formed adjacent to the ventricular surface and migrate to the ectal surface. A portion remains in the nuclear (granular) layers and corresponds to the granules which lie adjacent to the ventricles in the brain. The method of formation of the rods and cones is still a matter of dispute. Professor His thinks they are formed by protrusion of backward-growing processes of the neuroblasts. It is, perhaps, doubtful if we have not to do with the nuclei of the spongioblasts and the greatly modified homologues of the cilia characteristic of ventricular epithelium. In any case the true neurons collect in a single or double series on the vitreous surface of the retina, and give rise to an axis-cylinder process which passes through the chiasm to the tectum opticum, and to protoplasmic processes which subdivide in the "inner molecular layer" (equivalent to the marginal reticular zone of the brain). The direct connection between the ganglion cells and the rods and cones has not been observed, and probably the connection is through a reticulum or neuropilem as in all other cases. The nerve fibres develop in the human retina at about the fifth week. It is obvious, from the results of recent investigation, that fibres arising in the tectum opticum pass toward the retina as well as vice versa.

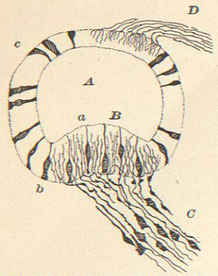

FIG. 1910.—Collecting Filaments of the Vestibular Branch of the Auditory Nerve. (Ramón y Cajal.) Transverse section of the semicircular canal of a mouse. *A*, Lumen of the canal; *B*, acoustic crest; *C*, bundle of nerve fibres containing bipolar cells; *D*, a similar bundle supplying the top of the canal; *a*, *b*, and *c*, varieties of bipolar epithelial cells.

Further discussion of the organs of special sense is rendered unnecessary by the fact that vision and audition are fully treated under these heads.

Muscle Spindles are problematical nervous organs which are supposed to supply the sensory stimuli on which are based the muscular sense and pressure sense. They were first described by Kölliker but were first proven to be sensory by Sherrington. The most complete account is that of Huber and DeWitt (*Journ. Comp. Neurol.*, vii., 3, 4) from which the following is taken.

"The capsule or perimysial sheath, has essentially the same structure in all vertebrates examined, although it varies much in thickness. It is made up of concentrically arranged layers of white fibrous tissue, the several layers being often in close apposition, or again more or less distinctly separated one from the other, leaving larger or smaller clefts between them. The number of these concentric layers varies; Sherrington places it at six to eight, which number holds good for many of the muscle spindles seen by us, especially those found in mammalian muscle. The fibrous tissue of the concentric lamellæ is white fibrous, practically devoid of yellow elastic tissue. At the beginning of the muscle spindle (proximal end), the capsule becomes continuous with a somewhat thickened perimysial sheath, which surrounds the muscle fibres about to enter the muscle spindle. The behavior of the capsule at the distal end of the muscle spindle depends somewhat on its relative position in the muscle. The spindle may be embedded in the muscle substance, in which case, as Sherrington correctly states, 'its long axis lies parallel to the muscle fibres amid which it is embedded'; here the distal end of the capsule seems again to become continuous with the internal perimysium.

"More immediately surrounding the enclosed muscle fibres, designated by Sherrington as '*intrafusal fibres*,' there is found a connective-tissue sheath which he has described as the '*axial sheath*,' consisting of thin bands or plates of white fibrous tissue in which nuclei are numerous.

"Between the capsule and the axial sheath is found a relatively large lymph space—Golgi and Sherrington—designated by the latter as the '*periaxial space*'; this, he correctly states, is 'bridged across and partially subdivided in many points by extremely tenuous membranes and filaments.' The periaxial lymph space is broadest near the middle of the muscle spindle, generally tapering off toward the ends. The intrafusal fibres are sometimes in the middle of this space and again eccentric. The space also shows buddings here and there, which seem, however, in a large measure due to foldings in the capsule, the result of contraction of the contiguous muscle fibres."

From one to four large medullated nerves end in the smaller spindles and from five to eight in the larger, compound spindles.

Single spindle nerves are surrounded by a thick sheath of Henle; small bundles of spindle nerves, by a connective-tissue sheath, which becomes in part continuous with the capsule, in part with the axial sheath. The spindle nerves remain medullated until they are within the axial sheath, the internodal segments becoming shorter as the muscle spindle is approached; but this is more especially noticeable after they have penetrated the capsule. After losing the medullary sheath (within the axial sheath), the non-medullated continuation of spindle nerves undergoes further subdivision, before the ultimate ending is reached.

Ruffini, whose account we may here follow, describes, for the cat, three types of ultimate endings of the spindle nerves—spiral, circular, and flower-like endings ("terminaisons à spirales, à anneaux, et à fleurs"). Of these, the spiral endings may be first considered, as they seem to us the most typical. The non-medullated terminal branch of the spindle nerve thus ending, flattens out into a ribbon-like ending, more or less irregular, which is spirally wound around the intrafusal fibre, this spiral extending for a longer or shorter distance along the intrafusal fibre; the spiral turns are sometimes so close together that they almost touch each other, or again, farther apart, so that they can be clearly made out. These spirals have also been described by Kerschner, who very correctly adds that from place to place offshoots proceed from the spiral, which may end on the intrafusal fibre surrounded by the spiral, or on some contiguous intrafusal fibre. The "ring-shaped" endings of Ruffini have, we believe, been correctly interpreted by Kerschner as lateral views of flat spirals. Such ring-shaped endings may, however, now and then be formed by short side branches of the

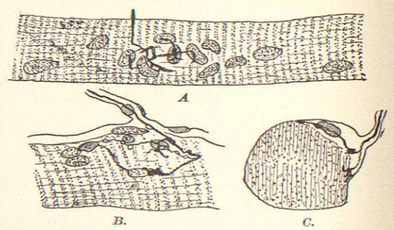

FIG. 1911.—*A* and *B*, Motor Plates from Muscle of Rabbit; *C*, cross section of muscle and motor plate of Frog. (After Huber and DeWitt.)

non-medullated terminal branches, which almost completely, or completely, encircle an intrafusal fibre; several such endings may be side by side on an intrafusal fibre. The flower-like endings mentioned by Ruffini, are, no doubt, as suggested by Kerschner, the terminal endings

of the spirals, or of branches from the spirals; they may, however, now and then be seen as branches from the terminal, non-medullated continuation of the spindle nerves, which have a zigzag course on an intrafusal fibre without forming a spiral.

Batten shows that "in infantile paralysis the spindle remains absolutely normal, although the surrounding tissue undergoes complete atrophy. In tabes, he shows that certain changes take place in the termination of the nerve, the general structure of the spindle remaining normal. In progressive muscular atrophy the spindle remains unaltered, and the same is probably true with regard to peripheral neurites. Section or atrophy of the nerve trunk leads to atrophy of the muscle fibres within the spindle, though it is probable that it takes a considerable length of time for changes to take place in the muscle fibre within the spindle."

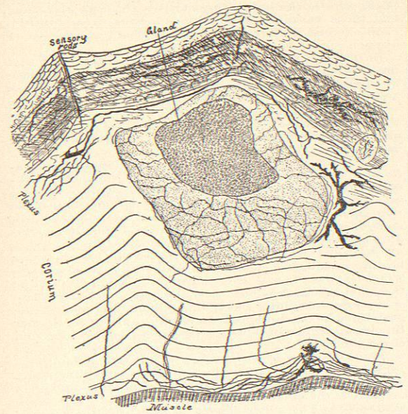

FIG. 1912.—Section of the Skin of the Head of a Toad (Bufo) after *intra-vitam* injection with methylene blue and fixation with Bethe's solution of molybdate of ammonia. Examined in glycerin. The section is somewhat oblique so that the duct and part of the body of the gland are absent. The delicate non-medullated fibres are seen generously distributed over the uncut surface of the gland. Coarser fibres are also seen in the lower and upper plexuses, also a bundle of sensory rods at the left.

KINESODIC END-ORGANS.—The most important terminal of the centrifugal system are those upon muscles and glands. The motor end-plates are the points of attachment of the motor nerve fibres upon the muscles and are accordingly the receiving stations of the muscle and the points whence the stimulus is distributed to the fibre prior to its contraction. They were first observed by Doyère in 1840 and have been the subjects of much patient investigation since that time. The best work in this field is that of Kuehne, which has been ably supplemented by Huber and DeWitt. The fibre penetrates the sarcolemma and forms a very complicated arborescent figure by the ramifications of the axis cylinder, and this may be regarded as the end-brush of one or more motor neurites. The granular mass in which the nerve fibre terminates was at first supposed to be an expanded portion of the nerve fibre. It contains nuclei (the sole nuclei) which have been variously interpreted. The following summary from Huber probably expresses the present state of our knowledge:

"(1) The ramified terminations of the axis cylinder in the motorial endings of striped muscle are the end-brushes of the neuraxes of motor neurons, and are similar in structure to the end-brushes of other cerebro-spinal fibres.

"(2) This end-brush (*das Geweih*, Kühne) terminates in the sarcoplasma, therefore under the sarcolemma of the muscle fibres. At the place of ending of the nerve fibres, the sarcoplasma may be accumulated in a circumscribed mass, forming an elevation, more or less distinct, on the side of the muscle fibre, as in reptilia, birds, and mammalia, or spread out over a proportionately greater area of the muscle fibre, as in amphibia. In the mass of sarcoplasma, the muscle nuclei (sole nuclei of other writers) are relatively more numerous than in other parts of the muscle fibre.

"(3) The neurolemma of the nerve fibre terminating in the motorial ending becomes continuous with the sarcolemma at the point of entrance of the said nerve fibre into the sarcoplasma. Over the endings, sarcolemma or neurolemma nuclei—telolemma nuclei—are seen.

"(4) The neuraxis of the motor neuron loses its medullary sheath before piercing the sarcolemma."

With reference to the endings in glands and other visceral organs space need not be taken here as the discussion will naturally accompany the articles on these organs. The drawing in Fig. 1912 will sufficiently illustrate the complexity of the nerve supply to glands and the difference between these endings and those of a sensory nature.

C. L. Herrick.

ENDOTHELIOMA. See *Sarcoma*.

ENDOTHELIUM. See *Epithelium*.

ENEMATA. See *Enteroclysis* and *Alimentation, Rectal*.

ENGADINE (UPPER), SWITZERLAND.—The Upper Engadine valley extends from Maloja, at the summit of the pass, to a little beyond Samaden, in a direction from southwest to northeast. Through this valley runs the Inn, while high mountains belonging to the Bernina and Julier chains enclose it on either side. The Upper Engadine valley is wider than the lower and contains several lakes. It is about thirty miles in length, and varies from a half a mile to a mile in width; and its mean height above sea level is 5,500 feet. The whole Engadine is one of the highest inhabited valleys in Europe. In the Upper Engadine are situated the health resorts of Maloja, St. Moritz, and Samaden, where consumptives go in the winter for the "air cure"; and Pontresina and others which are visited in the summer only.

The Upper Engadine valley is again divided into an upper and a lower portion, quite different in the character of their scenery. In the upper portion, extending from Maloja to St. Moritz, where are situated the lakes before-mentioned, the mountain boundaries on either side are grander and wilder and much loftier, and their summits are covered with extensive glaciers and snow fields. In the lower half, extending from St. Moritz to the termination of the valley, the picture is quite different. "Here there are no lakes, the floor of the valley is much wider, and is occupied by broad stretches of meadow-land through which the Inn quietly and tamely flows along." "The mountains on each side are of lower elevation; they all rise in gentle slopes from the floor of the valley, and present no bold or striking features of form or outline."

The upper or southern end of the valley is open and affords a ready ingress to storms of wind and rain approaching the valley from the southwest; the wind, however, blows most in spring and summer, while the winter is the calmest season of the year.

Climate.—The climate of the Upper Engadine is very similar to that of the neighboring valley of Davos, already described. (Cf. *Davos*.) In the first place, there is the striking variability of the temperature as in all high-lying stations. The diurnal variations are sudden and

great; for instance, in August, between seven and ten o'clock, the mercury rises from 44.6° to 53.6° F.; and again at sunset it falls as rapidly as in the morning it rose. Secondly, the great radiant heat of the sun is another characteristic; for instance, the maximum sun temperature in the upper Engadine on February 4th, 1876, was 118° F.

The number of hours of possible sunshine in winter is somewhat greater in the Engadine than at Davos; for example, on January 1st, the sun rises at Maloja at 9:35 and sets at 3:45, while at Davos it rises at 10:03 and sets at 3.

The average rainfall, most of it being snow, is 32.67 inches; it lies on the ground for over five months, beginning about November 14th. The relative humidity is 75 per cent. The mean annual temperature is about 36.5° F., and for the seasons as follows: Winter, 18.1° F.; spring, 33.7° F.; summer, 50.9° F.; autumn, 36.5° F. There is said to be rather more cloudiness in the Upper Engadine than at Davos. As at Davos, the purity and exhilarating quality of the air in this region constitute, in brief, the great striking characteristic which all experience who enter this valley. The writer can never forget his own sensations as he came over the pass from Chiavenna into this delicious atmosphere. Merely to exist was a delight, and to spend the day in tramping over a glacier or mountain climbing was exquisite pleasure, and after such exertions no sign of weariness was experienced.

A considerable number of consumptives take the winter cure here, and there are excellent accommodations at Samaden, St. Moritz, and Maloja; at the latter is the large Kurhaus, accommodating five hundred guests and especially arranged for a winter residence; the ventilation and sanitary arrangements are of the best. In the village of St. Moritz is the great caravansary "Engadiner Kulm," with a wonderful view over the whole district of St. Moritz. Here one can find every comfort, and even luxury,—large reception-rooms, a library, a dining-room for three hundred and fifty persons, and a fine collection of engravings and pictures. The English and Americans chiefly patronize this hotel. St. Moritz is the highest village in the Engadine or in Switzerland, having an elevation of 6,085 feet.

A mile or two from St. Moritz village are the St. Moritz baths. These are supplied from two acidulous iron springs,—the old and the new, containing soda with a large proportion of fixed solids and free carbonic acid. These waters are used both for drinking and for baths and are visited in the season—from the middle of June to the middle of September—by numerous patients of all nations. The conditions benefited by these waters are anæmia, chlorosis, dyspepsia, menstrual irregularities, various derangements of the nervous system, etc. There is a large Kurhaus with many rooms, two bath houses containing eighty baths, and complete hydrotherapeutic arrangements (warm, cold and Scotch douches, sitz baths, vapor baths, etc.), as well as facilities for massage. There is a covered promenade leading from the Kurhaus to the spacious pump room of the new spring. There are generally about three hundred and eighty patients in the Kurhaus, and every attention is given to their comfort and diversion.

What has been said regarding the winter climate of Davos in the treatment of pulmonary tuberculosis applies equally to that of the Engadine; there is no material difference between the "air cure" of the Davos and that of the Engadine valley, and the results should closely resemble each other. In the winter resorts of the Upper Engadine there is greater variety of scenery and the life is more restful and quieter.

Regarding the uses of such a climate as that of the Upper Engadine for cases other than tuberculosis, a few words can properly be said here, applicable also, in a measure, to all high-altitude resorts. Whatever the malady or condition there should exist a "certain integrity and reactionary power of the constitution," if the patient is to be benefited by a climate which is stimulating and bracing, such as this. This being presupposed, we can say, in general, that where functional activity needs to be improved, and the whole system toned up, a few weeks' residence in this pure, clear, dry, bracing air will almost surely produce favorable results. "I believe," says Burney Yeo, "this kind of climate is especially useful to those who have been *strong*, but by some accident or other, such as overwork, or illness, or trouble, have become weak; to those who possess a latent power of reaction." To enumerate especial conditions, there may be mentioned, nervous dyspepsia, want of appetite, sleeplessness, malaria, neuralgia, anæmia, the later stages of convalescence from severe illness, hypochondriasis, asthma uncomplicated with emphysema or organic disease of the heart or arteries, chronic bronchitis with much secretion, and those various mal-conditions arising from "insufficient exercise in the open air and deficient absorption of oxygen."

Burney Yeo happily expresses it when he says that much of the benefit that is derived from a short residence in an elevated region like that of the Upper Engadine is due to the alterative influence which it exercises on the human organism. "In passing," he continues, "from the sea-level to an elevation of over 6,000 feet we must alter in a very essential manner the conditions of our lives."

It is well also to bear in mind some of the contra-indications of a mountain climate like this. Such are, weakness from extremes in age; constitutional weakness; organic cardiac disease; atheroma; chronic bronchitis with dilated bronchi; and emphysema, muscular debility and general exhaustion, rheumatism and inability to endure great and sudden changes of temperature.

Finally, if we are not in search of health or better health, we all need change occasionally,—"that change which is the type of life and the condition of health; that change which is rest." Where can a more complete or a more refreshing change be found than among the grand glaciers and majestic mountain peaks of the Upper Engadine, where we can "draw in easier breath from larger air."

Edward O. Otis.

ENTERITIS.—An inflammation of the small intestine, involving particularly the mucous membrane, and to a less extent the submucous layer. It may be either acute or chronic. The whole length of the intestine may be involved or, more usually, the inflammation is limited to certain portions of this.

The meaning of the term *enteritis* has varied considerably as used by different authors, and at different periods in medical literature. It does not appear to have been in use by the ancients. In the eighteenth century it was applied to the group of symptoms now included under peritonitis, although Cullen (1784) mentions two varieties of the disease, one of which evidently refers to an inflammation of the mucous membrane and subjacent tissues of the intestine. In France, at about the end of the eighteenth century, Pinel limited the use of the word to an inflammation of the intestinal mucous membrane. Its meaning was further restricted during the first half of the nineteenth century by Broussais (1821), who applied it to an inflammation of the mucous membrane of the small intestine only, and gave the name colitis to a similar process in the colon. This restricted meaning has been more or less generally retained up to the present time.

At the beginning of the last century the lesions of the intestinal lymphoid structures found in typhoid fever were included under the general term enteritis, and this use of the term was continued to some extent even after the specific nature of the lesions had been demonstrated. At present the term is avoided by some authors, "intestinal catarrh" being used instead as indicating the character of the most frequent form of inflammation of both the large and the small intestines. While it is recognized that the same etiological factors may produce similar changes in either the large or the small bowel, that usually each is involved to a greater or less extent in both the acute and the chronic catarrhs of the intestine, and

that at times it is difficult to determine the exact parts involved, yet, as the symptoms referable to the one or other part of the intestine vary to some extent, and as the treatment must necessarily differ accordingly, it may be wise to use the term enteritis, as will be done in this article, as applying to the small intestine, the term colitis being used for the affection of the colon, and ileo-colitis for the combined involvement of the two.

The summer diarrhœas of children will not be discussed here, nor will the specific infections of the intestine.

As the catarrhal variety of enteritis is by far the most common, and for this reason the most important, both the acute and the chronic forms of this will be discussed at some length.

Catarrhal Enteritis.

Catarrhal, as here used, has the common meaning of the term, that is, as indicating an inflammation of a mucous membrane characterized by a free exudation from the surface, usually rich in mucus. During life such an inflammation is evidenced by the presence of the inflammatory exudate which is discharged from the body, as well as by various other symptoms which are explained by the process.

Etiology.—*Acute Catarrhal Enteritis.*—The causes of this are most numerous. They may act as predisposing to, or direct excitants of, the inflammatory process. The dividing line between these two classes is frequently difficult to determine. The disease of the intestine may occur alone, or it may accompany or result from various other disorders. It is to be noticed that because of its position and the length of its canal, the small intestine is particularly liable to be affected by any kind of irritating substances which are ingested, unless these are rendered harmless in the stomach, as well as by certain excretory products which pass through its wall; and of prime importance among the predisposing factors is the ease and frequency with which an abnormal condition of the blood supply of the intestinal wall occurs, in part due to some obstruction to the returning blood in the portal system, and in part to the lack of sufficient support for the blood-vessel walls by the surrounding tissue.

An unsuitable dietary is probably the most frequent direct cause of intestinal derangement. This may be at fault only in quantity, or in quality, or in both. Food which is entirely wholesome may, when eaten in too great quantities and only partially masticated, excite a diarrhœa, as may also unripe fruit, uncooked vegetables, etc. This may be only an evidence of increased peristalsis, but often it results from a true catarrhal inflammation of the intestine. The undigested food here acts either as a mechanical irritant, or it furnishes favorable conditions for abnormal bacterial development in the intestinal canal. This microbic growth, in which the common inhabitants of the intestine chiefly take part, gives rise to a variety of active irritants. These in large part are only excessive quantities of substances normally present, chiefly acids, such as lactic, butyric, acetic, and formic, together with different kinds of gases. But besides these, substances of a more decidedly toxic nature may be formed here, probably closely resembling those referred to in the next group. This group embraces those foods which, before being eaten, have already undergone bacterial decomposition and contain poisonous products resulting from this. Such are tainted meat and fish, at times milk and its various products, etc. The active toxic agents in several of these are already known. Among them may be mentioned Vaughn's tyrotoxicon, Firth's lactotoxin, and the various ptomaïns which Brieger has isolated. At times the inflammation can be explained as due to some idiosyncrasy. Thus lobsters, cheese, eggs, etc., when entirely wholesome and in moderate quantities, may in certain individuals give rise to an acute enteritis. Foul water also frequently produces a similar disturbance.

Among the active poisons whose entrance into the alimentary canal is followed by severe inflammatory processes are included arsenic, corrosive sublimate, antimony, the mineral acids and caustic alkalies, and many others. The drastic purgatives, as croton oil, colocynth, elaterium, etc., in unsuitable doses may produce enteritis.

Exposure to cold, particularly a sudden chilling of the body after over-heating, is a recognized cause of the disease. In what way this acts, whether reflexly through the nervous system, as seems probable, or otherwise, is a question; but some disturbance of the intestinal function is produced sufficient to excite an inflammatory process. Cold drinks, ice, ice-cream, etc., when taken in immoderate amounts may have a similar result.

Excessive summer heat is also a common cause of catarrhal enteritis, particularly in young children; hence the popular term "summer complaint" so frequently applied to this. Its action is largely an indirect one, furnishing favorable conditions for bacterial growth in food before its consumption. Extensive burns of the skin may give rise to an inflammation and ulceration of the duodenum. The actual exciting agent here is probably a toxic substance which is formed at the site of the burn, and is excreted into the upper portion of the intestine.

The rôle of bacteria in producing decomposition products in various articles of food has already been referred to. No specific micro-organism can be accepted as the usual cause of enteritis, although the common colon bacillus is undoubtedly a frequent factor, due to conditions which favor its rapid development and increased virulence in the intestinal canal. Gärtner has cultivated and described a bacillus which was obtained from the flesh of a cow having an intestinal disease, and also from the spleen of a man who had been poisoned by eating some of this meat. Cultures of this produced a marked enteritis in susceptible animals. To this organism was given the name Bacillus enteritidis. Gaffky has likewise found in the stools of a cow having a bloody diarrhœa, and in those of patients who were made sick by the milk from this cow, a small highly virulent bacillus. Each of these, however, closely resembles the Bacillus coli communis, and they are probably members of the so-called colon group.

Traumatic causes, such as blows on the abdomen, may give rise to intestinal inflammation. Gall stones may mechanically produce this, as can also the presence of certain intestinal worms.

Among the more important predisposing causes is age. Young children show but slight resistance to intestinal irritants, so that even cow's milk may be sufficient to produce a catarrhal enteritis in an infant. Old and debilitated persons have an increased intestinal susceptibility, and chronic congestion of the intestinal wall predisposes to the disease. Previous attacks of inflammation usually render the mucous membrane very susceptible for a time to slight irritation.

A catarrhal enteritis accompanies numerous other diseases of the intestines, as tumors, invagination, peritonitis, etc., and also occurs in many of the acute infectious diseases.

The causes of *Chronic Intestinal Catarrh* are largely those of the acute form of the disease. A severe acute attack of enteritis, when prolonged because of unfavorable conditions for recovery, may gradually pass into the chronic type. Or the repeated action of slight irritants, as indigestible food, alcohol, purgatives frequently employed, intestinal parasites, etc., may give rise to this condition. Here the process is at times evidenced by several acute attacks, or the symptoms of chronic enteritis constitute the first appearance of the disease. Anything which interferes with the normal circulation of the blood or lymph in the vessels of the intestinal wall tends to render it susceptible to inflammatory excitants. Thus cirrhosis of the liver, and chronic diseases of the lungs and heart, which give rise to a continuous overdistention of the venous system, are very frequently associated with a chronic enteritis. Continual excretion of toxic substances through the intestinal wall, as occurs in chronic nephritis, and probably also in tuberculosis, malaria, and