best conditions of nutrition are found in the small tumors of the uterus, which sometimes are composed entirely of muscle fibres and blood-vessels. Such tumors have the grayish-red, dull appearance which the uterus shows on section, and microscopically they cannot be distinguished from the uterine tissue. The small lymph spaces which were spoken of may become widened to form large cysts filled with a clear fluid analogous to serum and coagulating spontaneously on exposure to air. Often these do not seem to have a special lining membrane. Small processes of connective tissue sometimes grow from the walls of these cysts, which penetrate between the adjoining bands of muscular tissue, and in this way a series of smaller cysts may arise. These *cystomyomata* of the uterus may attain a large size, especially when, as often happens, heterologous formations of a myxomatous or sarcomatous character arise in them. Single cysts of large size, entirely surrounded by muscular tissue, are sometimes found. Their contents are fluid, generally more or less colored with blood pigment from numerous hemorrhages which have taken place into them. The contents of all of these cysts will usually coagulate spontaneously. The walls often contain a layer of fibrin of variable thickness, and the cysts may be traversed by bundles of muscle tissue. Dilated blood-vessels are often found in the neighborhood of the tumor, and in the extramural forms they run in the loose connective tissue of the attachment. These are the most frequent source of the hemorrhages which so often accompany this form of tumor, they being often torn across by the traction of the tumor. The dilatation of these vessels is nothing but a passive process, but in some cases there is a very abundant formation of vessels in the tumor itself. Virchow distinguishes this variety under the name *telangiectatic myoma* or *cavernous myoma*. There is little or no development of connective tissue, and the vessels are immediately in contact with the muscular bundles. It is in such tumors that marked variations in size are seen, the tumor appearing sometimes double its usual size. It is probable that this variability in size may be due both to changes in the amount of blood in the dilated vessels and to different degrees of contraction of the muscle cells.

There may be mixed forms of myomata. The most frequent combinations are with myxomatous and sarcomatous tissue. The myxomatous degeneration occurs when much fibrous tissue is present. Sarcomatous change is much less frequent. Such tissue develops around the vessels in the septa between the bundles of muscles. The myxomatous tissue in the tumor can be recognized as patches of grayish, gelatinous material, while the sarcomatous portions are whiter and less refractive than other parts. Combinations with other forms of tumors do not take place. In the uterus carcinoma may coexist with myoma, and the carcinoma may erode and grow into the myoma in the same way that it grows into the muscle tissue of the uterus itself.

Of the degenerative processes the most frequent is calcification, which may affect the whole tumor or only parts of it. When the calcification is complete the whole tumor may be changed into a hard, stony substance, in which no tissue or blood-vessels can be made out. Generally the process is not so complete as this, and a network of calcified tissue traverses the tumor, in the meshes of which small bands of muscle tissue and vessels are seen. In some cases a true formation of osseous tissue has been made out in the tumor, and in one tumor the writer has observed areas of adipose or true fat-bearing connective tissue. Occasionally complete gangrene may result from interference with the blood supply of large areas. Suppuration is rare but may occur. After the menopause these growths are said to undergo atrophy.

An interesting form which occasionally occurs is one which contains glandular structure of the type of the uterine mucosa and is known as adenomyoma. It is distinctly a benign tumor, though its growth may be diffuse. It is usually situated in the inner layers of the muscular wall. Opinions vary as to the origin of this growth. Von Recklinghausen believes that it develops from remnants of the Wolffian body, but admits the possibility of its origin from the uterine mucosa. Cullen (Johns Hopkins Hospital Reports, vol. vi., 1897), who has studied carefully two cases, believes the latter to be the only possible origin.

The presence of a myoma usually produces more or less hypertrophy of the muscular coat. This is especially true of the mucous form. Distortion of the uterus is common. The mucosa is usually atrophied over submucous myomata, but elsewhere is unaltered (Cullen).

Broad Ligament.—It is very doubtful if myomata ever arise in the broad ligament. Tumors found there are in reality subserous forms which have developed in the lateral wall of the uterus, and have finally become separated from it.

Prostate.—The myomata of the prostate come next in importance to those of the uterus, and are most frequently found in advanced age. Some of these enlargements of the prostate depend on an actual hypertrophy, in which all parts of the gland participate. In others, the enlargement is principally due to hyperplasia of the glandular elements, and this form passes most readily into adenoma. In the third class Virchow has shown that the enlargement is principally due to a hyperplasia of the smooth muscle fibres, which make up a large part of the gland.

This new formation is sometimes diffuse, but more often is in the form of distinct nodules. The favorite seat for their formation is on the posterior upper portion of the gland, and this distinct tumor formation is generally spoken of as hypertrophy of the third lobe of the prostate. The lateral halves of the gland are the next most frequent seat of this formation. It is rather rare that the anterior part of the gland is affected, although Thompson has described a tumor here as large as a walnut.

Digestive Tract.—The myomata of the digestive tract are, next in order, most frequent. Their microscopic characters do not present any differences from those of the uterine myomata. Cyst-formation and degenerative processes are not commonly found. They occur in the œsophagus, generally near the cardiac end, in the stomach, and in the intestine. Myoma of the appendix has also been reported. They are comparatively rare in all these localities, they seldom attain a large size, and usually do not give rise to symptoms, unless of sufficient size to produce obstruction or invagination. In the duodenum such tumors may obstruct the common bile duct (Delafield and Prudden). These tumors develop from the muscular coats of the canal, soon project into the lumen, are covered only by the mucous membrane, and may become pedunculated. Less frequently they project outward beneath the peritoneum.

Skin.—Myomata in this location are divided by Besnier (Hyde) into two groups: simple and dartoic. The former are rare, less than a dozen cases having been reported. They are generally multiple, occurring chiefly on the upper extremities and in old people, especially men. They are supposed to arise from the erector pili muscles.

The dartoic type is more common, generally occurs singly, and is found most frequently in the skin of the mammæ, scrotum, and labia majora. They may be sessile or pedunculated, and vary from the size of a nut to that of an orange. Mixed forms may occur, as fibromyoma, angiomyoma, and lymphangiomyoma.

Bladder.—Myoma of this organ is rare. It was first described by Virchow, who supposed it to be an outgrowth of the prostate; but a myoma of the bladder pure and simple, arising from the muscularis and extending beneath the peritoneum, has since been described by Belfield (*Wien. klin. Woch.*, 1881, 329), and a somewhat similar one by Verhoogen (Kelly, "Operative Gynæcology"). These tumors may be sessile, but are usually pedunculated. They may be submucous or subserous, and vary greatly in size. In Verhoogen's case it was the size of a child's head. They are usually quite vascular.

Urethra.—Myoma in this location is rare. Büttner (quoted by Kelly) found an ulcerated myoma the size of a hen's egg in a woman of forty years of age.

Veins.—Small leiomyomata have been found in the saphenous and ulnar veins. A large myosarcoma of the inferior vena cava has been reported.

Kidney.—Minute myomata, usually multiple, are occasionally found in the kidney. They are generally found in the cortex, close beneath the capsule, and may arise either from the capsule or from blood-vessels (Lartigau and Larkin, *Journal of Medical Research*, N. S., vol. l., No. 1, 1901). They give rise to no symptoms during life.

Other locations in which leiomyoma is occasionally found are the spermatic cord (the growth occurring here sometimes as a myolipoma), the liver (where these growths are of slight significance), the Fallopian tubes, ovaries, vagina, and vulva; in all of which locations the type is generally that of a fibromyoma. In mixed tumors of the mammary gland small masses of both smooth and striated fibres are occasionally seen.

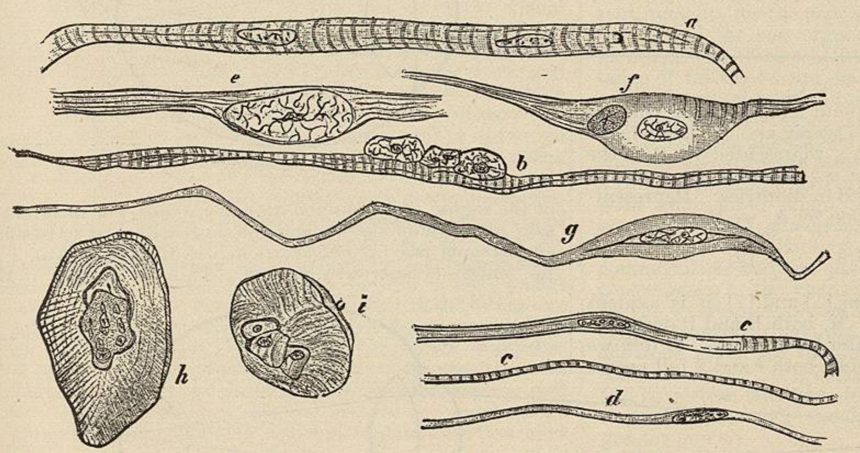

FIG. 3467.—Cells from a Rhabdomyoma. (From Ribbert and Wolfensberger.) *a*, *b*, *c*, Fibres of various sizes with transverse striation; *d*, small nucleated fibre without striæ; *e*, spindle cell with longitudinal striæ; *f*, spindle cell with longitudinal and transverse striæ: *g*, spindle cells, non-striated, with elongated processes; *h*, *i*, round cells with concentric and radial striation.

Rhabdomyoma.—This form of myoma, into whose structure striated muscle fibres enter, must be considered one of the rarest of tumors. The first of these tumors was described by Rokitansky, and since then not more than thirty or forty cases have been reported. Von Recklinghausen found in the hearts of newly born children, in a few instances, small tumor masses which contained striated muscle fibres. Generally the tumors are not pure forms, but are mixed with sarcoma. The muscle fibres are, as a rule, not straight and arranged in masses, but are separated from one another and irregularly distributed in the tumor. The character of the fibres varies. The well-developed fibres appear as nuclear bands of varying width and may have both longitudinal and transverse striations. The poorly developed forms are narrow bands without transverse striations, or spindle cells with long processes and imperfect or no striations; also there may be seen irregular round or oval cells, varying in size, with radial or concentric striation. Associated with these are numerous cells of indefinite origin. (See Fig. 3467.) A sarcolemma is not always demonstrable, but has been described.

The most frequent place of formation of these tumors is in the genito-urinary system, especially in the kidney or testicle, and frequently in the uterus, vagina, bladder, or ovaries. They occur occasionally, however, in other locations, as in the skeletal muscles, parotid gland (Prudden), subcutaneous tissues, mediastinum, and œsophagus. They are found almost exclusively in children, and may reach a very large size; as in the case described by Marchand, in which such a tumor of the left kidney extended from the diaphragm to the pelvis and weighed 2,770 gm. Most probably the explanation given by Cohnheim of their origin, which refers them to unused embryonic material, is the correct one. Their presence in such parts where complications in the embryonic formations take place, and where there is a mingling of the germinal layers, speaks in favor of this. *Richard Mills Pearce.*

MYOPIA—M—(*μυωπία*, *μυωπίασις*, also *μυωπός*, *μυώψ*—from *μύω* and *ὤψ*, signifying winking or contracting the eyelids—German, *Kurzsichtigkeit;* French, *vue courte;* English, short- or near-sightedness)—is mentioned by Aristotle, in the Galenical writings, and by the Byzantine medical authors—Oribasius, Aëtius, Paulus Ægineta, and Actuarius. It is described as a congenital condition, in which small near objects are seen distinctly, but distant objects imperfectly or not at all; also as the opposite condition to that occurring in old persons who distinguish small near objects, such as written characters, imperfectly, but see well at a distance. It is further recognized as incurable.

These brief statements, which comprehend practically the sum of the teaching of the earlier writers on medicine, and which were not seriously questioned until after the middle of the last century, include, nevertheless, two fundamental errors: (*a*) M, although very common in children, and dependent in many cases on inherited tendencies or conditions, is very rarely congenital; and (*b*) M is not the opposite condition to presbyopia—which is a disability resulting from impairment of the function of accommodation incident to advancing age—but is really the opposite of hypermetropia—H—(see *Hypermetropia*), which is a congenital condition, and which, like M, consists essentially in a faulty proportion between the radii of curvature of the refracting surfaces of the eye and the length of the antero-posterior axis of the eyeball.

As in H the axis of the eyeball is, as a rule, actually shorter than in the normally proportioned (emmetropic) eye, so in M the axis of the eye is, as a rule, longer than in the emmetropic eye. These two opposite anatomical conditions constitute, in fact, the essential variations from the normal in typical H and M respectively, namely, *axial* H and *axial* M.

Fig. 3468 represents, in section, a myopic eye, the dotted outline indicating the section of the emmetropic eye (*cf.* Fig. 2758, vol. iv., p. 796). It has been explained (see *Accommodation and Refraction*, vol. i., p. 56) that the sum of the successive refractions at the cornea and the two surfaces of the crystalline lens is just sufficient to focus pencils of parallel rays upon the retina at its normal position *E*, and that, through the exercise of its accommodation, the emmetropic eye is able to focus, upon its retina, pencils of divergent rays, such as are received from near objects (*cf.* Fig. 2762, vol. iv., p. 797). In the myopic eye the principal focus—*i.e.*, the focus for pencils of parallel rays—is in front of the actual position of the retina, so that the retinal image of any distant object is made up of overlapping circles of confusion and is, therefore, imperfectly defined.

The unaccommodated myopic eye is, however, adapted for the correct focussing of pencils of divergent rays emanating from an object at some particular short distance, as shown in Fig. 3469, in which a pencil of rays diverging from r is represented as refracted to a focus on the retina of the myopic eye at M. The distance of this *far-point* of distinct vision (*punctum remotissimum*—r), measured from the eye in metres or fractional parts of a metre, is the reciprocal of the grade of the myopia expressed in dioptries. Representing this distance by R, and the grade of the myopia by M, we have:

$$R = \frac{1}{M} \text{ metre} \quad . \; . \; . \; . \quad [1]$$

By the exercise of its accommodation the myopic eye is able to adjust itself for distinct vision at any distance less than R, up to a limiting point p (Fig. 3470), which is called the *near-point* (*punctum proximum*). The distance of the near-point from the eye, represented by P, is the reciprocal of the grade of the myopia plus the range of accommodation, both expressed in dioptries. Representing the range of accommodation by A, we have:

$$P = \frac{1}{M + A} \text{ metre} \quad . \; . \; . \; . \quad [2]$$

From the form of equations [1] and [2], it is evident that, for increasing values of M, both R and P decrease, but that R decreases at a greater rate than P. It follows that for higher grades of myopia, both r and p fall nearer to the eye than for lower grades of myopia, and that they also fall nearer together.

Subtracting equation [2] from equation [1], we have:

$$R - P = \frac{1}{M} - \frac{1}{M+A} \text{ metre} \quad . \; . \; . \; . \quad [3]$$

The linear measure R — P, which represents the difference in the distance of the far-point (r) and the near-point (p) from the eye, and which represents, therefore, the linear distance through which the myopic eye is able to adjust itself for distinct vision by the full exercise of its accommodation (A), is its *region of accommodation*. As R is the reciprocal of M, the region of accommodation, R — P, is at its maximum (infinity) when M = zero (emmetropia). Table I. shows the measure of R, of P, and

TABLE I.

M =.	$R = \frac{1}{M} =.$	$P = \frac{1}{M+A} =.$	$R - P = \frac{1}{M} - \frac{1}{M+A} =.$
1. D........	$1 = 1.000$ m.	$\frac{1}{11} = 0.091$ m.	$\frac{10}{11} = 0.909$ m.
2. D........	$\frac{1}{2} = 0.500$ m.	$\frac{1}{12} = 0.083$ m.	$\frac{10}{24} = 0.417$ m.
3. D........	$\frac{1}{3} = 0.333$ m.	$\frac{1}{13} = 0.077$ m.	$\frac{10}{39} = 0.256$ m.
4. D........	$\frac{1}{4} = 0.250$ m.	$\frac{1}{14} = 0.071$ m.	$\frac{10}{56} = 0.179$ m.
5. D........	$\frac{1}{5} = 0.200$ m.	$\frac{1}{15} = 0.067$ m.	$\frac{10}{75} = 0.133$ m.
6. D........	$\frac{1}{6} = 0.167$ m.	$\frac{1}{16} = 0.063$ m.	$\frac{10}{96} = 0.104$ m.
7. D........	$\frac{1}{7} = 0.143$ m.	$\frac{1}{17} = 0.059$ m.	$\frac{10}{119} = 0.084$ m.
8. D........	$\frac{1}{8} = 0.125$ m.	$\frac{1}{18} = 0.056$ m.	$\frac{10}{144} = 0.069$ m.
9. D........	$\frac{1}{9} = 0.111$ m.	$\frac{1}{19} = 0.053$ m.	$\frac{10}{171} = 0.058$ m.
10. D........	$\frac{1}{10} = 0.100$ m.	$\frac{1}{20} = 0.050$ m.	$\frac{10}{200} = 0.050$ m.

of R — P, respectively, for progressively increasing grades of myopia, from 1. D to 10. D, in a young person with an unimpaired range of accommodation of 10. D.

Inspecting Table I., it will be observed that in high grades of myopia both the near-point (p) and the far-point (r) are very near to the eye, and that the region of accommodation (R — P), although extended, by a few centimetres, in the direction toward the eye, is so greatly contracted, as a whole, as practically to annul the part played by the accommodation in seeing at short range; only in the lower grades of myopia, in which r lies farther from the eye than the reading distance, is there a limited field for a partial exercise of the accommodation to meet the restricted requirements of near vision.

As a consequence of the displacement and contraction

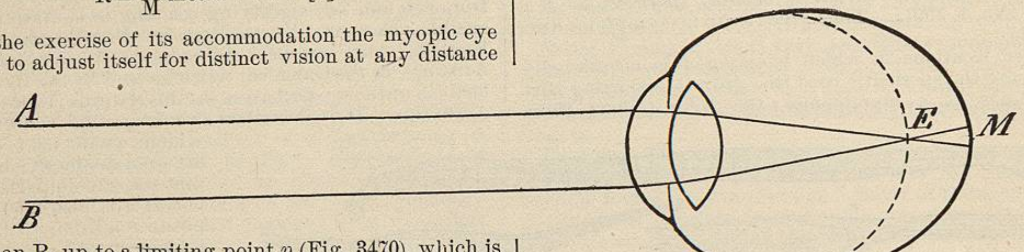

FIG. 3468.

of the region of accommodation in myopia, the interrelation of accommodation and convergence, as it exists in emmetropia (see *Accommodation and Refraction*, vol. i., pp. 55–58), is materially altered. Thus, in myopia of M

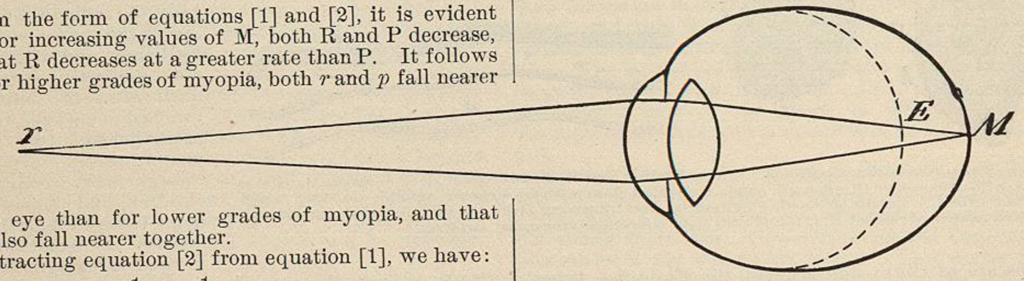

FIG. 3469.

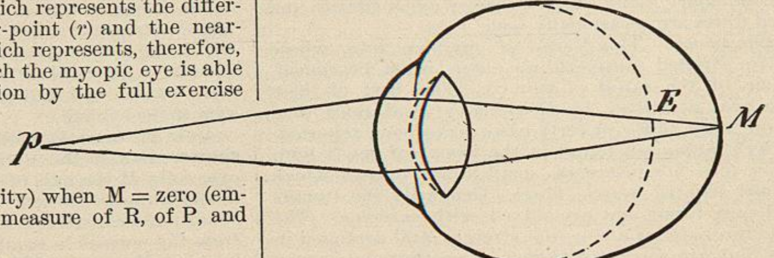

FIG. 3470.

dioptries, the farthest point of distinct vision—r—(under full relaxation of the accommodation) is at a distance of $\frac{1}{M}$ metre from the eye; but, in order to see an object at this distance with the two eyes, the axes of the two eyes must converge to an amount represented by M metre-angles (see vol. i., p. 583, note). It follows that for perfect binocular vision, at or within the distance of the far-point, a normal exercise of the convergence, corresponding to the distance of the (near) object, must be associated either with full relaxation or with less than the normal exercise (relative relaxation) of the accommodation; in other words, there is an essential change in the relation between accommodation and convergence from that which obtains in emmetropia, in which (normal) condition an exercise of the convergence measured by any number of metre-angles goes hand-in-hand with the

exercise of an equal number of dioptries of accommodation.

As a fact, a notable readjustment of the physiological bond by which the two functions of accommodation and convergence are linked together follows closely upon the progressive change in the refraction in most cases of myopia; and this readjustment is often so nearly perfect as to admit of the easy and sustained use of the two eyes together in near work. Thus in most cases of stationary or slowly progressive myopia, up to a grade of about 3. D, no difficulty is experienced in reading ordinary print, with the two eyes, at approximately the normal reading distance of about $\frac{1}{3}$ metre; also, in notably higher grades of myopia, very fine print may be read, easily and without fatigue, at some shorter distance corresponding to the distance of the point of intersection of the visual axes. Hence the very old and widely disseminated belief that myopes, as a class, enjoy a substantial advantage in respect of strong and fine vision in near work, and that this advantage, together with the further advantage of partial or complete exemption from the ordinary disabilities incident to presbyopia, may be held to outweigh the single recognized disadvantage of imperfect vision at a distance. That this old belief is, in the main, erroneous, and founded in ignorance or imperfect appreciation of the pathology of myopia as the visual expression of distention of the eyeball from disease, is proved by the anatomical demonstration of extensive and characteristic lesions in the fundus and coats of the eye in high grades of myopia; by the study of these lesions in the living eye in their successive stages of development, as revealed by the ophthalmoscope; by extended statistical researches on the refractive conditions existing in the eyes of school children in the lower and higher classes and grades; and by clinical experience based on successive examinations of the eyes of individual myopes, extending often over many years.

Two fundamental facts, based on exhaustive studies of myopia during the past half-century, are definitively established:

(*a*) Myopia is ordinarily the optical expression of an elongation of the antero-posterior axis of the eyeball, dependent on a pathological distention of the globe. Furthermore, this distention is in many cases rapidly progressive, and not infrequently attains to so high a grade as to become a grave menace to the integrity of the eye as an organ of vision.

(*b*) In many cases of myopia, especially when it is of high grade or of rapid development, the compensatory readjustment of the convergence to the displaced region of accommodation is in so far incomplete as to give rise to a state of persistent conflict between accommodation and convergence. As alternative issues of this conflict there may result either an habitual exercise of the accommodation in excess of that which is required for perfect vision at the distance of the point of intersection of the visual axes, or accurate accommodation for the actual reading distance accompanied by fatigue or insufficiency of the recti interni muscles—muscular asthenopia, or relative or actual strabismus divergens (see *Asthenopia* and *Strabismus*).

A myopic eye looking through a concave lens of any (negative) power up to the measure of its myopia is rendered virtually less myopic. With a concave lens of N dioptries, taking N < M, the uncorrected part of the myopia is M — N dioptries.

If we take N = M (Fig. 3471), we have M — N = zero, in which case the myopia is completely corrected (neutralized) by the concave lens, and the eye is rendered virtually emmetropic, *i.e.*, the far-point (r) is carried off to an infinite distance. At the same time the near-point (p) is removed farther from the eye, to a distance, $\frac{1}{A}$, determined by the magnitude of the range of accommodation (see *Accommodation and Refraction*, vol. i., p. 57).

The effect of a concave lens added to a myopic eye is, then, to remove both the far-point (r) and the near-point (p) to a greater distance from the eye; but the recession of r is greater than that of p. The region of accommodation (R — P) is therefore enlarged, attaining its maximum (infinity) when the (negative) power of the lens is numerically equal, in dioptries, to the grade of the myopia.*

As a result of this re-establishment of a normal region of accommodation, with the far-point (r) at infinity, the requirements for the conjoined exercise of the accommodation and the convergence in binocular vision become identical with those which obtain in emmetropia—the distance of the near-point, as determined by the exercise of a certain number of dioptries of accommodation, now coinciding with that of the point of intersection of the visual axes, as determined by an exercise of the convergence measured by the same number of metre-angles. As a rule, in uncomplicated myopia of low or medium grade, with unimpaired range of accommodation and normal acuity of visual perception, little or no inconvenience is experienced in utilizing fully the enlarged region of accommodation and, at the same time, re-adjusting the convergence to the changed optical conditions imposed by the wearing of neutralizing concave glasses. In the higher grades of myopia, especially if concave glasses are to be given for the first time, only a partial optical correction may be accepted in the beginning, and the full correction may have to be reached by a later change, or perhaps through one or more changes, to glasses of greater power.

With advancing years, as the crystalline lens becomes progressively harder and less capable of undergoing changes in form (see *Accommodation and Refraction*, vol. i., p. 59), the range of accommodation (A) diminishes in myopia just as in emmetropia and in hypermetropia. With decreasing A, approaching zero in old age, $P = \frac{1}{M+A} \, . \, . \, [2]$ increases, approaching $R = \frac{1}{M} \, . \, . \, [1]$ as a limit; the region of accommodation (R — P) being then reduced to zero through the recession of p to r. At the practically unchanged distance of r, the vision of the myopic eye is still perfect, and whenever r lies within a convenient reading distance from the eyes, as in myopia of not less than 3. D or 4. D, convex glasses are not needed for reading. In myopia of less than 3. D the need of convex reading glasses is first experienced later

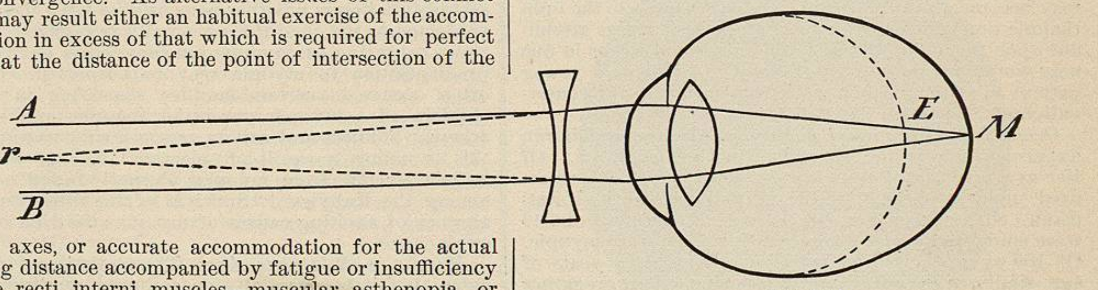

FIG. 3471.

in life than in emmetropia, and relatively weak glasses then suffice. Similarly, in the higher grades of myopia, concave glasses weaker than those which completely correct the eyes for distant vision must be given for reading at the best distance from the eyes.

* If we take N > M, the effect of the concave lens will be to over-correct the myopia, and the eye will be rendered virtually hypermetropic (see *Hypermetropia*.)

Although the tendency in axial myopia is, as a rule, in the direction of a progressive increase in grade as a result of progressively increasing distention of the eyeball, in a notably large proportion of all cases of myopia this tendency becomes arrested sooner or later, and the length of the axis of the eye may then continue stationary for many years or during the remainder of life. In such cases a small decrease in the grade of the myopia, amounting to a dioptrie or two, or perhaps a little more, may generally be detected in old age, as a result of a physiological decrease in the refractive power of the crystalline lens (see *Hypermetropia Acquisita*, vol. iv., p. 800). On the other hand, an increase of a few dioptries in the refractive power of the crystalline lens is not infrequently observed as an incident of beginning senile cataract, and from this cause a true lenticular myopia may make its appearance in old age, or a pre-existing myopia may develop a considerable increase. Thus certain elderly persons, who have used convex glasses in reading for perhaps many years, discover that they can read as well or better without glasses (so-called second sight), and in certain cases of myopia it is found that the concave glasses which have been habitually worn are no longer perfectly satisfactory in distant vision. A revision of the glasses worn by myopes, whether for distance or in reading, is therefore generally indicated in advanced life, changing oftenest to somewhat weaker concave glasses, but occasionally to stronger, according as the lenticular refraction is found to have diminished or to have undergone a pathological increase.

The size of the retinal image of any object situated at or within the distance of the far-point of the myopic eye is greater than in the case of the same object focussed by an emmetropic eye through the exercise of its accommodation, in the ratio of the respective distances of the second nodal point of the eye (k'') from the retina. The size of the retinal image increases, therefore, for every increase in the length of the eyeball, so that a young person, with uncomplicated myopia of high grade, may enjoy, for a time at least, exquisitely fine sight for small near objects. With the correction of the myopia by concave spectacles, the nodal point is moved nearer to the retina, and, in the case of a neutralizing concave glass worn at the anterior principal focus of the eye (about 13 mm. in front of the cornea), the distance of the nodal point from the retina, consequently the size of the retinal image, becomes the same as in emmetropia. Owing to this diminution in the apparent size of small near objects, it not infrequently happens that a myope of high grade, although accepting neutralizing concave glasses for distance, is disinclined, or, in the case of subnormal visual acuity, is unable to use them in reading. This may become a source of grave embarrassment to the ophthalmic practitioner, who recognizes the dangers attendant upon the habitual use of the uncorrected eyes in fine near work, but may find it difficult to persuade a young patient to abandon such work as a means to the conservation of his sight.

Origin and Development of Myopia.—In young children hypermetropia is the typical refractive condition. Of 100 eyes of infants from one to four weeks old, measured, under atropine, with the ophthalmoscope, by Horstmann,[1] 88 (aggregating 244. D) were hypermetropic, 10 were emmetropic, and 2 (aggregating 4. D) were myopic. Of 100 eyes of children between one and two years of age, similarly examined under atropine, 84 (aggregating 188. D) were hypermetropic, 10 were emmetropic, and 6 (aggregating 8. D) were myopic. Of 100 eyes of children between four and five years of age, 74 (aggregating 188. D) were hypermetropic, 13 were emmetropic, and 13 (aggregating 22. D.) were myopic.

Of 10,060 pupils of public schools in Breslau (including 1,486 children in five village schools) examined subjectively by H. Cohn,[2] the percentage of cases of myopia increased progressively from an average of 6.7 per cent. in twenty elementary schools, to an average of 26.2 per cent. in two gymnasia (colleges). The grade of myopia also increased from an average of 1.8 D, in the elementary schools, to 2. D in the gymnasia.

Erismann[3] measured the refraction in 4,338 pupils of schools in St. Petersburg; he found: Of hypermetropes, 43.54 per cent.; of emmetropes, 26.10 per cent.; of myopes, 30.36 per cent. Tabulated in percentages for successive years of school life, Erismann's statistics show, for seven consecutive school grades, a progressive decrease in hypermetropia from 55.6 per cent. in the lowest to 36.2 per cent. in the highest grade, and an increase in myopia from 15.8 per cent. in the lowest grade to 42.8 per cent. in the highest. The percentage of emmetropic is given as 28 per cent. in the lowest grade, 25.1 per cent. in the sixth grade, and 21 per cent. in the seventh (highest) grade; in grades I. to VI. it fluctuates between 28 per cent. and 25.1 per cent., averaging 26.1 per cent. Studied as a whole, the numbers show (*a*) a progressive increase in the percentage of cases of myopia, (*b*) a concomitant progressive decrease in the percentage of cases of hypermetropia, and (*c*) a nearly constant percentage of cases of emmetropia. They thus emphasize the fact, previously suspected, but denied by Donders, that the ranks of myopia are recruited, through emmetropia as a transient condition, from eyes originally hypermetropic. It follows that a condition of emmetropic or even of hypermetropic refraction may be present in an eye which has already undergone notable distention, and that the beginning of the pathological process typical of myopia must be dated back, in many cases, to a period possibly long antecedent to the development of myopic refraction. In this fact is found an explanation of the cases in which pathological conditions characteristic of myopia of high grade are seen in eyes of relatively low myopic refraction, or, more rarely and less highly developed, in eyes which are optically emmetropic or hypermetropic.

An enormous mass of statistical material gathered by many observers in many lands shows conclusively that with moderate and easily explicable variations in the percentages, the conclusions based on the original researches of Cohn and Erismann are essentially true for all highly civilized communities.

Distribution of Myopia.—Myopia is pre-eminently a disease of the higher ranks of society, and of highly cultured peoples. It is widely prevalent in Germany, where its causes may be referred, in part, to the national "studious habit"; partly to long hours of school work, supplemented by protracted study hours at home, by artificial light; partly to the general use of the old German text, in which the differentiation of certain letters is especially difficult; and possibly to racial predisposition.

In a relatively small proportion of cases, myopia of high grade and of malignantly progressive type is observed in laborers or other persons who have never been subjected to the conditions generally recognized as especially causative of myopia; in these cases an inherited predisposition to myopia may be suspected. Myopia often occurs in certain families, appearing in several children of a myopic parent or parents, and sparing others. Soldiers and sailors are, as a rule, exempt; but this is mainly a result of selection. Savage races are largely exempt from myopia; Furnari[4] found no cases among the Kabyles. "Survival of the fittest" and the absence of exciting causes of myopia afford an obvious explanation.

Myopia as Related to Age.—The statistics of myopia show that it is essentially an acquired condition; also that, in school or college, myopia of high grade occurs almost exclusively in the more advanced classes. Every case of myopia must, therefore, be regarded as having passed through a progressive change from a lower to a higher grade, and, especially in the case of a young person, as, possibly or probably, still in a stage of continuous or remittent progression. The study of the refraction of individual young moypes, examined from year to year, enforces the same conclusion. The age at which a more rapid increase is ordinarily first noticed follows very closely upon that at which considerably increased

demands are made upon the eyes in study, namely, about fourteen years. From about the fifteenth to about the twenty-fifth year the increase is generally most rapid. This corresponds, in a general way, to the years of advanced preparatory and collegiate study, with some added years in the university or in a professional school. It also includes the ordinary period of apprenticeship to trades which may demand close and continuous application. Furthermore, a somewhat rapid rate of increase may be expected to go on, for a time, after the special determining conditions have been mitigated or have ceased to be actively operative.

In considering the influence of age in its relation to the development of myopia, the greater extensibility of the scleral tissue in children may be assumed to play an important part. Also, in older subjects, the stretched and thinned sclera of the highly myopic eye may oppose inadequate resistance to continuing distending forces to which it has already yielded. As a fact, myopia is seldom developed, in a previously healthy emmetropic eye, after the term of youth has been passed; the apparent exceptions are almost always instances of increase in the grade of pre-existent, but unrecognized or unacknowledged, short-sightedness.

Myopia of high grade (10. D or more) is occasionally observed in a child of eight or nine years, and should then be contemplated with great solicitude in view both of the disability incident to the high grade to which it may be expected to attain and the fear that, later in life, the integrity of the eyes may be endangered.

It has been erroneously assumed that myopia tends to diminish with advancing age. On the contrary, it is always either progressive or, at the best, stationary. An apparent exception, based on certain cases in which a myopia of low grade disappears as a result of a decrease in the refractive power of the crystalline lens in old age, also the occasional late occurrence of a lenticular type of myopia dependent on a pathological increase in the refractive power of the crystalline, have been already mentioned.

Classification of Myopia.—Donders[5] has divided myopia into three categories, basing them on the course and progress of the disease, namely: (1) stationary M; (2) temporarily progressive M; (3) permanently progressive M.

(1) The type of the stationary class is represented mainly by cases of myopia of low grade, which increase slowly up to a limit not much exceeding 2.5 D to 3. D at the age of twenty-five years; after the twenty-fifth year the increase is insignificant. In this category are included certain cases of myopia of higher grade, which follow a similar course of slow and limited progression. After the age of about fifty years, distant vision often improves, owing in part to the smaller pupils, in elderly people, lessening the diameter of the circles of confusion in the retinal image, and in part to the slight physiological decrease in the refractive power of the crystalline lens.

(2) The temporarily progressive class includes those cases which increase rapidly up to about the twenty-fifth year, and become stationary, generally before the thirtieth year, after having attained a grade averaging about 8. D. At this grade the myopia remains practically stationary during the remainder of life, but with a tendency, in certain cases, to recrudescence, which may bring the case under the category of—

(3) Permanently progressive myopia. In this class a myopia of 6. D or more, at the age of twelve years, develops continuously, but generally at a decreasing rate, up to a limit which may reach or exceed 20. D at the age of sixty years. "The worst is then to be feared. It is rare at sixty years of age to find a tolerably useful eye with myopia of 16. D or even of 13. D" (Donders).

Ophthalmoscopic Appearances.—The region of the fundus about the entrance of the optic nerve (optic disc) is the seat of certain very characteristic changes which, although occasionally seen in eyes of emmetropic or even of hypermetropic refraction, are so constant in myopia that they are justly regarded as typical of this disease.

Especially characteristic is an alteration in the choroid which, from its general configuration, is known as the "crescent" or "sickle" (Figs. 3472, 3473, and 3474).

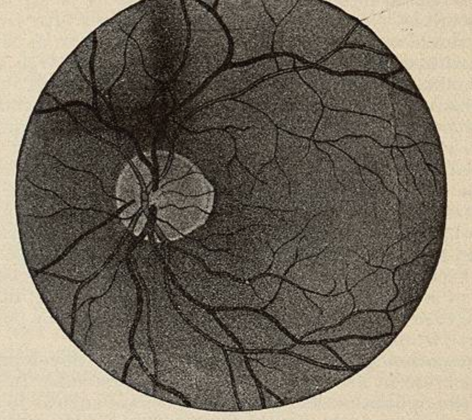

Fig. 3472.—Left Eye.

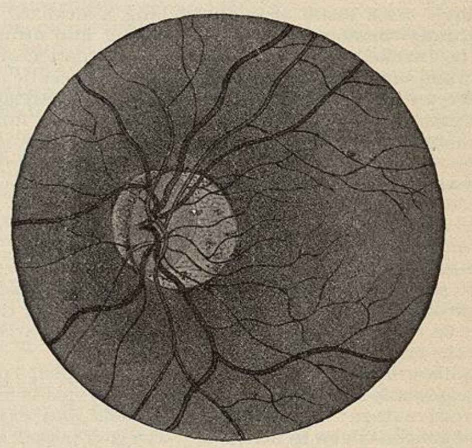

Fig. 3473.—Left Eye.

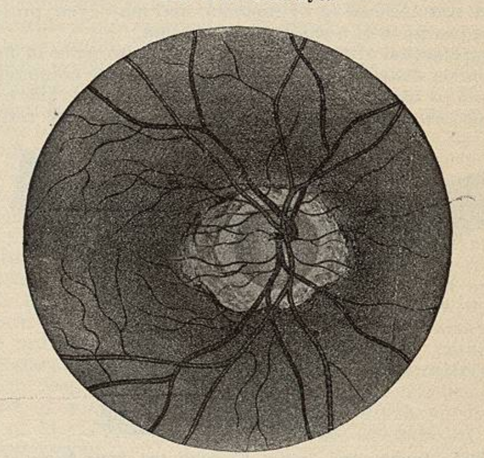

Fig. 3474.—Right Eye.

Figs. 3472, 3473, and 3474.—Represent Different Types of Crescents as seen in the erect image. (From Jaeger.)

This appears, ordinarily, as a whitish or grayish-white area, crescentic in outline, the concavity of the crescent closely hugging the outer margin of the disc, the con-