In a few cases recovery is not complete, and spasms and contracture of the muscles are left over as sequelæ. These conditions may exist separately, but they are usually associated with one another. The spasms consist of short, quick contractions of the muscles, occurring irregularly, and very much resembling facial tic. These spasmodic movements are unattended with pain and are often unnoticed by the patient.

Contracture is observed particularly in the levator palpebræ superioris alæque nasi and zygomatici muscles, and causes retraction of the angle of the mouth upward and outward. It thus tends to overcome the original deformity produced by the paralysis. When the contracture is very marked, the deepening of the naso-labial fold to which it gives rise may create a deceptive appearance of paralysis upon the opposite side of the face. An error in diagnosis may be obviated by directing the patient to laugh, whereupon it becomes evident that the contractured muscles remain motionless, while those on the healthy side contract normally.

Gowers thinks it probable that contractures and clonic spasms are due to changes in the facial nucleus, caused by continued interruption in the nerve tracts and constant irritation of the centre during attempts to move the facial muscles. The cell resistance is diminished and hence the cells react with abnormal facility.

If complete paralysis of the muscles remains permanent, the muscles will undergo atrophy, so that the affected half of the face looks smaller than the other side.

Oppenheim has described a rare combination of peripheral facial paralysis with hysterical symptoms, viz., hysterical hemianæsthesia on the same side. The paralysis persisted but the hemianæsthesia disappeared in a short time.

In diplegia facialis the face presents a remarkable appearance inasmuch as it is absolutely devoid of expression, and even the most violent emotions are experienced by the patient without the slightest change of countenance. The lower lip droops, and saliva is constantly flowing from the mouth. Articulation and deglutition are interfered with to a very marked degree.

Diagnosis.—The differentiation of peripheral from central facial paralysis is usually quite easy. In the latter affection the muscles of the forehead and eyelid are very slightly involved. As a rule, however, on directing the patient to close only the eye on the paralyzed side, it becomes evident that this is done with less vigor and promptitude than on the healthy side. The affected muscles present no changes of electrical excitability, however profound the paralysis may be. It will also be noticed that the voluntary and the reflex contractility of the paralyzed muscles are often in marked contrast to one another, the latter being much greater than the former. Furthermore, the clinical history of the two affections is usually decisive. In the cerebral variety the facial paralysis is almost always associated with paralysis in some other part of the body, usually of the arm and leg upon the same side. In addition, cerebral facial paralysis generally develops after an apoplectic seizure, which is usually accompanied by unconsciousness.

In a certain proportion of cases the disturbance of gustation on the anterior portion of the tongue, the paralysis of the velum palati and uvula, and the history of a previous disease which may have produced a lesion of the seventh nerve, will aid us in clearing up any possible doubt in diagnosis.

In rare cases, however, facial paralysis produced by lesions of the pons Varolii presents most of the characteristics of peripheral facial paralysis. If the lesion is situated in the lower half of the pons, the facial paralysis is associated, as a rule, with hemiplegia of the opposite side of the body. When the lesion is situated in the upper half of the pons (before the decussation of the seventh nerves), the face and limbs are paralyzed on the same side of the body. The frontalis and orbicularis palpebrarum may be entirely paralyzed, as in ordinary peripheral paralysis, and, in addition, there may be marked changes in the electrical excitability of the facial nerve and muscles. But a mistake in diagnosis is usually obviated by the presence of other symptoms of a pons lesion, such as contraction of the pupils, marked difficulty in swallowing and articulation, and paralysis of various cerebral nerves (trigeminus, abducens, hypoglossus), etc.

After the diagnosis of the peripheral character of the disease has been made, we should also endeavor to determine its location more accurately. As a rule, this can be done with great certainty on account of the peculiar anatomical relations of the nerve.

If the lesion is situated above 5 (Fig. 2079), the patient will suffer from paralysis of all the facial muscles, of the uvula and velum palati, and from disturbances of hearing, but gustation will be unimpaired. This is owing to the fact that the chorda tympani nerve enters the facial nerve, in all probability, at the ganglion geniculatum through the petrosus superficialis major nerve, *psm* (from the trigeminus). The chorda tympani leaves the facial nerve between 2 and 3, *cht*, and then joins the lingual branch of the trigeminus.

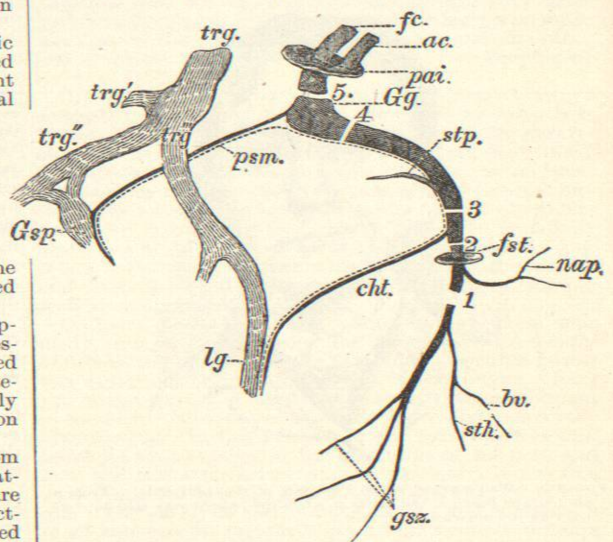

Fig. 2079.—Schematic Representation of the Ramifications of the Facial Nerve. (After Eichhorst.) *fc*, Trunk of facial nerve; *ac*, trunk of acoustic nerve; *pai*, internal auditory foramen; *gg*, ganglion geniculatum; *psm*, nervus petrosus superficialis major; *stp*, nervus stapedius; *cht*, chorda tympani; *fst*, styloid foramen; *nap*, posterior auricular nerve; *bv* and *sth*, nerves to the digastric and stylo-hyoid muscles; *trg*, *trg'*, *trg''*, *trg'''*, trunk and branches of the trigeminus; *gsp*, spheno-palatine ganglion; *lg*, lingual nerve.

If the lesion is situated between the ganglion geniculatum and the point at which the nerve to the stapedius muscle, *stp*, is given off, the symptoms will consist of paralysis of all the facial muscles, disturbances of hearing, and impairment of taste on the anterior third of the tongue. The velum palati is unaffected in this case, probably because its motor fibres are given off at the ganglion geniculatum, *Gg*. If the lesion is situated between the origin of the stapedius nerve and the point at which the chorda tympani, *cht*, leaves the facial nerve, the symptoms just mentioned will be present, with the exception of the disturbances of hearing. A lesion below the point at which the chorda tympani is given off will simply produce paralysis of the superficial muscles.

It must be remembered, however, that these remarks hold good only in those cases in which the lesion is of such character as entirely to destroy the conductibility of the nerve at the affected part.

Prognosis.—The prognosis depends chiefly on the character of the lesion which has given rise to the paralysis, and therefore varies according to that of the primary disease. When the nerve is involved directly, as in cases of rheumatic origin, or those due to infectious diseases, etc., the prognosis may be determined, in great measure, by the changes in electrical excitability.

When the excitability of the nerve and muscles is unchanged, the disease will usually recover spontaneously in from two to four weeks. If complete degeneration reaction is present, recovery cannot be looked for in less than from three to six or nine months. But the case should not be regarded as absolutely hopeless, even if the electrical excitability is abolished for a short period.

The development of muscular spasms and contracture is a very unfortunate event. In no case of this kind which has come under our observation has recovery occurred. The contracture usually continues to increase in severity, and after a while the muscles undergo a certain amount of atrophy. These two factors may give rise to considerable disfigurement of the face.

As a rule, the disease runs a longer course in those cases in which the lesion is situated within the Fallopian canal.

Treatment.—The causal treatment varies with the nature of the primary disease (affections of the middle ear, syphilitic lesions, tumors, etc.). The use of leeches, blisters, and the administration of strychnine, which are strenuously recommended by some writers, have been attended with such unsatisfactory results in our hands that we now rely exclusively upon electrical treatment.

In those cases in which the electrical excitability of the paralyzed nerve and muscles is unchanged, treatment is unnecessary, since recovery occurs spontaneously.

When complete degeneration reaction is present, electricity should be applied to both the nerve and the muscles, and in the case of the nerve the galvanic current alone should be employed. A small electrode, the anode, is placed immediately over the mastoid foramen (between the mastoid process and the lobe of the ear) on the affected side, the cathode (with a similar electrode) over the opposite mastoid foramen. The current will therefore pass through the petrous portion of the temporal bone, and act upon the nerve in its passage through the Fallopian canal. It should not be strong enough to produce a feeling of pain or vertigo, no interruptions should be made, and the sittings should be held for three or four minutes every other day. With this method we may combine labile galvanization of the muscles. One medium-sized electrode (usually the cathode) is placed upon the back of the neck, the other small electrode is slowly passed over the affected muscles. The frontalis and corrugator supercilii muscles are brought into play by passing the electrode horizontally across the forehead, a little above the eyebrow. The levator labii superioris alæque nasi, zygomatici, and buccinator are brought into play by passing the electrode along the side of the nose (beginning near the inner angle of the eye), and then outward across the cheek, immediately below the malar bone. Labile applications may also be made directly to the orbicularis oris and chin muscles. In applications to the orbicularis palpebrarum, we are in the habit of placing a very small electrode upon the muscle, at the outer angle of the eye, and then interrupting the current (by means of an interruptor in the handle of the electrode).

In an apparently incurable case of facial paralysis due to a gunshot wound, Faure and Furet stitched the peripheral extremity of the facial nerve to the adjacent branch of the spinal accessory. The results in this case were not very satisfactory, but in view of the experiments made by various observers it is probable that surgical interference will prove useful in a limited number of cases.

In some cases the excitability of the muscles will be found to have sunk to such a low ebb that it becomes necessary to employ the intrabuccal method of galvanization. One electrode is then placed upon the muscle which we desire to stimulate, the other directly opposite upon the mucous membrane of the cheek.

After the nerve has recovered its electrical excitability, the faradic current may be employed, either upon the muscles themselves, or by simply passing the electrode along a vertical line immediately in front of the ear, in order to stimulate the pes anserinus as it spreads out in this locality.

We may attempt to relieve contractures by stabile galvanization of the affected muscles, the negative pole being applied to the mastoid foramen, the positive pole to the contractured muscle. Massage of the muscles has also been employed for this purpose.

In all electrical applications in this disease, the electrodes should be very thoroughly moistened, and the current should merely possess sufficient strength to produce visible muscular contractions. *Leopold Putzel.*

FÆCES.—The term "fæces" is applied to the excrementitious substance that normally leaves the body through the anus. The material consists of the waste from the intestinal walls and the unabsorbed residues of the various secretions into the alimentary tract, together with an admixture, in varying amounts, of undigested and partially digested food, and at times such adventitious substances as may be taken into the alimentary canal *per os* and which are not absorbed. The common idea that the fæces in health consist chiefly of food residue is not sustained by the results of recent investigations.

After the intestinal contents have passed the ileo-cæcal valve, they rapidly take on the characteristic consistence, color, and odor of fæcal matter, being altered by the absorption of the liquids and soluble substances, as well as, to some extent, by the continuation of putrefactive and fermentative processes and by admixture with the strongly alkaline secretions of the large intestine. The extent of these changes is largely influenced by the rapidity with which the contents pass through the colon.

Physical Characters.—The *quantity* passed in twenty-four hours varies greatly, but is estimated to average 120–200 gm., in a healthy man on a mixed diet. It is dependent to some extent on the quantity and quality of food eaten, but is influenced as well by the condition of the digestive organs as regard secretion and absorption, and the frequency of evacuation. As a rule the quantity of fæces increases with the relative increase in the amount of vegetable food in the diet. It is probable that this is due largely to the greater resistance of vegetable food to digestive action and the subsequent stimulation of peristalsis by the undigested residues, with a resulting diminution of absorption. In an infant fed on cow's milk the quantity is regularly considerably greater, even up to ten times, than the amount passed by a breast-fed babe. This is due not alone to difference in digestibility, but to a considerable extent to the much larger quantity of milk given in artificial feeding, which both adds to the quantity of undigested food residue and increases the residue from intestinal secretion and waste. The quantity of fæces evacuated is occasionally increased by pathological products, including mucus, blood, pus, and serous fluid.

The *color* is normally derived from the intestinal secretions, notably from the bile, and under certain conditions is also very considerably influenced by the food, the stools of a mixed diet usually being a medium shade of brown, those of a meat diet dark to blackish-brown, and the evacuations following the exclusive ingestion of vegetable food being a light brown. The stools of an exclusive milk diet vary in color from orange to light yellow. The dark color is due to hæmatin, and to some extent to the compact, dry condition of the fæcal matter. In particular instances the color may be modified by special coloring matters ingested with the food, as, for example, chlorophyl, derived from large quantities of green vegetables. Adventitious ingesta as, *e.g.*, certain medicaments, may determine the color. Thus, calomel may cause a green coloration, probably by causing the presence of biliverdin, and bismuth or iron may each be reduced or may exceptionally appear as the black sulphide. Again, unusual changes in the intestinal contents may modify the color, as the growth of bacteria, producing pigment, notably green, or, as occurs frequently in infants, there may be a production of unusually strong alkalinity in the upper intestinal tract, causing the presence of biliverdin in the fæces in quantities sufficient to impart a green color. Finally, there are the clay stools after complete suppression of the bile and the similar appearance in cases without jaundice due to the presence of excessive amounts of fat.

The *odor* of the fæcal matter of adults is characteristic and is to be attributed to the presence of skatol and indol, and probably to other aromatic products formed by the putrefaction of the intestinal contents. When the passage through the intestines is rapid there may be little or no production of skatol, as in the rice-water stools of cholera, which are almost or quite odorless. The stools of an infant do not normally have a putrid odor, but if strongly acid they may have a rancid smell.

Normal stools are cylindrically *formed* and have a definite consistence. When the passage through the large intestines is rapid or the secretion into the bowels unusually abundant, they may become soft or even watery, while under opposite conditions they may be considerably hardened and assume the form of balls or very thin cylinders, these hardened masses being known as scybala. The so-called lead-pencil form is in no way indicative of intestinal stenosis, but is the rule when there has been complete abstinence from food, and may be caused by spastic or paralytic conditions of the large intestines.

After the exclusive ingestion of soft food the *structure* is usually homogeneous, while in fæces of the various mixed diets hard and undigested portions of food may be distinguished—as, for example, seeds, fragments of fruits and vegetables, or fibrous tissue. Adventitious admixtures of foreign substances are occasionally observed, such as fragments of wood, pieces of quill, buttons and pins. The appearance in the stools of bits of food tissue, recognizable to the naked eye, sometimes results from digestive insufficiency, either mechanical or chemical. Insufficient mastication is the most frequent mechanical fault. A failure of the chemical processes of gastric digestion is followed by the appearance of bits of connective tissue, while insufficient pancreatic digestion leads to the presence of undigested muscle fibre. Either biliary or pancreatic insufficiency may be followed by the appearance of much fat. Food fragments are more abundant in diarrhœal discharges, the material in some instances passing the entire length of the alimentary tract in a few hours and almost unchanged. In such stools pieces of meat may be seen or milk clots of various shapes and sizes. As a rule, the inner portion of formed stools is more recent than the outer, the passage through the intestines following the ordinary rule of flow, being more rapid in the centre and retarded at the periphery.

Fæcal matter has a certain *coherence*. If it does not contain evident food residue the mass usually does not crumble readily, when stirred with water, as do stools in which much food residue is present, particularly plant tissue and undigested casein. A large amount of fat increases the coherency, as does also in some instances much mucus, though possibly this is due to the accompanying fat.

Inspection of the alvine discharges occasionally reveals the presence of *pathological admixtures*. Blood, if from the lower bowel, is recognizable to the unaided eye, but, if changed by contact with the digestive juices, it merely imparts a dark color or tarry consistence to the stool. Likewise pus is recognizable only when it has been discharged into the lower part of the large intestine. The normal stool may contain on its surface visible mucus, but not in any considerable amounts. In catarrhal conditions of the intestines, however, the amount of mucus may be greatly increased, appearing either as a glassy layer surrounding the fæcal matter, as in diseased conditions of the lower portion of the bowel, or mixed with soft fæces, in which case the mucus adheres to a glass rod dipped into the evacuation; or, finally, it appears in watery dejecta as small floating particles, readily recognized. In membranous enteritis mucus is passed in long strings or as a continuous, tubular membrane, sometimes dense and opaque so as almost to appear fibrinous. In cholera and to a less extent in some other conditions great quantities of serous fluid, a true transudate, are evacuated with the intestinal contents.

Microscopic Characters.—Microscopic examination of fæcal matter reveals a mass of bacteria and detritus in which is embedded a greater or less number of recognizable morphological and crystalline elements, some being residue of food or adventitious ingesta, others being products from inhabitants of the intestinal tract, while still other such elements are those derived from the body itself and its secretions.

Vegetable cells and fibres of variable form may be encountered, some containing starch granules or masses of chlorophyl. Occasionally, especially in diarrhœal stools and where there is a failure of pancreatic digestion, starch granules more or less unaltered are recognized in considerable number. They turn blue in contact with a solution of iodine. Rosenheim states that he could not detect 0.6 per cent.; hence it appears that less than one-half per cent. of starch cannot be detected with certainty by microscopic examination.

Of the residues from *animal food*, connective tissue may be present in variable amount, being increased when this class of food is ingested in large quantity, and when there is a deficiency of gastric digestion. Where such food has been sparingly eaten, the appearance of areolar fibres in notable numbers is nearly always indicative of deficiency of the chemical processes of gastric digestion. Elastic fibres, except to a very limited extent in the instances in which they come from swallowed tuberculous sputa, are derived from the food and are not indicative of any condition of disease. Partially digested bile-stained muscle fibres are nearly always found in the stools, still preserving their transverse striæ so as to be recognizable, though the general appearance of the fibres may be much altered. They are not rendered more numerous by gastric deficiency, but they are apt to remain bound together by bands of undigested connective tissue. A large increase on a limited meat diet is indicative of deficiency of intestinal digestion. Undigested milk clot is at times present in the excrement of adults, and is frequently seen in the stools of infants. They are recognized by the absence of structure, the presence of fat globules and proteid, as indicated by microchemical tests, and the solubility of the coagulated proteid in dilute alkali and its reprecipitation by acetic acid.

Fat, in the form of globules and as fat tissues, is occasionally seen, but is commonly present as needles, single or in clusters. These are probably fatty acids in combination with calcium and magnesium, alkali-earth soaps. They are present in enormous numbers in acholic stools and are regularly increased when there is a deficiency in the absorption of fat.

Cholesterin *crystals* rarely appear in the stools, this substance not being a normal constituent of fæcal matter. Since it is usually present in meconium, in the stools of starvation, and in evacuations when digestion is arrested, its appearance in crystalline form is to be looked for in these conditions. Stercorin, into which cholesterin is normally converted in the intestinal tract, crystallizes in thin delicate needles and hence is distinguished with difficulty from alkali-earth soaps. Whether this substance appears in crystalline form in the stools is unknown.

Phosphate crystals are regularly seen in the microscopic examination of fæces, either as wedge-shaped prisms, single or in clusters, of the neutral calcium salt or as the triple phosphate in its various forms (see under *Urine*). They are without pathological significance.

Calcium oxalate crystals are frequently recognized in fæcal matter. They are in many instances derived from the food, but there is reason to believe that oxalate is at times formed in the fermentative and putrefactive processes of alimentation. In the light of our present knowledge its occurrence in crystalline form cannot be considered significant of any pathological process.

Crystals of other organic salts of calcium are described as occurring in stools, the lactate in the discharges of children, appearing as sheaves of radiating needles, and the acetate and butyrate in the discharges of gastric and intestinal catarrh. The occurrence of amorphous particles or dumbbell crystals of calcium carbonate and of prisms or dumbbell-shaped amorphous masses of calcium sulphate is exceedingly rare and probably devoid of pathological significance. After the administration of bismuth black crystals appear in the stools; in shape they closely resemble hæmin crystals.

Charcot-Leyden crystals are occasionally seen, most frequently when intestinal parasites, particularly worms, are present. They are also seen in typhoid fever and in catarrhal conditions of the bowel.

Of the *morphological elements* derived from the body epithelial cells are most frequently seen, as they are always present. Squamous epithelia come from the region of the anus, and are the least changed. The columnar variety is less frequently recognized, being much altered by partial digestion and abstraction of moisture. If in great numbers they point to intestinal catarrh, but are of no further diagnostic importance. The possibility of the presence of bits of neoplasm should always be borne in mind, but their recognition when such a growth exists is only occasionally possible. The casts of mucous enteritis and colitis frequently seem to be fibrinous, but microscopic examination shows that they consist of dense, more or less transformed mucus. Portions may be infiltrated with large numbers of small round cells. Blood, unless present in large amount, is recognized from the red corpuscles only when it comes from the lower portion of the rectum. Hemorrhagic stools frequently, however, contain reddish-brown hæmatoidin, sometimes presenting a somewhat crystalline structure, the crystals appearing in some instances after a hemorrhage had occurred several days before the stools were passed. In black tarry stools the presence of blood can be proved only by chemical tests (see Vol. II., page 74). Pus corpuscles occur in dysentery, ulcerative processes, and where an abscess has emptied into the bowel. Leucocytes are usually much degenerated and, if present in considerable numbers, are usually significant of ulceration.

Parasites.—Fæces contain lower forms of vegetable life which von Jaksch divides into two classes according to the manner in which they stain with iodo-potassic-iodide solution, viz., those that stain brown or brownish-yellow, and those that stain blue. The latter occur in relatively small numbers in health. Moulds are rarely present in fæcal matter, only the thrush fungus being occasionally seen, and then in children with thrush. Yeast cells are very common, being present even in the stools of breast-fed infants. They are more abundant in the acid stools of children. The fission fungi, chiefly bacteria, probably in most instances constitute the greater portion of the bulk of fæcal matter, occurring in enormous numbers, the figures obtained by different observers who have attempted to enumerate them ranging from 15,000 to 80,000 or even higher as an average for each milligram. Animals thrive in the absence of these forms of life in the intestinal contents, and they are not present during fœtal life, yet their presence is probably not without benefit. On a strict milk diet the number rapidly diminishes. In the stools of infants the bacteria commonly present are the Bacillus coli communis and the Bacillus lactis aerogenes; they give rise to acid fermentation with the production of acetic and higher fatty acids and occasionally formic acid, but they do not occasion a true putrefactive process. The varieties in the stools of adults are very numerous, more than fifty species having been identified, a number that does not at all adequately express the many species that probably are present under all possible conditions. It is generally accepted that the colon bacillus is the most constant inhabitant of the lower bowel, and with it are several of the different species active in putrefactive processes. For an account of the individual species and of the pathogenic bacteria, see the article on *Bacteria* and those that treat of the various diseases. Animal parasites of various description at times inhabit the intestinal tract, and may be passed with the stools. They include various protozoa, many species of worms, and not a few insects. For an account of these see the article on *Parasites*.

Chemical Composition.—Normal fæces contain *moisture and volatile* substances to the extent of from sixty-eight to eighty-two per cent. of their weight, the water comprising about five per cent. of the total amount lost by the body through the various channels. In soft and watery stools the amount of water may increase to ninety-seven per cent. or more, while in hard stools it may diminish considerably. The other volatile constituents present in relatively small amounts are volatile fatty acids, phenol, indol, and skatol.

On ignition fæces usually yield an amount of *ash* equal to about one-eighth or less of the total solids, but this does not represent the condition of the mineral matter in the fresh material, since the acids of the ash are to a considerable extent formed from the organic matter in the process of combustion. Avoiding this error, Grundzach found in a normal adult, living on a mixed diet, that the bases were chiefly calcium and in smaller amounts potassium and magnesium, with still less of sodium and a very small amount of iron, and that twenty-two per cent. of these bases were combined with inorganic acids, chiefly phosphoric, but with small amounts of sulphuric and hydrochloric, and that the remaining seventy-eight per cent. were combined with organic and carbonic acids. In stools containing much serous transudate the quantity of chloride is greatly increased. Studying the secretions of the large intestine in a patient with an artificial anus in the lower ileum, Kobert and Koch found that on an average one-fourth of the solids is ash, about one-half of this in one examination being phosphate. It is evident, then, that the inorganic solids are derived from the intestinal and other secretions as well as from the food residue. The quantity of iron is usually found to vary between 2 and 25 mgm. in twenty-four hours, but it has been found to be 50 mgm. or more in malarial infection with much destruction of hæmoglobin.

The chief class of organic substances in the fæces is the *proteids*, the most important of these, the albuminoid bases of intestinal mucus, forming the chemical basis of fæcal matter. This is not mucin as was formerly supposed, but a phosphorus-containing, albuminous substance, probably identical with, or closely allied to, nucleo-albumin. True mucin is not regularly present in fæcal matter. It is, however, the chief substance imparting to human bile its mucilaginous character, and presumably may at times pass from the bile into the fæces, as well as from the saliva in which it is an important constituent, and from the food; but it has not been proved to be a regular constituent of human excrement. Appreciable quantities of albumins and globulins are present in pathological conditions only, namely, when there is serous fluid present, or when the food has passed through the body so rapidly as to escape complete digestion, and less frequently when the digestive function itself is not properly maintained. Thus in typhoid and dysentery albumins may be found; in the rice-water stools of cholera they are constantly present; they have likewise been found in stools deficient in bile. Since microscopic bits of bile-stained meat fibres can always be recognized in stools after a meat diet, it is presumable that myosin is present at the same time; but the quantity under ordinary conditions is hardly appreciable. Another class of proteids not present in the fæces of health is the products of digestion, the proteoses and peptones. They are constantly present whenever pus is found in the stools, and irregularly in certain other conditions. Nucleins are stated to be commonly present in fæcal matter. Whether in most instances they are true nucleins derived from the food or are paranucleins from mucus and nucleo-albumins of the food residue is uncertain, but it seems probable that in many instances they are paranucleins. Leucin and tyrosin are not present in the evacuations of health, and in diseases only when the passage through the lower bowel has been so rapid as not to permit of absorption. Hence they are to be looked for, and are frequently found in the stools of cholera and other conditions characterized by watery movements. Crystals of calcium and magnesium soaps were at one time believed to be tyrosin crystals, but their true nature is now recognized.

An important class of substances appearing in the fæces in greater or less quantity is the *fats* and their derivatives, consisting chiefly of neutral fat and soaps with some free fatty acids. The total quantity of these in an adult on an average mixed diet in health is only exceptionally as high as twenty-five per cent. of the dry solids of fæcal matter, the soaps and free fatty acids usually present making up three-quarters of the amount, with perhaps rather more soaps than free acids. The absolute quantity is influenced by the character of the food, only to a limited extent. In starvation and on some diets the fat of the excrement even exceeds the quantity ingested, while it has been observed that increasing the fats of the diet as much as twenty times only doubles the amount in the stools. When 100 gm. are ingested not more than from 4 to 6 per cent. of this amount should be contained in the fæces. It is interesting that the fat of lower melting-point is more readily absorbed, the fatty acids recovered from the stools usually melting seven degrees higher than those of the food. With diminished absorption the difference is less, and in diarrhœa may be almost inappreciable. The presence of free fatty acids in the ingested fats likewise favors absorption and correspondingly diminishes the amount excreted. In obstructive jaundice the total quantity of fat is greatly increased, the amount in some instances reaching seventy-five per cent. or more of the dry solids, without there being any considerable relative increase of neutral fat. With a failure of the pancreatic secretion, either with or without obstruction of the bile, there is likewise an increase in the fats excreted, but with a marked relative increase in the neutral fat. When the fats are thus increased, whether from insufficient bile or pancreatic fluid, the stools take the gray-white color and soft consistence that characterizes the so-called acholic stool. Mention should be made of the enormous, thick, pulpy stools of a dirty dark gray color and greasy appearance sometimes seen in diabetics. They contain a large quantity of neutral fat and other food residue, and are to be attributed to a diminution or absence of pancreatic fluid, from extensive lesion of the pancreas, which in these cases is the primary cause of the diabetic condition. Other conditions, in which an increase in the excretion of fats has been observed, are fevers, though usually not typhoid, and some cases of anæmia.

Carbohydrates appear in the fæces only when they are ingested and escape digestion and absorption. If they are easily soluble their utilization is usually complete, being determined entirely by the motor and absorptive functions, while starch demands the action of diastatic ferments for solution, and starch granules enclosed in cell walls are dependent still more on this latter function, and also call into exercise the action of bacteria to dissolve or decompose the cell cellulose. These facts are in accord with the observation that raw starch is more apt to appear in the stools than cooked and soluble carbohydrates. Considerably smaller quantities of starch can be detected by the fermentation test than by microscopic observation of the iodine reaction, by the former method 0.1 per cent. in one instance having been readily indicated, while by the latter 0.6 per cent. was not recognized, though it does not seem improbable that here the structural form was lost, and even that the starch was present in the soluble condition. Dextrin and gums may sometimes be detected in the stools, but even in diabetes dextrose is not present, though secretion into the intestines be induced by purgation. Of the pentoses rhamnose readily appears in the stools, xylose less readily, and arabinose only after its ingestion in large quantities. Cellulose is not dissolved by the digestive ferments, but to a slight extent is decomposed into methan and carbon dioxide by bacterial action. A large percentage is evacuated unchanged.

Of the *bile derivatives* the most important is the pigment. Under ordinary conditions bilirubin is reduced in the intestines to the color constantly present in fæces, known as hydrobilirubin, and to certain colorless closely allied substances capable of ready oxidation into pigment. The name "stercobilin," used by Vanlair and Masius, who supposed the color to be formed from bilirubin by oxidation, is still used by some writers rather than Maly's term, which expresses the true chemical relationship. The average amount contained in the twenty-four hours' evacuation was found by one observer to be 0.36 gm., not including the colorless products capable of yielding pigment by oxidation, of which a very considerable amount may be passed. Under certain conditions, as has been seen, the usual change in bile pigment does not occur, and biliverdin is present, giving to the discharge a green color. In the gray "acholic" stools, either bile pigment is absent or it is obscured by the presence of excessive quantities of fats. In the latter instances, the residue of fæces will be seen to be colored, when the fatty matter has been extracted with alcohol-ether. Biliary acids are to a large extent absorbed from the intestinal tract, either as such or after decomposition. Cholalic and cholcidic acids are regularly present in the fæces, but not in large amount. Taurin is likewise present, but it has been found that the quantity in twenty-four hours is only 0.32 gm. When the passage through the intestines is very rapid, so as not to permit either the usual chemical changes or absorption, the bile acids or the products of their decomposition appear in the fæces in greater amount.

Lecithin is not present in more than traces, being either decomposed or absorbed as such; of the products of its decomposition the fatty acids are in part excreted with the fæces. It has been already stated under what conditions cholesterin is present and that ordinarily this substance is reduced, during its passage through the intestines, to stercorin. This discovery of Flint has received abundant confirmation in the last few years, and it is now established that normal fæces of the adult do not contain cholesterin. The amount of stercorin is usually one gram or less in twenty-four hours. This substance differs from cholesterin, not only in crystalline form but in chemical composition, its formula being $C_{27}H_{48}O$ (cholesterin $C_{27}H_{46}O$), and in chemical behavior. The chloroform solution gives with concentrated sulphuric acid a yellow coloration which on long standing changes to deep yellow and finally deep red. It does not form halogen addition products. The crystalline needles melt at 95–96° C. Little need be said of the fats and soaps of the bile, since they meet the same fate as these substances in food. That they appear in the fæces in part is indicated by the passage of fat in starvation, and also with a fat-free diet.

The volatile substances of fæces include volatile fatty acids and aromatic products of decomposition. Of the former three-fourths consist of acetic acid and the remainder of butyric, isobutyric, valerianic, and caproic acids, and perhaps traces of others higher in the fatty acid series. These bodies are formed very largely as a result of putrefying and fermenting of the intestinal contents. Lactic acid should be mentioned in this connection since it is regularly present in the acid stools of infants on a milk diet. The aromatic decomposition products phenol, indol, and skatol are present in the putrid fæces of the adult. Occasionally hydrogen sulphide, ammonia and other volatile bases contribute to the odor. In the milk stools of infants decomposition products are usually absent, though occasionally indol may be found. Indol and skatol are colorless crystalline solids formed in the large intestines from albuminous substance by putrefaction and possessing a disagreeable pungent odor. Indol has the formula $C_8H_6.NH$, while skatol is methyl indol, $C_8H_5CH_3.NH$. Each of these substances may be absorbed and is then eliminated in the urine or sweat, after undergoing slight oxidation and entering into ethereal combination either with acid potassium sulphate or with glycuronic acid, the indol in this condition ap-

pearing as indoxyl, the indican of the urine. In the fæces the quantity of these substances is small, but sufficient to give character to the excrement.

The *nitrogenous substances*, usually excreted by the kidneys, at times leave the body in the fæces in considerable amounts. Thus both urea and ammonium salts may be present in uræmia in notable quantities, while it appears that the purin bases, xanthin and hypoxanthin, are in leukæmia excreted through this channel to the extent of 1 gm. a day, which amount is even greater than leaves the body in the urine. Since these substances are present in small quantities in health, they must be considered normal constituents of the fæces. They are not increased in gout. Uric acid has not been found in the fæces of man.

Mention should be made of the components of intestinal flatus. They consist of carbon dioxide, hydrogen, nitrogen, and methan. Ad. Schmidt concludes that the amount of nitrogen decreases with an increase in the tendency of the material to undergo fermentation, which condition depends on the amount and degree of digestion of the carbohydrate of the food. The quantity of methan varies in the same way.

There are present in the fæces substances that render this material poisonous. Regarding them and the poisonous products in the various diseases the reader is referred to the article on *Auto-intoxication*, and he is also reminded of the probability that the fæces will at times contain the toxins produced by the bacteria that are active in the intestines during the formation of the fæces.

An account of the chemistry of the fæces is incomplete without mention of the *chemical reaction*. In the adult it is alkaline, the acid contents of the upper intestinal tract being more than neutralized by the abundant secretion of sodium carbonate by the large intestine, and furnishing conditions favorable for ammoniacal fermentation. In typhoid, ammonium carbonate is present in unusual quantity, giving an increased alkalinity. After a diet rich in vegetables the fæces may be slightly acid; when bile is wanting they are strongly so. They are usually acid in infants, and in adults as well are markedly so in acute indigestion, the acidity being due to lactic and butyric acid fermentation.

Finally, mention should be made of certain *ferments* usually present in fæcal matter. A diastatic ferment is constantly present, derived apparently from the lower part of the small intestine, the amount varying inversely with the solids, being greatest in diarrhœa. It is not influenced by the character of the diet. Invertin is said to accompany diastase in the stools of infants. A proteolytic ferment, which is apparently trypsin that has escaped destruction in its rapid passage through the bowel, is reported to be present in diarrhœal discharges.

In the study of the digestibility or utilization of a definite food or dietary, it is important to distinguish the fæcal matter containing the residue from this particular ingested material. The *separation of the stools* thus becomes an important part of the experimental observation. This is accomplished by the ingestion, at the beginning and end of the experimental period, of material which so marks or characterizes the fæcal discharge as to render possible a mechanical separation, both from the fæcal matter preceding and from that immediately following. A considerable number of substances have been employed for this purpose, including in dogs bone, silica, and cork, and in man lampblack, milk, and carmin. Perhaps the most satisfactory procedure is to limit the meal immediately preceding the period of the special dietary, and also the meal immediately following, to milk, with which, at the same time, several gelatin capsules containing lampblack are to be taken. In the separation advantage can then be taken both of the salve-like consistence of milk stools and the dark color imparted by the lampblack. In many instances this separation is very satisfactory, but in diarrhœa, and particularly in constipation with formation of scybala, the boundary line is not always well marked.

After the fæces corresponding to a definite period have been obtained, it is then desirable to distinguish what portion of the material is residue from the ingested diet, and what is waste from the intestinal tract. The distinction between the *metabolism residue*, as these products are called, and the food residue is a matter of extreme difficulty, and although it has received much attention, there is no method known at the present day that serves to accomplish this end, except under definite and restricted conditions. The procedure of estimating the metabolic products in the fæces of starvation and deducting this amount from the total is inapplicable, since the metabolic products are increased with the ingestion of food and are dependent upon its character and amount. In many instances no effort is made to distinguish between metabolic and food residues, the total fæces being deducted from the amount of food ingested and the difference, instead of being termed "digestible" food, being called "available" or "utilized" food, and the factors deducted being termed "coefficient of availability" or "coefficient of utilization." Evidently these factors represent the net gain to the body rather than the digestibility of the food.

The fæces are at times the subject of special examination to ascertain the condition of the intestinal processes. The macroscopic appearance alone may indicate a diminution of the chemical or an increase in motor function, by showing an excess of fat or particles of food residue; but the microscopic appearances are of greater service to this end. When more exact knowledge is desired, the coefficients of availability of the nutrients of a given dietary of known amount and composition may be determined and these results compared with the coefficients in health. Ad. Schmidt and Strasburger have recently recommended different procedures that promise to be of some value in determining the utilization of carbohydrates. At the outset, after the ingestion of 0.3 gm. carmin, the patient is put on a special diet, known as No. 2, consisting daily of milk, 1,560 c.c., four eggs, 100 gm. zwieback, one plate barley soup (40 gm. barley), one plate flour soup (25 gm. flour), 375 c.c. bouillon, all containing 20 gm. sugar, in combination with the more common diet of 60 gm. chopped beef, and 250 gm. mashed potatoes (potatoes 190 gm., milk 60 gm., butter 7 gm.). In diet No. 1 the chopped beef and mashed potatoes are omitted. No. 3 consists of 1,690 c.c. milk, 2 eggs; flour soup, bouillon, and mashed potatoes as in diet No. 2, sugar 10 gm., milk rolls 225 gm., meat (cutlet) 150 gm. The diets are seen to contain carbohydrate in increasing amounts from 1 to 3 and successively in more difficultly utilizable form, as well. For most cases either or both 1 and 3 will be found advantageous in addition to 2. After the disappearance of the carmin, usually after an interval of three or four days, during which the diet is continued, the fæces are submitted to a fermentation test, as follows: The fresh stools are mixed with water (usually two parts) to the consistence of a thick fluid, and the mixture is put in a fermentation tube of about 30 c.c. capacity and left at body temperature. The formation of gas in twenty-four hours to one-third the capacity of the tube is a weak reaction; to two-thirds moderate, and more than this strong. Five conditions determine the development of the reaction, namely, the presence of (1) starch, (2) nutritive material, (3) obligatory bacteria, (4) a diastatic ferment, and (5) the absence of a high grade of acidity. A late appearance of gas is due to putrefaction of the material, and is not to be given the same consideration as the early fermentation. Strasburger concludes that early fermentation with diet 1 is always pathological; with diet 2, is on the boundary, but is more frequently pathological; with diet 3, is normal, yet in the majority of normal stools does not appear. Only positive results are of diagnostic value. Under most conditions carbohydrate is the variable factor, and it is apparent that Schmidt's method is primarily directed to the estimation of the utilization of this class of nutrients. The same investigator has devised a method of measuring the bulk of undigested meat fibre in the fæces after the ingestion of these same dietaries. The method consists essentially in determining the reduction in volume which the residue in the fæces undergoes when submitted to the action of pepsin-hydrochloric acid. The value of the procedure remains to be determined.

Ernest Ellsworth Smith.

FAHRENHEIT AND CENTIGRADE SCALES.—The following table, showing the value in degrees, tenths of a degree, and hundredths of a degree, according to the Fahrenheit scale, of every tenth of a degree of temperature from 44° to 32° Centigrade, while perhaps belonging more properly in the article entitled *Thermometer*,

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
44.0	111.20	0.9	0.82	0.9	0.62
.9	111.02	.8	.64	.8	.44
.8	.84	.7	.46	.7	.26
.7	.66	.6	.28	.6	96.08
.6	.48	.5	103.10	.5	.90
.5	.30	.4	.92	.4	.72
.4	110.12	.3	.74	.3	.54
.3	.94	.2	.56	.2	.36
.2	.76	.1	.38	.1	.18
.1	.58	39.0	.20	35.0	95.00
43.0	.40	.9	102.02	.9	.82
.9	.22	.8	.84	.8	.64
.8	109.04	.7	.66	.7	.46
.7	.86	.6	.48	.6	.28
.6	.68	.5	.30	.5	94.10
.5	.50	.4	101.12	.4	.92
.4	.32	.3	.94	.3	.74
.3	108.14	.2	.76	.2	.56
.2	.96	.1	.58	.1	.38
.1	.78	38.0	.40	34.0	.20
42.0	.60	.9	.22	.9	93.02
.9	.42	.8	100.04	.8	.84
.8	.24	.7	.86	.7	.66
.7	107.06	.6	.68	.6	.48
.6	.88	.5	.50	.5	.30
.5	.70	.4	.32	.4	92.12
.4	.52	.3	99.14	.3	.94
.3	.34	.2	.96	.2	.76
.2	106.16	.1	.78	.1	.58
.1	.98	37.0	.60	33.0	.40
41.0	.80	.9	.42	.9	.22
.9	.62	.8	.24	.8	91.04
.8	.44	.7	98.06	.7	.86
.7	.26	.6	.88	.6	.68
.6	105.08	.5	.70	.5	.50
.5	.90	.4	.52	.4	.32
.4	.72	.3	.34	.3	90.14
.3	.54	.2	97.16	.2	.96
.2	.36	.1	.98	.1	.78
.1	.18	36.0	.80	32.0	89.60
40.0	104.00				

is introduced in this place for the reason that such early introduction is likely to prove a convenience to many readers of the HANDBOOK. In the determination of the limits of this short table only the needs of the clinician have been considered.

FAINTING. See *Brain, Anæmia of*, and *Syncope*.

FALKENSTEIN, GERMANY.—There is nothing remarkable about the climate of Falkenstein which would warrant any extended account of it as a health resort. The name "Falkenstein," however, has become famous in connection with the renowned sanatorium situated there, and this demands notice as being one of the best exponents of the sanatorium treatment of pulmonary tuberculosis in the world.

Nine miles out of Frankfort is the picturesque village of Cronberg in the Taunus Hills, where resided the late Dowager Empress of Germany for a good part of the year. A walk of about forty minutes up the hill from here brings one to the tiny village of Falkenstein, commanding an extended view over the valley of the Main with Frankfort in the distance. Here, in a location protected on the north, west, and east is situated the sanatorium, 1,300 feet above sea-level. The institution consists of a main building with two wings joining it at an obtuse angle and enclosing a large terrace, and two annexes united to the main building by covered promenade galleries. The terrace enclosed by the wings of the main building and looking toward the south, has a continuous broad veranda of glass, provided with sun blinds and curtains, where upon cushioned reclining chairs one sees long rows of patients lying rolled in rugs, taking the rest cure, some reading or writing, others conversing, and a few sleeping. There are also, near by, pavilions, some revolving, affording further opportunity for the same treatment. The climate is that of central Germany, its principal characteristic being a pure atmosphere free from dust, which, from Dettweiler's point of view, is the chief consideration in the climatic treatment of phthisis, provided it can be utilized continuously. Only about half the days in the month are sunny.

The internal arrangements are similar to those in the other large sanatoria: A large, well-ventilated dining-hall accommodating two hundred persons; reading, music, and billiard rooms; post and telegraph office; bacteriological and analytical laboratory; throat and douche rooms; various offices and consulting rooms. Each sleeping-room has a special ventilating flue and the usual simple furnishings; linoleum floors, washable walls; they are never swept but cleaned with damp or wet cloths. The windows are always open. Near by are the dairy and stable, gas-works, and a disinfecting apparatus. As in most of the other sanatoria the system of drainage is on the principle of chemical precipitation with cleansing basin. The large corridors for rest treatment (*Liegehallen*), which were first introduced as a means of treatment at Falkenstein, have a powerful gaslight between the heads of every two chairs, permitting the patients to read as they lie out in the evening. Blue-glass spittoons containing water are distributed in the halls on brackets, smaller ones in the rooms, and white crockery ware ones on the grounds. Each patient is required to carry with him the Dettweiler pocket spit-cup, and expectoration except in these receptacles is absolutely prohibited—handkerchiefs or cloths not being allowed. The compliance with this law seemed to be perfect. The sputum is disposed of by throwing it into the waste water or by burning.

The *jour médical* for an average patient, as told by one of them, is as follows:

7 A.M. Rubbing—dry or wet—or a douche.

8. Breakfast, consisting of coffee, tea, or chocolate, with rolls, butter, honey, and milk.

Until 10, the rest treatment in the reclining chairs.

10. Second breakfast, of bread, butter, milk and soup, with wine or cognac. (Upon this latter Dr. Dettweiler places a high value.)

10:30 to 1 P.M. The rest treatment again.

1. Dinner: soup, fish, vegetables, several kinds of meat, fruit, dessert, and coffee.

2 to 4:30. The rest cure again.

4. Milk.

4:30 to 7:30. Rest or walking.

7:30. Supper, consisting of soup, hot and cold meats, salads, preserves.

After supper the rest treatment until 10, with milk at 9.

10. Retire.

It will be seen from the above that the rest treatment in the open air (*Ruheluft-Kur*) occupies most of the day, and herein is a marked difference between Görbersdorf and Falkenstein. Dettweiler lays great stress upon *rest* in the open air, while Brehmer puts the emphasis upon methodical *hill-climbing*. Dettweiler so insists upon this system of open-air rest treatment that the most of his patients spend from seven to eleven hours daily in the open air in spite of rain, fog, or snow, and of cold, even to 12° below zero. As Ransom observes: "This form of treatment is almost independent of weather." Each patient on admission is carefully studied, not only his physical condition, but his temperament and will power, and his intelligent and willing co-operation with the physician is obtained. His plan of life is then arranged in all its details. He is constantly under the eye of the physicians, and always sees them at the principal meals. To this skilled watchfulness and care, the hygienic-dietetic measures, and the hyperaëration is due the success attained in such an institution. Here, as at the other sanatoria, the treatment of fever is continued rest, physically and mentally, and this applies to all patients who have a temperature of 37.5° to 38° C.

(99.5° to 100.4° F.) or over. At some sanatoria, as at Hohenhonnef, the patient is not even allowed to lie out in the *Liegehallen*, for fear the moving and excitement may keep up or increase his fever, but is kept absolutely quiet in his room. Generally this treatment alone, with some Hungarian wine or cognac, suffices in a short time to reduce the temperature to normal. Knopf explains this disappearance of fever after a short sojourn at a sanatorium by the almost total absence of pathogenic microbes, especially the streptococci, in the pure atmosphere.

I was struck with the appearance of the patients as I saw them at dinner; they hardly differed from the persons one would see in the dining-room of an ordinary hotel, and presented only to a slight degree, if at all, the appearance one usually associates with a consumptive. During the entire meal I hardly heard a cough. Moreover, it was as contented and happy-looking an assemblage as one would see anywhere. The average length of residence is about three months.

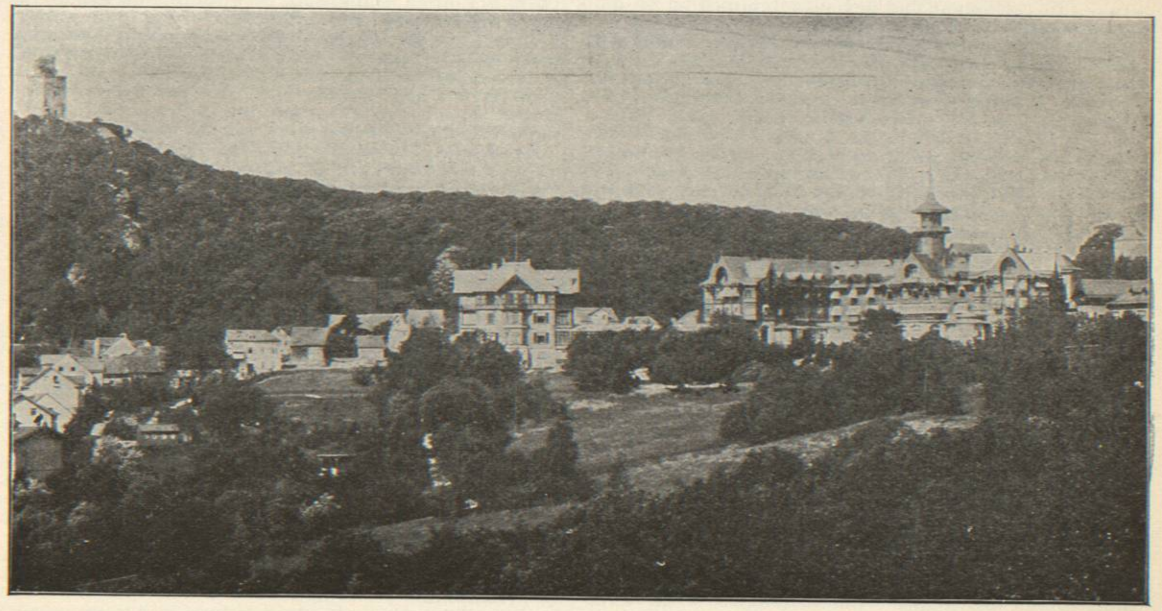

FIG. 2080.—The Sanatorium at Falkenstein, as seen from Adolfsfelsen.

The results at Falkenstein, from 1876 to 1886, of the patients who have been kept under observation since their discharge, is 13.2 per cent. of complete cures, and 11 per cent. of relative cures (disease arrested), a total of 24.2 per cent.; 60 per cent. or more are improved. The expense here, as at most of the other sanatoria, is from $20 to $25 a week.

One cannot leave Falkenstein without carrying away a lasting impression of its founder and guiding genius, Dr. Dettweiler. It was my good fortune to ride up to the sanatorium with him from his modest home in Cronberg. It was a chilly, disagreeable morning in May, much like our March weather, which perhaps suggested his remark that it was not so much a climate as a method; tuberculosis could be cured in any climate. He told me of his early struggle with tuberculosis in his own case, when it seemed that he could not live. But the struggle was successful, and now he is a man of middle age or more, and has accomplished an immense amount of work, and is still the inspiration of his sanatorium. He is a man of great simplicity and sympathy, inspiring enthusiasm, and well illustrates the power of the personal factor in the success of the physician. He makes his patients love him, and in consequence they readily yield to his will and guidance. "In him," as Dr. Thorne says, "reason, science, and long experience are correlated into action by discrimination, adaptability, sympathy, and unbending will. In both of the senses in which the term can be employed, he is a presiding genius."

Edward O. Otis.

FALLOPIAN TUBE. (ANATOMICAL.)—See *Generative Organs, Female.*

FALLOPIAN TUBES, DISEASES OF.—ANATOMY.—In order to comprehend completely the nature of the diseases and neoplasms of the Fallopian tubes or oviducts, a thorough knowledge of their anatomy and embryology is requisite. The oviduct has a common origin with the vagina and uterus from the Müllerian ducts. The upper portion of these ducts remains open externally and that portion forms the pavilion of the tube. The occurrence of secondary pavilions, or ostia, may be explained by supposing that the canal of Müller is not completely closed in all its extent at that period of embryonic life when the two borders of the gutter which give origin to it are turned toward each other to transform the channel into a tube. The Müllerian ducts unite lower in their course to form the uterus and vagina, and the limit of this union is the insertion of the round ligament. The similarity in structure and the continuity of mucous membrane explain how readily disease of vagina and uterus extends to and involves the tubes. These structures are veritably the excretory ducts of the ovaries and are placed, one on each side of the uterus, to permit the passage of the spermatozoid toward the ovary and to transmit the ovule from that organ to the uterus. They are in the upper folds of the broad ligaments, and their average length is from 10 to 12 cm. Their length may be unequal and is subject to considerable variation, as in cases of ovarian tumors, when it may be very much increased. The tube consists of three coats, the incomplete peritoneal, the