliminary papers by Sutton and Cannon. It was found by Montgomery that in certain species of bugs the spermatogonia contain a pair of chromosomes that are unusually large or otherwise peculiar, and that after the synapsis in these cases there is only one large chromosome. Evidently the two peculiar ones have united. As a result of the maturation divisions each spermatid likewise contains one peculiar chromosome. The same is probably true of the egg. So one of these bodies in the spermatogonium is probably of paternal and the other of maternal origin. For this and other reasons Montgomery reaches the important conclusion that during the synapsis each bivalent chromosome formed is half of paternal and half of maternal origin, and the subsequent reducing division results in the separation of homologous paternal and maternal elements and their final isolation in separate germ cells. Now, as announced by Wilson, W. S. Sutton has found in the study of the spermatogenesis of a grasshopper, Brachystola, nearly complete proof of this inference, and W. A. Cannon has come to the same conclusion from the study of the maturation divisions of hybrid cotton plants. The chief results of Sutton's work are illustrated by Figs. 3936 to 3941. The last generation of spermatogonia have lobed nuclei, and each chromosome is formed in a separate diverticulum (Fig. 3936). In the late prophase of division the chromosomes are seen to be of different sizes, and there is one pair of each size, as *i*, *j*, *k*, Fig. 3937. In the following synapsis stage the chromosomes are seen to unite in pairs by their ends (Fig. 3938) and in the subsequent prophase there are eleven bivalent chromosomes, *a*, *b*, *c* . . . *k*, Figs. 3939 and 3940, corresponding to the pairs in the spermatogonium. The second maturation division is a true reducing division (Fig. 3941). If the oögenesis is the same, and the individuality of the chromosomes is maintained throughout the germinal cycle, then, of the two chromosomes that unite in synapsis, one must be of paternal and the other of maternal origin.

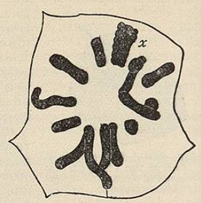

FIG. 3941.—Polar View of Equatorial Plate of Secondary Spermatocyte, showing eleven chromosomes and the accessory, *x*. (After Sutton.)

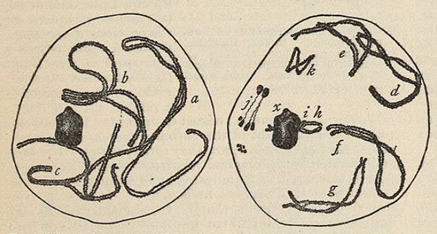

FIG. 3939.—Spiremes, or Chromosomes, from a Primary Spermatocyte in Early Prophase. Drawn in two groups to avoid confusion. From a smear preparation. (After Sutton.)

FIG. 3940.—Chromosomes from Primary Spermatocyte in Middle Prophase, showing Longitudinal Split. *a*, *b*, *c*, etc., same as in Fig. 3939. (After Sutton.)

It was discovered recently by Boveri, that when the chromosomes in the segmenting ovum of a sea urchin have become disarranged as the result of double fertilization, and consequently unequally distributed to the blastomeres, abnormal larvæ result. He inferred from this that the chromosomes differ qualitatively and stand in definite relation to inheritable characters.

Taking all these results together, Wilson points out that they seem to confirm and to show a physical basis for Mendel's principle of heredity, which is being much discussed at present (see *Reversion*). Whether Mendel's theory be true or not, it is certain, as was shown in the article dealing with heredity, that it is in the nucleus of the germ cells, and especially in their chromatin constituents, that we must look to find the physical basis for heredity, and therefore the changes which these constituents undergo in the course of sexual reproduction possess the deepest interest for all students of biology.

Robert Payne Bigelow.

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REEDY CREEK SPRINGS.—Marion County, South Carolina. POST-OFFICE.—Latta. Hotel and cottages.

This resort is located about three-quarters of a mile from the Atlantic Coast Line Railroad. The surrounding country is level and covered by the long-leafed pine. The springs are three in number, and have had a local reputation for more than thirty years. The water has a constant temperature of 45° F., and its flow is very large. Mr. John L. Dew, of the springs, sends us the following list of ingredients resulting from a partial analysis by former State Chemist Chizzell: Iron carbonate, calcium, magnesium, and sulphur. The water is used more particularly for stomach, liver, and kidney disorders and debilitated states of the system. *James K. Crook.*

REFLEX ACTIONS OR REFLEXES. See *Knee-Jerk*.

REFLEXES. (CLINICAL.)—Descartes introduced the conception of reflexes into biological literature. In "Passions de l'âme" he stated that stimulation of a sensory nerve impulse may be transmitted through the brain to motor nerves and thereby give rise to contraction of muscles, and that this contraction takes place without volition, and even contrary to it. The general reflex centre he believed to be the glandula pinealis.

This definition of reflexes was correct in the early days of biology, but, with the advance of knowledge, our conception of the reflexes has been enlarged.

The term is used in medical literature to-day in a twofold sense:

1. *Specifically*, as in pupillary, knee, plantar reflexes, etc.

2. *Generically*, as in reflex neurosis, reflex spasms, reflex cough, etc.

In both the strict sense (pupillary and knee reflexes, etc.) and in the broader sense (reflex cough, reflex neurosis, etc.) reflexes are centrifugal phenomena produced by reflexion and eventual transmutation of centripetal stimulation. In other words, reflexes are physiological or pathological, motor, vaso-motor, viscero-motor, secretory or trophic phenomena, the cause of which is to be found in sensory stimulation.

There is still another group of phenomena called "reflex," to which the foregoing definition does not apply. This group is represented by a set of *centripetal* phenomena—reflex pains, reflex neuralgias, etc. Investigation shows that these phenomena are not genuine reflexes. One group of them, for instance pain in the distribution of the fifth nerve due to disease of the teeth or other structures of the head, or arm pain accompanying an anginoid attack, is, according to Head, an irradiation of a sensory stimulus to other parts or branches of the peripheral sensory apparatus of the affected locality.

Another group, for instance headache due to disease of the abdominal viscera, is, according to the same author, due to irradiations of the sensory stimulation to a central sensory station, and from here to allied sensory structures. Thus the difference between the two types becomes quite apparent.

The genuine reflex phenomena consist of neural stimulation that is reflected from one set of neurones (centripetal neurones) to a physiologically different set of neurones (centrifugal neurones).

The other type consists of neural stimulation that is irradiated and propagated from one set of neurones (centripetal) to another physiologically homologous set (centripetal neurones).

Finally, the term reflex is used promiscuously in medical literature to denote a phenomenon, the cause of which operates at some distance from where its effects are manifest.

According to the conception of genuine reflexes outlined above, all organic functions, save perhaps the distinctly voluntary functions, and some automatic visceral functions, may be looked upon as reflexes. Whether this be fully so or not, we will not attempt to decide. The considerable interest bestowed upon these phenomena, since the times of Descartes, testifies to the great importance of reflexes. (For further details in regard to these, consult the article on *Knee-Jerk* in Vol. V.)

In 1875 Erb and Westphal, working independently, demonstrated the clinical value of reflex phenomena, and since then their importance is daily more appreciated.

Prior to the publications of Erb and Westphal reflexes were observed and registered at the bedside in Charcot's Clinic. Charcot apparently divined their importance, but he had not yet appreciated their clinical significance.

Abundant clinical, experimental, and histological facts have been collected for the proper theoretical interpretation of reflex phenomena. However, a unanimity of opinion has not yet been reached. Some accept the original teachings of Erb, who interpreted reflexes, particularly tendon reflexes, as true reflexes; others adhere to Westphal's teaching, who believed that they were not true reflexes, but phenomena dependent upon the muscle tonus. Gowers calls the tendon reflexes myotatic phenomena, and his conception is akin to that of Westphal.

We shall not consider here the evidence which tends to substantiate either of these theoretical views. Here the theoretical basis of the reflex phenomena will be discussed only in so far as is necessary for a proper and intelligent interpretation of these phenomena at the bedside. The best-known and most studied of all reflexes are the tendon reflexes, and their classical representative is the knee-jerk.

The subsequent remarks apply to tendon reflexes in general, and to the knee-jerk in particular.

A reflex is a neural phenomenon which originates in a sensory end organ, travels along a centripetal pathway, passes a ganglionic station, and leaves it changed or unchanged in quality or quantity, and pursues its way outward on a centrifugal pathway to a centrifugal end organ. The anatomical structure subserving this consists of: A sensory end organ, a peripheral sensory fibre, a ganglion cell, a peripheral motor fibre, a motor end-organ—in other words, a sensory and a motor neurone of the peripheral kind.

This anatomical structure is called a reflex arc. The primary reflex arc is under the influence of one or more secondary arcs, which are represented by an analogous arrangement of secondary neurones.

The centrifugal branch of one of the supposed secondary arcs is represented by the fibres of the pyramidal tracts. The centripetal partner and the central connection of the two are not fully known. The former is probably found in the ascending cerebral and cerebellar tracts, and the central station is probably situated in the gray matter of the cerebrum and cerebellum, and in the nuclei and gray matter of the mesencephalon. The tendon phenomena are accompanied by conscious sensation. Whether this sensation is carried up along the centripetal pathways above mentioned or not is not known. Usually, when a reflex arc is spoken of, only the strict neural elements are understood to represent it, while the sensory and motor-end-organs are not included. The ganglionic stations are spoken of as reflex centres. In addition a reflex arc is under the modifying influence of individual segments of the spinal cord above it.

In the lowest forms of life the anatomical substratum of most reflexes is represented by one reflex arc only. This is the case also in some of the simpler forms of reflexes.

All that has been said thus far applies particularly to the tendon phenomena. For other reflexes, skin reflexes, visceral reflexes, etc., analogous anatomical structures are supposed to exist. Their exact location and connections are fully known in some instances, not entirely in others, while in still others they are altogether hypothetical.

Reflex centres are constituted either by the gray matter of the cerebro-spinal axis, or by the gray matter of the sympathetic (visceral) system. The afferent and efferent pathways are either exclusively cerebrospinal, or exclusively sympathetic (visceral) or mixed.

It is believed that a reflex arc is constantly traversed by neural energy which establishes in this arc a sort of functional equilibrium. Under normal conditions this equilibrium is altered in consequence of changes in the secondary reflex arcs, and this results in voluntary action or reflex action. Within physiological limits a variety of general and local causes, acting on all or some parts of the reflex arcs, will greatly modify reflex activity. This will be still more so in the domain of pathology.

It is thus seen that the semeiological value of reflexes is not exclusively reserved for neuropathology. Diagnostic and particularly prognostic aid is occasionally received from a study of reflex phenomena in general diseases. Attention has lately been drawn to this fact by Pfaundler and Luethye in their investigations on the behavior of reflexes in pneumonia and other acute infectious diseases (*Münch. med. Wochenschrift*, July, August, 1902).

The systematic study of reflexes in neuro-visceral diseases will probably yield valuable information.

The theoretical controversy about the nature of reflexes is exclusively concerned with tendon reflexes and hinges upon the question of the interrelation and interdependence of tendon phenomena and so-called muscle tonus. The nature of all other reflexes (skin and visceral) is apparently undisputed; they are believed to be genuine reflexes.

According to Jendrassik reflexes investigated at the bedside may be divided into three categories, according to the supposed situation of their centres.

1. *Spinal:* Tendon, muscle, periosteum, bone reflexes, jaw-jerk.

2. *Cerebral* (cortical) cutaneous reflexes: Scapular, abdominal, cremasteric, scrotal, gluteal, plantar, palpebral, conjunctival, pharyngeal, anal.

3. *Visceral* (sympathetic): Sneezing, swallowing, vomiting, coughing, erection, ejaculation, etc.

The first group, also called physiological spinal reflexes, is characterized by the following points:

(1) The reflex is elicited from moderately sensitive areas.
(2) The reflex movement is usually not accompanied by specific sensation.
(3) The exciting stimulus is a simple mechanical irritation.
(4) The intensity of the reflex movement is not so variable as in the second group.
(5) It can be elicited on one's self as well as on others.
(6) The period of latency is the shortest.
(7) The reflex movement is a simple twitch and is apparently not adapted to certain ends.
(8) Muscular exertion increases this reflex.
(9) In diseases of the brain (after a certain time) these reflexes are increased.
(10) Delay is not observed.
(11) Mental influences are of little effect. Distraction of attention makes the demonstration easier.

Reflexes of the second group are characterized by the following points:

(1) The elicitation of the reflexes takes place from very sensitive localities.
(2) The reflex is accompanied by sensation.
(3) The exciting stimulus must be of sufficient duration to produce a distinct sensation.
(4) The intensity of the exciting stimulus is not always proportionate to the result. Individual variations are great.
(5) These reflexes can be elicited on one's self only with great difficulty.
(6) The period of latency is longer than in the first group and not as constant. The period of latency is proportionate to the speed of the sensory conduction.
(7) The resulting movement is more complicated and seems to have the purpose of removing the irritated parts from the source of irritation.
(8) Increased muscular activity frequently diminishes these reflexes.
(9) These reflexes are diminished or absent in cerebral lesions.
(10) They are delayed in appearance when the sensory conduction is delayed.
(11) Mental influences increase or diminish these reflexes. Distraction of attention frequently diminishes them.

Reflexes of the third group are characterized by the following points:

(1) These reflexes are elicited from sensitive points.
(2) They are accompanied by specific sensation. The sensation here is of greater importance than in the reflexes of the second group.
(3) The time for the necessary stimulation is here the longest.
(4) These reflexes have great individual variations.
(5) They are elicitable on one's self, but depend upon specific stimulation.
(6) The time of latency is the longest.
(7) The resulting movement is very complicated—bilateral.
(8) Muscular exertion diminishes these reflexes.
(9) In cerebral lesions they are increased or diminished.
(10) Mental influences are of great importance.

Dejerine divides reflexes, according to the nature of the peripheral parts of the reflex arc, into four groups:

1. Reflexes, the centripetal and centrifugal branches of whose arc are represented by cerebrospinal fibres: tendon reflexes, cutaneous reflexes, reflexes of deglutition.

2. Reflexes, the centripetal branch of whose arc is a cerebrospinal fibre, and the centrifugal branch a sympathetic (visceral) fibre: salivation, blushing, intestinal contraction, pain reaction of the iris.

3. Reflexes, the centripetal branch of whose arc is a sympathetic (visceral) fibre, and the centrifugal branch a cerebrospinal fibre. This group is represented mostly by pathological reflexes: reflex phenomena due to irritation or disease of the abdominal viscera.

4. A group which logically would be presented by reflexes, the centripetal and centrifugal branches of whose arc are built up of sympathetic or visceral fibres. Physiological: secretion of digestive juices. Pathological: Visceral congestion, redness or pallor of the skin in consequence of hepatic colic, etc.

In Dejerine's original article,* however, this last-named group is thus characterized:

4. In the last group can be placed the reflex acts whose paths of conduction do not arise from the sympathetic system. Physiological: The secretion of intestinal juices in the course of digestion. Pathological: The phenomena of visceral congestion, blushing, pallor, coldness of the skin produced by organic affections (colics, etc.).

For the clinical understanding of the tendon phenomena, Sherrington's classification seems helpful. He believes that one ought to distinguish under the name of tendon reflexes two different varieties of phenomena:

1. True spinal and cerebrospinal reflexes, excited by stimuli applied to the tendons.

2. Peudo-reflexes, commonly called tendon phenomena or tendon concussions.

The true tendon reflexes have no considerable clinical importance. The pseudo-reflexes are not genuine reflexes because: (1) The time occupied for their production is very short. (2) The muscular contraction is a simple twitch and not prolonged or tetanic; therefore the knee phenomenon is not a true spinal reflex, but a direct response of the muscle to a sudden mechanical tension. Only when the muscle is in connection with its neural supply can this response be obtained. For the production of the knee phenomenon the tonus of the muscle is indispensable.

* Ch. Bouchard: "Semeiologie des Reflexes." "Traité de Pathologie générale," tome v., p. 999, 1901.

The number of reflexes so far described is quite considerable. Additions are constantly being made, and the future will undoubtedly bring more. Only a few of this large number have general clinical importance. The others gain in importance and prove useful and reliable guides in segmental and topical diagnosis, in proportion to their anatomical elucidation.

The following reflexes are among the older and better known:

A. *Superficial Reflexes:* Palpebral, corneal, conjunctival, pharyngeal, interscapular, epigastric; upper, lower, middle abdominal; cremasteric, scrotal, anal, gluteal, lumbar, pilomotor or goose-skin reflex.

B. *Deep or Tendon Reflexes:* Patellar, Achilles, triceps or olecranon, biceps, ulnar, radial, masseter or jaw-jerk.

C. *Visceral Reflexes:* Pupillary, bladder, rectal, sexual.

Some of the newest reflexes are: The lumbo-femoral of Bechterew, the infraspinatus of Steiner, the supra-orbital of McCarthy.

The exciting stimulus necessary for the production of a reflex varies in quality and quantity. The pupillary reflexes respond to specific irritation of the optic nerve—photic stimuli. The superficial reflexes are evoked by stimulation of the tactile or algetic senses. The tendon reflexes are the result of mechanical stimulation of the tendon. Under certain conditions mechanical stimulation of the adjacent structures (periosteum, bone, articulatory surface) yields a reflex contraction.

The sensory (tactile or algetic) stimulation of the skin around the knee occasionally gives rise to a contraction of the quadriceps muscle. This is not a genuine tendon phenomenon, but is known under the name of pseudo-knee-jerk, and has been described by Wespthal, with a note of warning to keep this phenomenon distinct from the genuine tendon jerk. The pseudo-knee phenomenon may be observed even when the genuine knee-jerk is absent.

The intensity of the sensory stimulation necessary for the production of a reflex has an upper and lower limit of efficacy. Below a certain limit of irritation the reflex phenomenon dependent upon this irritation naturally does not ensue. Equally disturbed is the reflex response in its clearness, or it is even entirely frustrated when the sensory stimulus is above a certain limit of intensity. Therefore the intensity of the sensory stimulus may be looked upon as an index of the reflex activity of the centres or arcs, which vary considerably within physiological limits. The intensity and extensity of the reflex response are also quite variable. The muscular contraction is sometimes vigorous, quick and lightning-like, at other times sluggish and less active. When the reflex response is considerably exaggerated, the irritation is followed by a succession of contractions, known as clonus (patellar clonus, ankle clonus, wrist clonus). In a still higher degree of increased reflex irritability, this clonic response spreads over wide territories, and is then called "epilepsie spinale."

Under certain conditions the muscular contraction is limited to one muscle only, and at other times it spreads to neighboring muscles, or even to homologous muscles of the opposite side of the body. Furthermore, a cumulative quality of the sensory stimulation is occasionally observed. A reflex occurring at times from one stimulation will need at other times a repeated stimulation for its production. Sometimes the reflex response shows a peculiar exhaustibility. This is seen when the same stimulation is followed at one time by a normal contraction, at another by a much weaker one or by none at all. Another expression of the same tendency is to be seen when a reflex that responds to a stimulus becomes exhausted after frequent stimulation, then reappears again after a short interval of rest. These variations when occurring under the same conditions of stimulation also permit the inference as to the state of the reflex activity of the centres or arcs. At the same time these variations of the reflex response may be profitably kept distinct from the variations of the response depending upon the intensity of the stimulation. The latter may be designated as variations of the reflex irritability, and the former as variations of reflex mobility.

Frequently the attempt has been made to express the described variations of the sensory stimulation and motor response of the reflex phenomena in more exact terms. Apparatuses have been devised for the purpose of measuring the one as well as the other; these investigations have aided the physiological conception of reflexes; but clinically they have not been of much value.

If all of the foregoing be borne in mind, the following propositions will be self-evident:

Reflexes are Increased.—1. When the sensory end apparatus, or the centripetal fibre, or the centrifugal fibre, or the primary reflex centre, is in a more or less marked state of irritation.

2. When the inhibitory influence of the secondary reflex arc is diminished or paralyzed.

Reflexes are Diminished or Absent.—1. When the sensory end-apparatus, or the centripetal fibre, or the centrifugal fibre, or the primary reflex centre, is in a state of more or less marked paresis or paralysis.

2. When the stimulating influence of the secondary reflex arc is diminished or paralyzed.

Lastly, reflexes will be increased or diminished according to the increase or diminution of the exciting stimulus.

There are a maximum and a minimum of conditions favorable to the elicitation and demonstration of reflexes. For the pupillary reflexes it is necessary that the difference between the stimulations (light and dark) be quite marked. The skin and tendon reflexes are considerably impeded by the will and by concentrated attention; the skin reflexes less so than the tendon reflexes. Difficulties encountered clinically in the demonstration of pupillary reflexes are obviated by examining the patient in a dark room, with artificial light, and by taking care that accommodation is excluded.

In the case of skin and tendon reflexes, various means have been devised for distracting the patient's attention during the examination. To obviate these difficulties recourse is had to what is commonly called the method of reinforcement, or the Jendrassik method. This consists of the following: The patient is directed to link his hands into each other and then to attempt to pull the hands forcibly apart. Care must be taken that the tap of the tendon is synchronous with the greatest effort of the patient.

A characteristic and peculiar degree of muscular contraction is indispensable for the demonstration of tendon reflexes. A muscle contracted above a certain limit is incapable of expressing an additional contraction, and a muscle relaxed beyond a certain limit is also irresponsive to reflex stimulation. Finally it is not to be forgotten that recent or previous disease of the structures around the knee- or ankle-joint is carefully to be excluded.

It should not be said that a reflex is absent unless the examination has been made with the above-mentioned precautions.

At the end of this article will be found a list of all reflexes with their respective anatomical locations and constituents, and their clinical significance.

It remains only to discuss in detail the most important reflexes: the pupillary phenomena, the knee-jerk, the Achilles jerk, and the plantar reflex.

Pupillary Phenomena.

The following points are noted in the examination of pupillary phenomena:

1. The size of the pupils.
2. Their shape and outline.
3. The light reactions (direct and consensual).
4. The accommodative and convergence reactions.
5. The pain reaction.

Recent or previous disease of the structures of the eyeball (cornea and iris, anterior chamber, etc.) must be carefully excluded before any conclusions are drawn. Under average physiological conditions both pupils are of medium dilatation and equal when exposed to diffused daylight. Inequality of the pupils (anisocoria) is, as a rule,

pathological. Exceptions to this rule are few and not fully understood. Very wide pupils (mydriasis) are sometimes within physiological limits, but are most often observed in sensitive neurotic subjects. Very small pupils (myosis) are more often pathological than the preceding. It is not to be forgotten that drugs are occasionally the cause of the mentioned states of the pupils (belladonna, opiates).

Normally the outline of the pupil is circular, and the free border smooth. Serrations of outline and imperfections of the circle are significant. As a rule this denotes previous syphilitic infection.

The direct reaction consists of dilatation of the pupil when light is shut out, and of contraction of the pupil when light is admitted.

To ascertain this reaction, the patient is directed not to accommodate for any near object, and both pupils are alternately exposed to and protected from the light, and the result is watched. This reaction, "reaction to light," is never absent in health.

When the light reaction does not ensue, and care has been taken to avoid the mentioned possibilities of error, the pupils are said to be "stiff." This constitutes the Argyll-Robertson phenomenon.

The consensual reaction consists of contraction or dilatation of the pupil of the opposite side, following the admission or exclusion of light from the other pupil. This is best examined for as follows: The pupil is watched while the lid of the other eye is raised or lowered. This reaction is rarely disturbed alone. It is seen sometimes in conjunction with other disturbances of the pupillary play.

The accommodation reaction consists of contraction of the pupil on fixation of near objects and of dilatation of the pupil when looking into the distance.

The convergence reaction is a contraction of the pupil on convergence of the eyeballs (simultaneous innervation of both internal recti).

The pain reaction consists of a dilatation of the pupil upon painful stimulation of face or neck, or sometimes upon painful stimulation of any part of the body.

The hemiopic pupillary reaction of Wernicke is a rare pupillary phenomenon. It occurs in cases of hemianopsia, central or peripheral.

Light reaction occurs only on stimulation of the sensitive half of the retina, and does not ensue when the nonsensitive half is irritated. It is best demonstrated when one-half of the pupil is protected by a small shield and the other is alternately stimulated by admission and exclusion of light.

Occasionally one finds in literature the term paradoxical pupillary reaction. The reaction is said to be paradoxical when the pupil dilates on admission and contracts on exclusion of light.

Sluggish and lively pupillary reactions are likewise spoken of. These depend of course upon the speed with which, and extent to which, reactions take place.

Lastly a phenomenon has been described by Strasburger and Saenger (*Neurol. Centralbl.*, 1902) under the name of myotonic pupillary reaction. They mean reactions that occur in such a way that the iris remains for a short time in dilatation or contraction, as the case may be, before changing.

Pupillary reactions have also been observed as a type of associated movements coincident with looking upward or upon forcible closure of the eyes.

It has further been stated, by good authority, that even the mere suggestion of light and dark, for instance to totally blind people, is sometimes followed by the corresponding pupillary reaction.

A state of unrest and constant change of width of pupil has also been noticed at times, and been given the name of hippus.

Knee-Jerk.

The knee-jerk (knee kick, knee reflex, patellar reflex, knee phenomenon, Erb or Westphal phenomenon) is the name given to a contraction of the quadriceps femoris, that follows a blow upon the patellar tendon. The contraction is more marked in the internal division of the muscle (vastus internus). The knee-jerk is rarely absent in health.

In order to demonstrate this phenomenon, it is necessary, as was explained before, to prevent inhibition on the part of the patient.

The knee phenomenon is elicited in the following way:

1. The knee is allowed to swing freely on the examiner's hand, or the foot is put flatly upon the floor, so that the leg and thigh form a slightly obtuse angle, or one leg is crossed upon the other, and the leg is allowed to swing freely.

2. A sharp tap is made upon the patellar tendon with the tips of the fingers, with the ulnar border of the hand, with a percussion hammer, or with any other suitable instrument. Thereupon a contraction of the quadriceps muscle ensues, more or less quick and vigorous. This contraction can frequently be seen and felt, and it gives rise to a more or less marked excursion of the leg. This reflex varies quite considerably within physiological and pathological limits. These variations are designated by the names of normal, lively, increased, diminished, exaggerated, etc. In states of exaggeration, a reflex response is elicited not only upon mechanical stimulation of the tendon, but also upon irritation of a wider area around the knee and the upper part of the tibia. In states of diminution of the reflex response, the reflexogenic zone is considerably narrowed, and the reflex response is more liable to occur upon stimulation of the median than upon stimulation of the lateral half of the patellar tendon.

Evidence of greater exaggeration of the knee reflex is patellar clonus. This is demonstrated in the following way:

The lower extremity is slightly hyperextended and the patella is pushed quickly downward, and percussed or tapped in this position. A sharp clonic contraction is the result. Sometimes the reflex contraction is not limited to the quadriceps muscle alone, but is observed in the adductor group of muscles of the same side, or occasionally of the opposite side of the body. Rarely the contraction occurs even in the quadriceps muscle of the other side. The latter phenomena are called crossed adductor and crossed knee-jerk respectively.

Direct mechanical stimulation of the belly of the muscle is also followed by contraction of the muscle. This is, however, the expression of the so-called mechanical muscular irritability, and reveals itself clinically in two forms:

1. The contraction is fascicular and limited to the site of the irritation.

2. The entire muscle contracts.

This last-named contraction is not to be confounded with the true knee reflex. It is frequently found, for instance, in cases of tabes, in which the reflex is absent.

The occurrence of a pseudo-knee phenomenon—a contraction of the quadriceps upon algetic stimulation of the skin around the knee—has been mentioned above.

Achilles Jerk.

The Achilles jerk consists of a contraction of the calf muscles upon tapping of the Achilles tendon. This reflex is examined for in the following way:

1. The foot is slightly dorsiflexed, the knee is slightly flexed, and the Achilles tendon is tapped. A plantar flexion of the foot ensues.

2. The lower extremity is slightly flexed at hip and totally flexed at knee, and in this position the entire leg rests on a chair while the foot is free. In this position the Achilles tendon is tapped, and a plantar flexion of the foot is the result.

When this reflex is exaggerated, a forced dorsiflexion of the foot is followed by a succession of contractions. This is called the ankle clonus. This clonic contraction keeps up as long as the dorsiflexion of the foot is maintained. At other times it soon ceases and may or may not reappear. The ankle clonus which is difficult to demonstrate, and in which the clonic contractions are not vigorous and are easily exhaustible, are sometimes spoken of as pseudo-ankle clonus.

Sometimes difficulties are encountered in the demonstration of ankle clonus, and then it is well to use the following procedure: Bend the lower extremity slightly at hip- and knee-joints; exert sharp dorsiflexion of the foot, and in addition tap repeatedly the Achilles tendon.

The pseudo-ankle clonus is very rarely evidence of organic disease, although undoubtedly cases of disease of the pyramidal tracts occur in which the ankle clonus is of a pseudo type.

On the other hand, the genuine ankle clonus which is expressed by vigorous clonic contractions, which persist as long as the dorsiflexion of the foot is kept up, is usually, though not always, evidence of organic disease.

The question of the occurrence of genuine ankle clonus in hysteria is not fully decided. There are undoubtedly a few cases of hysteria with marked ankle clonus on record.

Care should be taken not to confound the genuine Achilles reflex with the expression of the mechanical irritation of the muscle. The Achilles reflex is rarely, if ever, absent in health, although it is not believed to be as constant as the knee-jerk.

Plantar Reflex.

The plantar reflex is the most constant representative of the skin reflexes. It consists of a sequence of contractions of a variety of muscles of the lower extremities, following tactile or algetic stimulation of the sole of the foot.

For the production of the reflex, the median half of the sole is more sensitive than the lateral half. Under normal conditions, and under mild stimulation, the muscles most frequently seen to contract are the tensor fasciæ and the plantar flexors of toes and foot.

In states of increased reflex excitability the whole foot is dorsiflexed, and in a still higher degree the entire lower extremity is removed from the source of irritation.

The same takes place when the exciting stimulus is stronger or frequently repeated in succession.

Reflexes.	Neural Mechanism.			Demonstration.	Remarks.
	Afferent.	Efferent.	Centre.		
Corneal and conjunctival.	Fifth nerve.....	Seventh nerve...	Nucleus of seventh nerve.	Irritation of conjunctiva or cornea, followed by contraction of orbicularis oculi.	Diminished in Basedow disease. (Stollweg phenomenon.)
Pupillary (light)	Optic nerve.....	Oculomotor	Ciliary ganglion (?).	Alternately illuminating and shading the pupil.	Absent in tabes and general paresis.
Pain reaction of pupil.	Cerebral or spinal sensory nerves.	Cervical sympathetic fibres.	Cilio-spinal centre, fourth to seventh cervical	Painful stimulation of skin anywhere, particularly around neck, followed by dilatation of pupil.	Absent in diseases of cervical sympathetic.
Pharyngeal.....	Ninth nerve	Seventh nerve...	Nucleus of seventh nerve.	Tickling of palate, followed by contraction of velum.	Believed to be absent or diminished in hysteria.
Jaw-jerk (chin phenomenon).	Fifth nerve.....	Motor portion of fifth.	Motor nucleus of fifth.	Percussion of lower jaw, with mouth slightly opened, followed by contraction of masseters.	Inconstant in health. Exaggeration observed in disease of upper part of pyramidal tracts.
Mimetic reflex of face.	Nerves of special senses. Psychic stimuli.	Facial nerve.....	Thalamus opticus (?).	Laughing or crying on appropriate mental stimulation.	Absent in disease of thalamus. In exaggerated states, impulsive laughter and impulsive crying. In intracranial disease, particularly of basal ganglia.
Scapular.....	Sensory roots, fifth cervical to first dorsal.	Same motor roots	Anterior horns, seventh cervical to first dorsal.	Tactile or algetic stimulation of skin, along inner border of scapula. Adduction of scapula.	Absent in disease at this level. Inconstant.
Palmar	Sensory nerves, seventh cervical to first dorsal.	Motor nerves, seventh cervical to first dorsal.	Anterior horns, seventh cervical to first dorsal.	Tickling of palmar surface of hand, followed by closure of hand.	Very inconstant.
Epigastric	Sensory nerves, fourth to seventh dorsal.	Motor nerves, fourth to seventh dorsal.	Anterior horns, fourth to seventh dorsal.	Tactile or algetic stimulation of upper abdomen. Contraction of abdominal muscles.	Absent in disease of this level of the cord. Diminished or absent on one side in disease of contralateral cerebral hemisphere.
Abdominal	Sensory nerves, seventh to eleventh dorsal.	Motor nerves, seventh to eleventh dorsal.	Anterior horns, seventh to eleventh dorsal.	Tactile or algetic stimulation of lower abdomen (below umbilicus). Contraction of abdominal muscles.	Absent in disease of this level of the cord. Diminished or absent on one side in disease of contralateral cerebral hemisphere.
Cremasteric	Sensory nerves, first to third lumbar.	Motor nerves, first to third lumbar.	Anterior horns, first to third lumbar.	Tactile or algetic stimulation of skin around inner and upper part of thigh, followed by pulling up of testicle.	Absent in disease of this level of the cord. Diminished or absent on one side, in disease of contralateral cerebral hemisphere. Not to be confounded with the tunica dartos reflex.
Gluteal	Sensory nerves, fourth to fifth lumbar.	Motor nerves, fourth to fifth lumbar.	Anterior horns, fourth to fifth lumbar.	Sensory or algetic stimulation of skin of buttocks. Contraction of glutei.	
Plantar.....	Sensory nerves, first to second sacral.	Motor nerves, first to second sacral.	Anterior horns, first to second sacral.	Tactile or algetic stimulation of sole of foot, followed by contraction of various muscles of lower extremities.	Babinski phenomenon.
Triceps	Sensory nerves, sixth cervical.	Motor nerves, sixth cervical.	Anterior horns, sixth cervical.	Relaxed and semiflexed upper extremity. Tapping of tendon of triceps. Contraction of triceps.	Inconstant. Exaggerated in disease of pyramidal tracts.
Biceps.....	Sensory nerves, sixth cervical.	Motor nerves, sixth cervical.	Anterior horns, sixth cervical.	Relaxed and semiflexed upper extremity. Tapping of tendon of biceps. Contraction of biceps.	Inconstant. Exaggerated in disease of pyramidal tracts.
Wrist-jerks	Sensory nerves, sixth to eighth cervical.	Motor nerves, sixth to eighth cervical.	Anterior horns, sixth to eighth cervical.	Tapping of ends of ulna or radius, followed by flexion or extension, respectively.	Inconstant. Exaggerated in disease of pyramidal tracts. Occasionally wrist clonus. Forcible dorsiflexion of hand followed by clonic palmar flexion.
Patellar reflex..	Sensory nerves, second to fourth lumbar.	Motor nerves, second to fourth lumbar.	Anterior horns, second to fourth lumbar.	Mechanical irritation of the patellar tendon followed by contraction of the quadriceps femoris.	
Achilles reflex..	Sensory nerves, third to fifth sacral.	Motor nerves, third to fifth sacral.	Anterior horns, third to fifth sacral.	Plantar flexion of foot upon tapping of Achilles tendon.	

The plantar reflex has lately been invested with considerable clinical importance through the investigations of Babinski. Under the name of Babinski phenomenon, or big toe phenomenon, the following variations of the plantar reflex have been described:

Upon stimulation of the sole of the foot, the big toe is dorsiflexed, and the other four toes are plantar-flexed. When this occurs slowly this is the typical Babinski phenomenon. It is believed to denote disease of the pyramidal tracts.

In children below two years of age, in whom the pyramidal tracts are not fully medullated, this variety of plantar reflex is normal.

While the typical *Babinski phenomenon*, as just described, is believed to be undisputed evidence of disease of the pyramidal tracts, with the mentioned exception in children, its absence does not prove that the pyramidal tracts are not diseased.

There are many combinations and changes of the Babinski phenomenon, and the significance of all of them is still under dispute.

At present it is best for clinical purposes to accept the following guide:

The Babinski phenomenon is positive, and the inference therefrom justified:

1. When upon stimulation of the sole of the foot there is dorsiflexion of the big toe and plantar flexion of the other toes.
2. When upon stimulation of the sole of the foot there is dorsiflexion of the big toe only.
3. When upon stimulation of the sole of the foot, there is dorsiflexion of all the toes.

The significance of the third variety is doubtful. All authorities do not agree that the Babinski phenomenon is always an indication of organic disease of the pyramidal tracts.

In examining for the plantar reflex, it is well to observe carefully the result of the first stimulation. After repeated stimulations, the patient's attention and conscious interference can never be fully excluded and a variety of cerebral reflexes occur which obscure considerably the interpretation of the result.

As a result and consequence of disturbed and changed reflex activity, a set of phenomena have received clinical study and attention. These phenomena are comprised under the name of associated movements and contractures. From among them the so-called Strümpell phenomenon is of clinical value, although limited.

The *Strümpell phenomenon* consists of the following:

When the patient is asked to flex the thigh upon the hip, and the leg upon the knee, there is an associated plantar flexion of the foot observed in cases of disease of the pyramidal tracts.

Under physiological conditions, or when there is no disease of the pyramidal tracts, the foot is dorsiflexed under the above-mentioned conditions. The so-called Kernig sign, which is believed to be pathognomonic of cerebro-spinal meningitis, also belongs to this group. The Kernig sign is an inability on the part of the patient to extend the leg when the thigh is flexed.

Contractures and muscular rigidity are frequent accompaniments of exaggeration of tendon reflexes; the exceptions to this rule are few.

The state of the reflexes has been of considerable value for diagnosis and correct anatomical interpretation of pathological motor phenomena.

The terms flaccid and spastic paralysis refer particularly to the state of the reflexes of the paralyzed muscles.

A flaccid paralysis is a more or less marked motor paralysis, with loss of reflex activity and diminution of the reflex tone.

A spastic paralysis is a more or less marked motor paralysis with increase of reflex activity, and increase of tonus.

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REFUSE DISPOSAL.—By this term is here meant the disposal of the waste matters of a city, town, village, or family, not including the sewage which is deposited in and escapes through the underground system of sewers. The items usually embraced in the term "refuse," as distinguished from "sewage," are the following:

Garbage or offal, consisting of the organic waste matter from kitchens; ashes; house dust; waste paper and rags; tin cans, crockery, bottles, and broken glass; street sweepings; night soil, or contents of vaults, cesspools, and pail systems.

Broadly speaking, the term refuse includes sewage, but since this form of waste product is usually disposed of by a distinct system of underground pipes managed by a board of sewer commissioners, the term refuse will here be limited to its usual significance, that of the material gathered periodically from houses, hotels, and streets, by a system of collection intended for this purpose. The municipal management necessary for conducting this class of work often constitutes a serious problem, in consequence of the liability of causing nuisance, either in

FIG. 3942.—Push-Cart Used for Collection of Street Sweepings. (From report of Street Department, Boston, 1900.)

the methods of storage, collection, and transportation, or in the final disposal of the material.

GARBAGE.—Garbage is usually defined as the waste products of food material. In addition to this, Chapin[1] enumerates, under the head of "refuse," such waste materials as glass, crockery, street sweepings, oyster and clam shells, sawdust, corkdust, old boots and shoes, dead

animals, lawn clippings, bottles, earthen, tin or iron ware, rubbish, tin cans, poisonous matter, excrement, urine, coal, and dirt. Dead animals and slaughterhouse refuse add value to garbage if it is to be made into fertilizers.

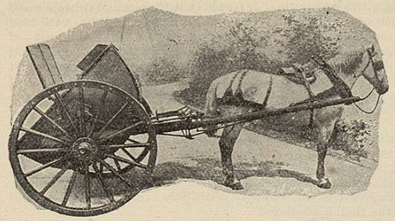

FIG. 3943.—Garbage Cart at an Angle for Washing or Easy Loading.

If the materials are sorted and such articles as tin cans, bones, and paper are selected out for utilization, then there is no objection to the deposit of such articles with garbage. But if the garbage is to be fed to hogs, or ploughed into the ground, tin cans are usually excluded. The rules and regulations in force at Lowell provide that "kitchen refuse, apple and potato parings, corn husks, cabbage leaves, shoes, rubbers, old bedding, soiled linen or cotton, and all refuse that can be burned shall be placed in the garbage vessels."

Household Storage.—In order that nuisance may be prevented, it is desirable that proper receptacles shall be provided by householders, hotel and restaurant keepers, and others for the storage of ashes, garbage, waste paper, etc., and that these be placed in convenient and accessible places for collection. Receptacles for ashes are best

FIG. 3944.—"Columbian" Dumping Cart showing Use of Dumping Lever.

made of metal. Those intended for garbage should be water-tight and provided with a well-fitting cover to exclude rain, prevent leakage, escape of odors, and access of dogs and other animals. In some cities separation of ashes, garbage, and paper is required by regulation; in others such separation is not so required.

Frequency of Removal.—Garbage is usually collected three times a week, but in some cities collection is made oftener, and in others not so often. In some cities definite hours are specified for such removal.

Vehicles of Removal.—The best form of vehicle for removal of garbage is made of metal, and so constructed as to admit of dumping instead of shovelling the contents. In some cities stout wooden barrels or iron casks are used, ten or more making a load.

In some large English cities where the pail system of collection for the removal of excremental waste is employed, the receptacle is removed from each house with the contents, and replaced with an empty or clean pail or tub. These receptacles are usually of metal painted and have a capacity of about a half-bushel. (Fig. 3943.)

The vehicles used for this purpose should always be provided with covers, either fixed or movable, for use when driving through the public streets.

Collection of Garbage.—In some cities garbage is collected by contract, and in others by some city authority. Municipal removal, however, as a general rule secures the most satisfactory service.

The following data present the cost and amount of collection of garbage in some of the largest American cities, the data referring either to 1898, 1899, or 1900. The following table relates to garbage only:

City.	Amount collected—tons.	Cost of collection.
Brooklyn	102,000	$120,000*
Baltimore	49,000	65,404
Boston	60,000	112,641
Buffalo	22,881	33,000*
Cleveland	22,375	69,400*
Milwaukee	28,716	61,883
New York (Borough of Manhattan)	152,000	101,840
Philadelphia	120,357	308,000*
Pittsburg	25,000	92,000*
St. Louis	69,634	99,673
New Orleans	67,500	97,200*

*Cost of collection and disposal.

The Separation of Refuse.—In very many cities it is the custom to separate the refuse into two or three or even more sorts; a very common method requiring the separation of the ashes, garbage, and paper or light combustible rubbish into three classes, the ashes being usually disposed of as a filling for waste lands, the garbage being fed to hogs, and the paper or light rubbish sold or burned. In addition to other classes, it is quite a common practice to separate the tin cans, bones, old iron and glassware, each of which has a certain market value. Such separation is often made a requirement by city regulations, and may be enforced by a penalty.

The English law relating to refuse is as follows (Section 42 of the Public Health Act, 1875): "Every local authority may, and when required by order of the Local Government Board, *shall* themselves undertake or contract for the removal of house refuse from premises; the cleansing of earth closets, privies, ashpits, and cesspools, either for the whole or for any part of their district."

By Section 43 of the same act, the local authority is made liable to a penalty of five shillings per day, payable to the occupant of a house, for failure to remove refuse after notice in writing from such occupant.

The street refuse of London is removed daily by boys with shovels and brush, and placed in iron dust bins, which are stationed at intervals along the edge of the pavement. In dry weather the streets are watered before being swept. The manure and dirt are removed by carts and taken to depots generally close to the river or to a railway station.

Each house has its dust bin or ashpit for the house refuse, from which the contents are collected periodically. The necessary depots for refuse are subject to the following general regulations:

1. The depots must be as distant as possible from inhabited places.
2. The refuse must not be put into pits, but above the ground level. If necessary, a special floor, three inches above the ground, must be made.
3. The ground should be drained and paved with impermeable material.
4. The depots should be sheltered from sun and rain, but the air should enter freely.
5. The ground leading to the depot should be well paved, so as to prevent pollution of the soil.

The custom of sorting refuse is vigorously opposed by some authorities. Mr. Goodrich[2] quotes Dr. Sedgwick Saunders as follows: "When the dust carts arrive at the wharf their contents are tipped into heaps at a place most