nually 2,200,000 pounds of roses and 4,000,000 pounds of orange flowers.

At the foot of the village are great plains of olive trees. The views are very beautiful and extensive, and the excursions round about are many and attractive. The town itself is not particularly attractive, but this is compensated for by its picturesque situation and beautiful views.

The water supply is good, but the sanitary condition was said by Linn ("Health Resorts of Europe"), in 1893, to be far from perfect. The accommodations are good but apparently limited.

The climate is said to be beneficial to sufferers from asthma, gout, nervous affections, insomnia, neuralgia, and rheumatism. *Edward O. Otis.*

GRAVEL. See *Kidney Diseases.*

GRAVES' DISEASE. See the APPENDIX.

GREAT BEAR SPRING.—Oswego County, New York. This spring is located near Fulton. It has been known for many years, having been used by the aborigines. Within the last few years the spring has been improved and the water has an extensive sale in Syracuse. More recently it has been introduced into New York and other large cities. The water is but feebly mineralized, but it is remarkably pure, and its freedom from organic matter gives it excellent qualities for the table. Its very small cost is an additional advantage. The following analysis was made in 1890 by Dr. William Manlius Smith, of Syracuse:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium sulphate	0.72
Calcium carbonate	3.50
Magnesium carbonate	1.25
Magnesium chloride	.47
Sodium and potassium carbonates	Traces.
Total	5.94

James K. Crook.

GREEN LAWN SPRING. Jefferson County, Illinois.

POST-OFFICE.—Mt. Vernon. Hotels and boarding-houses. These springs are located in the city of Mt. Vernon, 76 miles east of St. Louis. This point is reached by the Louisville, Evansville and St. Louis, by the Jacksonville and Southeastern, and by the Louisville and Nashville railroads. The springs are six in number, and are surrounded by a park of about eight acres in extent in the centre of the city. Their waters are discharged from a vertical stratum of slate about eight inches in width and bisecting a horizontal stratum of slate of between two and three feet in thickness. They belong to the class known as saline-chalybeate waters, each spring differing somewhat in properties from its fellow. The one most used, known as the "Washington" Spring, contains the carbonates of lime, iron, and magnesia, bicarbonate of sodium and potassium, and chloride of sodium, with traces of iodine and bromide. Free sulphurous acid is present in considerable quantities, and the water is quite heavily charged with carbonic acid gas. The temperature of all the springs, with one exception, is about 56° F. In this single exceptional case, in which the temperature ranges about 10° higher, the waters are used for bathing purposes in rheumatism, with good results. A peculiarity of the Washington or main spring is its eccentric behavior, which seldom fails about the time of the autumnal equinox. It is said that the waters always become turbid at these periods and the same disturbances have been observed after great storms or earthquakes, even though these events occur in regions remote from the springs. The waters are said to remain red with an excess of iron for a short time after these disturbances and then to become harsh and acrid from an excess of alkaline ingredients. The country surrounding Mount Vernon is about equally divided between prairie and timber, a considerable portion of the latter being found on elevated ridges. On the north a belt of timber, about ten miles in depth, affords protection against the winds of winter and causes a considerable modification of temperature. The waters of the main springs are very efficacious in the treatment of dyspepsia, torpid liver, biliousness, and other disorders of the chylopoietic organs. *James K. Crook.*

GREENBRIER WHITE SULPHUR SPRINGS.—Greenbrier County, West Virginia.

POST-OFFICE.—White Sulphur Springs. Hotel and cottages.

ACCESS.—Viâ main line of the Chesapeake and Ohio Railroad direct to Springs. This celebrated summer watering-place is located on the western slope of the Appalachian Mountains, at an elevation above tide-water of more than 2,000 feet. The situation is well within the famous spring region. Within a radius of thirty miles are the Rockbridge Alum, the Hot, the Warm, the Healing, the Sweet, and other well-known springs, while the Natural Bridge, Millboro, the Alleghany, and other resorts are near by. For many years past the Greenbrier White Sulphur Springs have been regarded as a representative summer resort of the South, and it has lost none of its ancient and well-deserved prestige by the development of other springs. As in ante-bellum days, here will still be found the best elements of the social life of the South, with a generous intermingling of Northern beauty and gallantry drawn thither by the numerous attractions of the place. The surrounding scenery typifies the picturesque beauty and grandeur of the Alleghanies. The visitor from the heated and dusty city is at once attracted by the vast lawn of green, velvety turf, shaded by noble forest oaks, luxuriant sugar maples, and venerable pines. Under these monarchs of the forest wild flowers are seen in profusion and in great variety. Among the surrounding mountains are "Kate's" and "Greener," each a mile distant and reaching an altitude of 3,500 feet, and the mountains known as "White Rock," three miles distant, the summits of which form a figure of gigantic size, known as the old "Titan," which, in solitary grandeur, keeps guard like a giant over the White Sulphur. What has been said of other Alleghany resorts applies in full measure to this. The mean annual temperature from April 15th to November 15th is about 63° F., or about the same as the mean annual temperature of Naples, Nice, and the Madeira. The atmosphere is salubrious and invigorating, and at no time excessively warm. The Grand Hotel, with its one hundred cottages, gives accommodation to an immense number of visitors. There are two important springs here, viz., the famous old "White Sulphur," and the "Chalybeate." The Sulphur Spring yields 1,800 gallons of water per hour, and this amount does not vary even during the longest spells of wet or dry weather. It has a uniform temperature of 60° F. An analysis by Prof. A. A. Hayes, of Boston, shows the following mineral contents:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium carbonate	7.07
Magnesium sulphate	35.42
Calcium sulphate	78.35
Silicates	3.46
Magnesium chloride	1.00
Organic matter	4.36
Total	129.66

Gases.	Cubic Inches.
Carbonic acid	11.28
Sulphureted hydrogen	.24
Oxygen	.48
Nitrogen	4.64
Total	16.64

This analysis was made many years ago (1842), and a newer and further analysis is desirable. The water acts on the kidneys, bowels, liver, and skin. As a diuretic its effects are very soon apparent; but some days are usually required before it produces a decided action on the bowels. Its operation on the liver, too, may not be manifest for some time, and when there is much sluggishness of this organ some auxiliary medication is required. Its effect upon the skin is very apparent, though not immediate. The analysis does not fully explain another important action of the water, an effect which has been attested to by several generations of qualified medical men. This is its alterative power, or that peculiar influence by which it effects a salutary alteration in the blood, in the various secretions, and upon the numerous tissues of the body. No general directions can be given for the internal use of the water. The hours, the quantity, and the period for which the water should be drunk depend upon the individual requirements of the case, and should be ascertained by consulting a physician experienced in the use of such waters. Combined with the influence of the favorable surroundings, the use of the water often proves curative in obstinate cases of chronic bronchitis, in hay fever, in bronchial asthma, and in nasal catarrh. Conjoined with the use of the hot sulphur baths it is of decided value in rheumatism and gout, and is an efficacious adjuvant in the treatment of tertiary syphilis, chronic metallic poisoning, and dartrous skin diseases. According to Dr. Moorman, for many years the resident physician, the water is contraindicated in organic heart disease, carcinoma of the stomach, and phthisis pulmonalis. The water never proves beneficial when it persistently excites the frequency of the pulse. The water used for bathing flows from the sulphur spring. The bathing establishment has recently been greatly enlarged and remodelled, and it is now believed that it will prove in all respects satisfactory to those wishing to avail themselves of its use.

The Chalybeate Spring. About forty rods from the White Sulphur Spring is a chalybeate spring in which iron exists in the form of carbonates. For the last twenty years this water has been considerably used by a number of visitors who require a ferruginous tonic, and its effects have realized the early hopes that its discovery created. It has not been fully analyzed. *James K. Crook.*

GRINDELIA.—CALIFORNIA GUM-WEED. *Rosin-weed.* "The dried leaves and flowering tops of *Grindelia robusta* Nutt. and of *G. squarrosa* Nutt. (fam. *Compositæ*)" (U. S. P.). These are large and coarse, perennial, resinous herbs, of the far western and southwestern United States. The former was first introduced, then the latter, as possessing different properties. It being quickly determined that the properties were similar, they were united under one title. Nevertheless, many physicians prefer the *G. robusta.* It is much scarcer and more difficult to obtain, and the other is very commonly supplied, broken up or otherwise treated to make a distinction, when robusta is specifically called for. A good mark of distinction is given below. The following is the official description:

Leaves about 5 cm. (2 inches) or less long, varying from broadly spatulate or obovate to lanceolate, sessile or clasping, obtuse, more or less coarsely and sharply serrate, often spinosely toothed or even laciniate-pinnatifid, pale yellowish-green or yellow, very smooth, finely dotted, resinous, thick and brittle; heads many-flowered, the involucres of many series of imbricated scales with acute, spreading or recurved tips. The heads of *G. squarrosa* are mostly longer than broad, contracted-campanulate or conical-urceolate; those of *G. robusta* are broader than long, depressed-urceolate. Ray-florets deep-yellow, ligulate, pistillate; disc-florets yellow, tubular, perfect; pappus of two or three mostly unequal awns, about as long as the disc-florets; odor balsamic, slightly narcotic; taste resinous and gummy, pungently aromatic, somewhat bitter. The quality is roughly indicated by the amount of resinous matter exuded upon the surface.

Resin is the principal constituent. There are also a little volatile oil, wax, gum and tannin, together with a bitter glucoside, in small amount. Its uses are external and systemic. The fluid extract, if painted upon a surface poisoned by rhus and similar agents, is one of our best remedies. It forms a dry coating which excludes the irritating atmosphere and prevents the spread of the poisonous fat, probably also absorbing it into the resinous film. It is of some similar use for treating burns and as an injection for urethritis and vesical catarrh. Its internal action, as a sedative expectorant, is not so readily explained. It is largely used, by way of the stomach, in chronic and subacute bronchitis, in asthma, and in whooping-cough. It is mostly given in the form of the official fluid extract, in doses of 1 to 4 c.c. (fl. ʒ ¼ to i.).

Hysterionica or *Baylahuen*, the herb of *H. Baylahuen* (Gay) Baill. (*Haplopappus B.* Gay) is a Chilian drug, very closely related, botanically, chemically, and physiologically, to grindelia. It contains a large amount of a brown, odorous, somewhat acrid resin and an essential oil. It is considerably used at home as an anti-diarrhœal and anti-dysenteric, and was introduced to Europe and the United States about the year 1890. Repeated trials showed it to possess some value in ameliorating the diarrhœa of phthisis. At the same time, it was found to act as a sedative diuretic and not to produce gastric irritation. The fluid extract was given in ♏ x. doses every six hours, and the administration prolonged. The drug has not come into general use. *Henry H. Rusby.*

GRIPPE, THE.—See *Influenza.*

GROWTH.—This article is divided for convenience into four sections: I. Definition of growth. II. Growth as a function of cells and tissues. III. Human growth statistically considered. IV. The laws of mammalian growth.

I. DEFINITION OF GROWTH.—Definitions of growth are almost as numerous and various as the writers on the subject. Among these we may distinguish two principal points of view. According to one of these, growth is defined as increase of size or volume. From this point of view any increase of volume is growth no matter to what cause it may be due, and differentiation is regarded as an entirely distinct phenomenon which may or may not accompany growth.

From the other point of view the term growth implies in a general way an increase in the number or size, or in both, of the histological elements; and also, but more vaguely, implies that the elements advance, or at least remain stationary in the scale of organization. In other words, if the increase in volume be due to developmental processes, or if it be accompanied by progressive differentiation, it is growth. But if, on the other hand, increase of volume be due to the deposition of products of degeneration, as, for example, fat, it cannot properly be regarded as growth. This definition is not so definite as the first, which, therefore, should be preferred.

II. GROWTH AS A FUNCTION OF CELLS AND TISSUES.—It is evident that the growth of an organism is the sum of the growths of its tissues, and the growth of the tissues depends on that of the cells; hence growth ultimately rests upon, first, the increase in size of single cells, and, second, the multiplication of cells. Owing to their peculiar mode of growth, the plants afford the best material for the study of the process in its simplest form. At the tip of each stem or rootlet there is a mass of cells in an embryonic condition, and during rapid growth these cells undergo frequent cell division. There is at the extreme tip a cell or a group of cells that always divide by a transverse partition into a distal and a proximal daughter cell or cells. The daughter cell at the tip, the distal one, remains in an embryonic condition and divides again in the same manner. In this way the proximal daughter cell becomes separated from the tip by the successive divisions of the apical cell or group of cells. If we follow one of the proximal cells through its life history, we shall see that it at first divides repeatedly, forming a group of small cells with dense protoplasm and thin cell walls. This is the period of most rapid multiplication. A little later the process of cell division becomes less frequent in this group, and the cells become larger and exhibit large vacuoles containing a clear watery fluid. This is the period of greatest growth. Finally, the cells cease both to multiply and to increase in size; and the cell walls become thickened and assume the character of the tissue to which these cells belong. This is the period of histological differentiation.

In the development of the plant cell, then, may be recognized three stages: (1) Multiplication, (2) growth, and (3) histological differentiation. These three stages are represented by three zones in root or stem. The zone of multiplication surrounds the tip and extends but a short distance from it. Here growth takes place but slowly, so that between one act of division and the next a cell may double in size. But the most rapid growth is in the next zone, where a cell may increase to several times its original size without undergoing division. Sachs studied the daily rate of growth of the root of a bean (Phaseolus). A disc 1 mm. long was carefully marked off just behind the tip and was then measured daily. The rate of growth was found to increase from a little over 1 mm. on the first day to a maximum of about 14 mm. on the seventh day. After that the rate decreased rapidly to about 2 mm. on the tenth day. Ciesielski observed the rate of growth of different areas in the roots of several leguminous plants. The rootlets were marked off in half millimetres and the amount of growth in each space was measured after twenty hours. It was found that there was practically no growth in the first millimetre. Beyond that the rate increased gradually to the third or fourth millimetre, reaching there in the different species a rate of 1.8 to 2.6 mm. in twenty hours, and then the rate decreased again until at a distance varying from 5 to 6.5 mm. from the tip growth in length was found to have ceased.

From an analysis made by Kraus upon hothouse plants of *Heterocentron roseum* it was found that the percentage of water in the tissues increases from 73 per cent. at the tip of the stem to 88 per cent. at the first internode, and reaches a maximum of 93 per cent. in the second internode. Farther along the stem there is a slight decrease, the amount being 92.7 per cent. in the fifth internode. In plants, then, it appears that the period of most rapid growth is also the period of most rapid absorption of water by the cells.

In animals we do not find this division into zones of growth, and there is, as a rule, no area of embryonic cells to furnish material for growth for an indefinite period. On the contrary, the extent of growth for each species is more or less strictly limited by conditions of which we know very little. In the period of cleavage of the egg and anatomical differentiation (see article *Differentiation*) the whole embryo is in the condition found at the tip of the stem of a plant. The cells are all small, rich in protoplasm, and undergo division frequently, while there is little or no growth of the embryo as a whole. Then comes the period of most rapid enlargement accompanied by an increase in the amount of water, and this is followed by the period of histological differentiation. The rate of growth per unit of body weight decreases gradually until the animal reaches the limit of its species.

This was brought out by Davenport (1875) in his researches upon the embryos of frogs, the results of which are given in the following table:

GROWTH OF FROG EMBRYOS.

Days after hatching.	Average weight in milligrams.	Weight of dry substance in milligrams.	Weight of water in milligrams.	Per cent. of water.	Average increase daily in per cent. of body weight.
1	1.83	0.80	1.03	56	
2	2.00	.83	1.17	59	9.7
5	3.43	.80	2.63	77	23.9
7	5.05	.54	4.51	89	23.8
9	10.40	.72	9.68	93	54.0
14	23.52	1.16	22.36	96	25.2
41	101.0	9.9	91.1	90	1.2
84	1,989.9	247.9	1,742.0	88	

The frog embryo takes no food for several days after hatching, so that there is a loss of dry substance until about the eighth day; and yet it is between the seventh and ninth day that there is the greatest daily increment per unit of body weight. As the percentage of dry substance increases the rate of growth becomes less. The time of most rapid growth is the time when the cells absorb water most rapidly.

Similar results were obtained by Fehling (1877) from the measurement and analysis of twenty-one fresh human embryos, as shown in the following table:

GROWTH OF HUMAN EMBRYOS.

Number.	Length centimetres.	Sex.	Age.	Weight. Fresh grams.	Weight. Dry grams.	Per cent. of water.
1	2.5	F.	6th week	0.975	0.24	97.54
2	15.0	M.	4th month	36.5	3.0	91.79
3	13.5	M.	4th month	56.5	5.1	90.97
4	18.5	M.	5th month, 1st half.	95.5	8.9	90.7
5	18.5	M.	5th month, 1st half.	104.7	8.2	93.2
6	19.0	F.	5th month, 2d half.	156.8	14.6	90.7
7	21.5	M.	5th month, 2d half.	244.0	22.0	90.96
8	22.5	M.	5th month, 2d half.	235.0	24.0	89.81
9	23.0	F.	5th month, 2d half.	264.0	29.5	88.9
10	24.0	F.	5th month, 2d half.	299.0	32.8	89.3
11	26.0	M.	6th month	361.8	39.1	89.2
12	30.0	F.	6th month	575.0	79.5	86.4
13	33.5	M.	6th month	771.0	125.2	83.77
14	34.5	F.	7th month	910.0	159.0	82.6
15	34.0	M.	7th month	832.9	138.2	83.5
16	36.0	F.	7th month	836.0	136.5	83.9
17	35.0	M.	7th month	1,117.0	170.71	84.8
18	38.0	M.	8th month	928.0	159.5	82.9
19	53.5	M.	Term	3,284.0	855.52	74.1*
20	44.0	M.	9th month	1,760.6	456.1	74.7†
21	45.0	M.	9th month	1,495.7	391.2	73.9‡

* Still-birth. † Died in uterus.
‡ Premature birth; atrophic; died thirteen days later.

It will be noticed that the youngest embryo, in the sixth week, contains the largest proportion of water, 97.54 per cent. From that the proportion decreases to about 74 per cent. at the time of birth. These figures should be compared with the next table in which Fehling summarizes his results as to the increase of weights.

INCREASE OF WEIGHT OF HUMAN FŒTUS.

	Weight at beginning of period. Grams. a.	Absolute monthly growth. Grams. b	Relative monthly growth. $\frac{b}{a}$
Second month	1	3	3.0
Third month	4	16	4.0
Fourth month	20	100	5.0
Fifth month	120	165	1.29
Sixth month	285	350	1.22
Seventh month	635	585	.92
Eighth month	1,220	480	.39
Ninth month	1,700	540	.31
Tenth month	2,240	1,010	.45
Term	3,250		

The relative monthly growth is high in the second month and increases to a maximum in the fourth. After that there is a decrease, sudden at first, and then more gradual.

For comparison with the growth of the human embryo Fehling studied the growth of embryo rabbits. For this purpose he reckoned the age of the fœtus in periods of three days, each period being supposed to correspond to a month of human gestation. Two embryos, the largest and the smallest, were chosen from each litter for analysis. Some of his results are given in the following table:

WEIGHT OF RABBIT EMBRYOS.

Number.	Weight of mother.	Period.	Weight of fœtus in grams. Fresh.	Weight of fœtus in grams. Dry.	Per cent. of water.
1	1,850	5	0.619	0.052	91.5
2	1,850	5	.663	.057	91.4
3	1,500–1,600	7	10.631	1.5	85.9
4	1,500–1,600	7	12.83	1.7	86.7
5	....	8	23.6	3.5	86.3
6	....	8	24.6	4.0	83.8
7	....	8	15.95	2.25	85.9
8	....	8	12.3	2.0	82.2
9	1,806	8	18.61	2.94	84.2
10	1,806	8	18.68	2.32	87.6
11	3,240	9	62.35	11.35	81.8
12	3,240	9	45.78	7.6	85.6
13	2,854	9	41.98	8.0	81.0
14	2,854	9	50.33	9.33	81.5
15	1,800	9	29.25	4.9	83.2
16	1,800	9	28.56	5.83	79.6
17	About 1,800	10	34.29	7.22	79.0
18	About 1,800	10	33.05	6.7	79.7
19	....	New-born	38.4	8.4	78.4
20	....	New-born	38.3	8.8	77.1
21	....	14 days.	179.5	43.8	75.6
22	....	14 days.	224.0	75.4	65.1

The weight of the mother has great influence on the weight of the fœtus, and is given for that reason in this table. This factor is of less importance in human statistics, where the range of variation is comparatively much restricted.

The table shows a gradual decrease in the percentage of water in the tissues of the fœtus, and this is associated, as in man, with a gradual decrease in the relative rate of growth as shown in the following table:

GROWTH OF RABBIT EMBRYOS.

Period	Weight at beginning of period. Grams. a	Absolute growth during period. Grams. b	Relative growth per period. $\frac{b}{a}$
5	0.619	5.557	8.97
6	6.176	5.558	.89
7	11.734	6.916	.59
8	18.65	10.258	.55
9	28.908	4.762	.16
10	33.67	4.68	.13
Term	38.35		

The figures for the sixth period in this table are somewhat doubtful, for there is nothing to show that they were obtained by actual observation.

Per period the relative growth of the rabbit embryo appears to be less than that of the human embryo, but the period in the former case is only one-tenth as long as in the latter. The relative daily growth of the two, as calculated by Fehling for each period, is as follows:

RELATIVE DAILY GROWTH OF FŒTUS.

Period.	Man.	Rabbit.	Period.	Man.	Rabbit.
2	0.1		7	0.032	0.197
3	.142		8	.014	.183
4	.178		9	.011	.054
5	.049	2.99	10	.015	.046
6	.044	.305			

The more rapid rate of relative daily growth observed in the rabbit is associated, according to Fehling, with a greater percentage of water in the tissues.

All these results tend to show that in both animals and plants the most rapid increase in weight in proportion to the weight of the body takes place at the time when the tissues are at their least density. As the solid constituents of cells increase the relative rate of growth decreases.

Little is known of the effects of external conditions upon the rate of growth of animals, but upon the growth of plants external conditions have been shown to have a very marked effect. For a full discussion of this subject the reader should consult Davenport's very excellent summary ("Experimental Morphology," vol. ii., 1899).

III. GROWTH OF MAN.—We know very little concerning the earlier period of the growth of man, since the growth of the fœtus and of the infant has been but little studied. We have numerous observations on the weight of the child at birth, and on the growth from the fifth to the twentieth year (during the school age); some on the growth up to twenty-five years, referring chiefly to the upper classes (college and university students), and valuable statistics of men in armies have been compiled. As régards the growth and size of man, American investigations easily lead, for the anthropometric work of Gould and Baxter, and the researches of Bowditch, on Boston school children, and of Porter on the school children of St. Louis, have never been approached in value. Peckham's work in Milwaukee is also excellent. Quetelet, the pioneer in this field, pursued an erroneous method, which led him to false conclusions, which are, nevertheless, still currently cited, especially in Europe.

We divide the subject as follows: 1 Growth of the fœtus; 2, weight of the new-born child; 3, growth of infants, 0 to 5 years; 5, growth of children; 6, size of adults.

1. *Growth of the Fœtus.*—The difficulty of determining the age of the human fœtus, and of obtaining specimens certainly fresh and normal, has prevented our having any very definite information on this subject. Preyer has compiled the following table of the length of the human embryo in centimetres:

Lunar month.	Toldt (200 obs.).	Hennig (100 obs.).	Hecker.
First	1.5 (1.3)	0.75	......
Second	3.5	4.0	......
Third	7.0	8.4	4 to 9
Fourth	12.0	16.2	10 to 17
Fifth	20.0	27.5	18 to 27
Sixth	30.0	35.25	28 to 34
Seventh	35.0	40.25	25 to 28
Eighth	40.0	44.3	39 to 41
Ninth	45.0	47.2	42 to 44
Tenth	50.0	(49.0)	45 to 47

If the absolute length at the end of each month is divided by the increase during that month we obtain what Preyer calls the relative growth. Hennig's figures give the following relative growth for each month: First, 1,000; second, 0.812; third, 0.523; fourth, 0.419; fifth, 0.410; sixth, 0.219; seventh, 0.124; eighth, 0.093; ninth, 0.069; tenth, 0.037. All the above data are obviously inexact. Toldt's are evidently cooked up, and not derived from observation; nor do the lengths mean the same thing, for of the early stages the head and trunk only were measured; of the later stages the head, trunk, and legs. A falser and more misleading device for studying growth has never been put in practice. The fœtus, too, being spirally coiled in early stages, cannot have its length determined accurately. Far better would it be always to determine the weight. The growth of the fœtus in weight has been most inadequately studied, although the weight is the *only* available measure of the growth of the fœtus as a whole. Hecker's data are perhaps the best. The weights are in grams:

Month.	Maximum.	Minimum.	Average.
Third	20	5	11
Fourth	120	10	57
Fifth	500	75	284
Sixth	1,280	375	634
Seventh	2,250	780	1,218
Eighth	2,438	1,093	1,569
Ninth	2,906	1,500	1,971
Tenth	....	1,562	....

The range of the maxima and the minima suggests that errors in the determination of the ages may have occurred—such errors of a month are not rare with obstetricians. These figures may be compared with Fehling's, given in the preceding section.

Appended here are Hecker's data as to the weight of the placenta in grams, and the length of the umbilical cord in centimetres:

Month.	No. of obs.	Placenta.	Cord.
Third	3	36	7
Fourth	17	80	19
Fifth	24	178	31
Sixth	14	273	37
Seventh	19	374	42
Eighth	32	31	46
Ninth	45	461	47
Tenth	62	481	51

2. *Weight of the New-born Child.*—It is subject to very considerable variations. For middle Europe the average may be held to be about 3,340 gm. for boys, 3,190 gm. for girls, the latter being somewhat lighter. The variations are very great, ranging from 1,000 to 5,000 gm. For instance, the following table is given by Pfannkuch, who unfortunately jumbles the two sexes together:

Kilograms.	Obs.	Kilograms.	Obs.
1.50 to 2.0	23	3.00 to 3.25	150
2.00 to 2.25	36	3.25 to 3.50	115
2.25 to 2.50	52	3.50 to 3.75	79
2.50 to 2.75	90	3.75 to 4.00	46
2.75 to 3.00	110	4.00 to 4.50	13

It will be noticed that the maximum number of cases (150) falls between 3.00 and 3.25 kgm., and that the further the weight is removed on either side, above or below, from this mean, the fewer are the cases. The tables by other authors show the same general results, with usually slight differences in the quantitative values. For the most part these tables cannot be combined with one another, for they nearly all fail to fulfil some obvious requirement of good statistics; indeed, amateur statistics are generally provoking to the expert. It is, therefore, not desirable to attempt an analysis of the recorded data. As an example of statistics at once valuable and grossly defective, the following table is given after Siebold. The author gives the weights in pounds, but has neglected to say, as is necessary in Germany, what kind of pounds; hence the metric equivalents cannot be calculated. Moreover, the number of cases weighing even pounds and half-pounds is far in excess of those weighing pounds, and one-fourth or three-fourths, which shows inaccurate weighing, of course. To correct this the quarter-pound groups of the original table are condensed into half-pound groups:

Weight in lbs.	Boys.	Girls.	Weight in lbs.	Boys.	Girls.
4.0 to 4.5	4	10	7.5 to 8.0	286	200
4.5 to 5.0	19	24	8.0 to 8.5	101	44
5.0 to 5.5	44	53	8.5 to 9.0	79	42
5.5 to 6.0	172	195	9.0 to 9.5	15	14
6.0 to 6.5	220	235	9.5 to 10.0	7	2
6.5 to 7	353	353	10.0 to 10.5	..	1
7.0 to 7.5	286	240	10.5 to 11.0	..	1

The extremes recorded in medical literature are very far apart, and statements of excessively large size are by no means rare, but can be received with incredulity only, as, for instance, the case reported of a still-born child weighing 8,250 gm.! (*Berliner klin. Wochenschr.*, 1878, No. 14.) Vierordt gives as the accredited extremes 717 gm. (Ritter), and 6,123 gm. (Wright).

The factors which determine the weight at birth are very obscure. It is, of course, safe to say, vaguely, that it depends on the nutrition of the fœtus; it is probable that individual differences in the rate of growth exist before as well as after birth, and it is probable that the length of gestation is the most influential single factor, to judge from my own experiments on the growth of mammals.

It has been demonstrated that the variations in the weight of the child depend upon various maternal circumstances.

First. It is correlated with the age of the mother, as is shown in the following table, giving the weight of the children in grams according to three observers:

Age of the mother.	Ingerslev.	Fassbender.	Petersson.
15 to 19 years	3,241	3,271	3,451
20 to 24 years	3,299	3,240	3,485
25 to 29 years	3,342	3,333	3,591
30 to 34 years	3,375	3,367	4,062
35 to 39 years	3,428	} 3,292 {	3,591
40 to 44 years	3,326		3,676

From such tables we learn that very young mothers have the smallest children, and those of about thirty-five years the heaviest. It is much to be regretted that the tables do not show the correlation by single years, and also the number of observations.

Second. The weight of the child increases with the weight (Gassner) and length (Frankenhäuser) of the mother. Gassner states that the weight of the child is to that of the mother as 1 to 19.13, or 5.23 per cent. of the maternal weight. Frankenhäuser states that if the height of the mother is less than 4 feet 6 inches, the child weighs 6 lbs. 15 oz.; if it is 4 feet 6 inches to 4 feet 11 inches, the child weighs 6 lbs. 25 oz.; if it is more than 4 feet 11 inches, the child weighs 7 lbs. 3 oz.

Third. The weight of the child increases according to the number of previous pregnancies, as indicated by the following table:

Number of pregnancies.	(Hecker.) Gm.	(Ingerslev.) Gm.
One	3,201	3,254
Two	3,330	3,391
Three	3,353	3,400
Four	3,360	3,424
Five	3,412	3,500
Six	3,353	

Here again we encounter faulty statistics, for it is not shown that we have any other effect than that of age, for the conclusion claimed cannot be established until it is proved that primiparæ have smaller children than multiparæ *of the same age*.

Fourth. Negri has maintained (*Annali di obstetricia*, 1885) that the compilation of three hundred and thirty-three observations shows that the children of women whose menstruation is early are larger than the children of those whose first menstruation is late.

Fifth and sixth, the influence of race and climate, which have not yet been subjected to any proper exact study.

In conclusion, I may add that it seems to me probable that all these influences produce their effect principally by prolonging or abbreviating the period of gestation. In other words, the variations in the weight of children at birth are to be referred immediately to two principal causes: (1) Differences in the age at birth; (2) individual differences of the rate of growth in utero.

3. *Growth of Infants.*—(*a*) *Alteration in weight during the first week.* There is an interruption of the normal rate of growth during a few days after birth, both in man and other mammals (Section IV.). It lasts for a variable period, and is variable in degree. In most cases, with the human species, it is so great as to cause an actual loss of weight, but frequently it shows itself only as retarded growth. A great many authors have written upon this subject, but there is not a single one who appears to have correctly understood the statistical relations. In fact, the discussion thus far has turned upon the question whether a loss or a gain of weight is normal and physiological. That question is of little importance, since it is now settled that the retardation of growth is constant. It depends on the degree of retardation whether there is merely a small gain or an actual loss. During the first month the average daily increase is about 35 gm. (Fleischmann), but during the first two or three days, or sometimes more, the rate of increase is very much less, often even negative. Gregory, for instance, gives the following data:

Day	1	2	3	4	5	6
Number observed	33	33	33	33	33	33
Weight change, grams	−139	−64	+33	+50	+50	+36

The retardation of the growth is prolonged by defective nutrition, of which the cause may lie in either the mother or the child, and by illness of the child. A healthy baby ought to get back to its initial weight by the sixth or seventh day, and failure to reach the initial weight by the ninth day may be taken as an indication of illness.

The cause of the post-natal retardation is not fully elucidated. That it is not due to the mother's condition is

shown by two considerations: (1) The retardation occurs also in chicks at hatching, although they are not dependent on the parent for nutrition; (2) Ingerslev put sixteen children, just born, to wet-nurses, who had borne four to five days previously and gave abundant milk, nevertheless the children all lost weight. It seems probable that the loss is due to the establishment of respiration, and to the increased expenditure (metabolism) of the body to maintain the normal temperature. During gestation and incubation the parent supplies caloric to its young, but after birth (or hatching) the young is self-dependent, and rapidly wastes its tissues to keep up its body warmth.

(*b*) *For the growth from the first to the fifty-second week* we must depend chiefly on—(1) the careful compilation given by Meek and quoted by Vierordt, in which, however, the sex, nutrition, race, and social condition of the children are not considered, all factors which have a very great influence on the weight; (2) the observations of Albrecht (*Central-Zeitung f. Kinderheilkunde*, 1879, No. 7), who followed the growth of eighty children at Berne. From Meek the following data are excerpted:

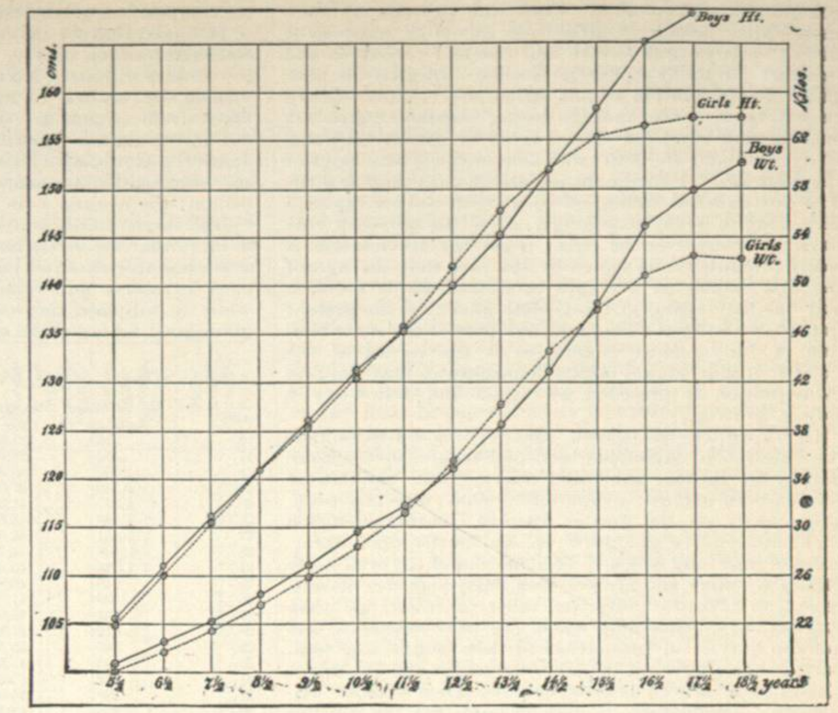

FIG. 2350.—Graphic Representation of the Growth of Boston School Children, based on the whole number of Bowditch's observations, irrespective of nationality of parents.

Week.	No. of observations.	Weight, gm.	Week.	No. of observations.	Weight, gm.
First	22	3,228	Twenty-eighth	21	7,187
Second	25	3,367	Thirty-first	19	7,524
Third	31	3,412	Thirty-fourth	19	7,842
Fourth	31	3,532	Thirty-seventh	18	8,126
Seventh	33	4,103	Fortieth	17	8,344
Tenth	34	4,600	Forty-third	17	8,533
Thirteenth	36	5,022	Forty-sixth	17	8,760
Sixteenth	34	5,529	Forty-ninth	15	8,995
Nineteenth	32	5,864	Fiftieth	15	9,102
Twenty-second	26	6,497	Fifty-first	14	9,198
Twenty-fifth	23	6,925	Fifty-second	8	(10,172)?

Albrecht states that in his experiments, taking the weight of the child at 3,300 gm. at birth, the following is the average daily increase for each month in grams:

Month	1	2	3	4	5	6	7	8	9	10	11	12
Grams	30	29	29	24	20	18	14	11	11	9	8	7

The corresponding figures by Bouchaud are:

Month	1	2	3	4	5	6	7	8	9	10	11	12
Grams	25	23	22	20	18	17	15	13	12	10	8	8

By Fleischmann:

Month	1	2	3	4	5	6	7	8	9	10	11	12
Grams	35	32	28	22	18	14	12	10	10	9	8	6

The individual variations are very great, and the growth of any individual goes by fits and starts. A considerable delay in growth is not important, even if lasting for several, say three or four, weeks, as it is counterbalanced by a subsequent excessively rapid growth.

(*c*) *Concerning the Growth from the End of the First to the End of the Fifth Year.*—No statistics sufficiently extensive and accurate to be worth quoting are known to me. Quetelet's, which are often repeated, are misleading, because he weighed only children which in his judgment were well developed; hence, his figures do not give an average of anything except Quetelet's notion of what a child ought to be, which is now definitely known to be essentially different from what children are.

5. *Growth of Children.*—Concerning school children we possess a good many valuable data. The best statistics by far are those of Bowditch. The average weights obtained by him are given in the accompanying table in kilograms; the clothes make up about eight per cent. of the weights given. The average standing heights, without shoes, is given for both sexes in the same table. These data refer to nearly twenty-five thousand measurements on the school children of Boston, Mass.

GROWTH OF BOSTON SCHOOL CHILDREN.

Age.	Boys.			Girls.		
	Height in cm.	No. of observations.	Weight, kgm.	Height in cm.	No. of observations.	Weight, kgm.
5 to 6 years	105.6	848	18.64	104.9	605	17.99
6 to 7 years	111.1	1,258	20.49	110.1	987	19.63
7 to 8 years	116.2	1,419	22.26	115.6	1,199	21.53*
8 to 9 years	121.3	1,481	24.46	120.9	1,299	23.61*
9 to 10 years	126.2	1,437	26.87	125.4	1,149	25.91
10 to 11 years	131.3	1,363	29.62	130.4	1,089	28.29
11 to 12 years	135.4	1,293	31.84	135.7	936	31.23
12 to 13 years	140.0	1,253	34.89	141.9	935	35.53
13 to 14 years	145.3	1,160	38.49	147.7	830	40.21
14 to 15 years	152.1	908	42.95	152.3	675	44.65
15 to 16 years	158.2	636	48.56	155.2	459	48.12
16 to 17 years	165.1	359	54.90	156.4	353	50.81
17 to 18 years	168.0	192	57.84	157.2	233	52.41
18 to 19 years	169.3	84	60.13	157.3	155	52.24

* In Bowditch's tables, as printed, incorrect numbers are given.

The results are more easily followed in the graphic representation, Fig. 2350, the ordinates represent the heights or weights, the abscissæ, the ages. We can distinguish three periods: (1) The steady growth of childhood, up to ten and one-half or eleven years in girls, to twelve or twelve and one-half in boys; (2) the period of præpubertal acceleration, when the growth is much more rapid, lasting in girls from eleven to fourteen or fifteen, in boys from twelve to sixteen and one-half; (3) the postpubertal decline. In girls the præpubertal acceleration begins earlier and is more marked than in boys; hence, though during childhood girls are smaller than boys, yet from twelve to fifteen they outstrip them, and are both taller and heavier than boys of the same age. Puberty ensues later in boys than in girls. The postpubertal falling off in growth is more rapid in girls than in boys; accordingly, after the fifteenth year boys gain fast over the girls. That the acceleration is really præpubertal is shown by the fact that the age of the first catamenia averages in Boston about fourteen and one-half years, so far as determined by the present imperfect statistics. Pagliani has proved the same relation in Italy. Most conclusive is the record of the growth of individuals, which demonstrates that the first menstruation is preceded by rapid, and followed by slower, growth.

Dr. Bowditch has shown, also, by his statistics that the children of American-born parents are, in the community of Boston, taller and heavier than children of foreign-born parents, a superiority which depends probably chiefly on the greater average comfort in which such children live and grow up, and partly upon differences of race and stock. The children of the well-to-do classes are taller and heavier than those of poorer classes. American (Boston) boys are taller for their age than English boys, concerning whom we have statistics, and are also heavier in proportion to their height; the comparison holds between the laboring classes and the upper classes both, as well as between boys taken without distinction. Incidentally it may be said that the popular conception of a "Yankee," as tall and slim, has no foundation in life, the Yankee, on the contrary, being stouter than the Englishman.

In general it may be said that growth is favored by healthful conditions; it is impaired by illness, probably, of any kind, but, of course, by some diseases much more than by others. It is favored by country more than by city life; by outdoor more than by sedentary occupations; by summer more than by winter; by vacation more than by attendance on school. A considerable body of statistical material on these and similar points is available, but unfortunately it is much scattered and has never been collated.

The growth of the organs calls for much further investigation. At present we can compare only the adult with the new-born child, but even of these the data are few. From Vierordt's compilation the following table is taken:

	New-Born Child.		Adult.	
	Weight in grams.	In per cent. of the body weight.	Weight in grams.	In per cent. of the body weight.
Skeleton	445	16.7	11,560	15.35
Muscle	625	23.4	29,880	43.09
Tendon		....		
Skin	337	....	4,011	
Brain	....	14.34	......	2.37
Suprarenals	8.5	.31	8.0	.014
Thymus	9.4	.54	5.0	.0086
Thyroid	6.5	.24	29.1	.05
Lungs	....	2.16	......	2.01
Heart	....	.89	......	.52
Liver	....	4.39	......	2.77
Kidney	....	.88	......	.48
Alimentary canal	....	2.53	......	2.34

The weights in grams and the percentages are from different authors. There are certain observations on the growth of organs, notably by Lorey, Frerichs, Bischoff, Bambeke, and Thoma, but the number of cases heretofore recorded is so small that no satisfactory statistics are possible.

It would be very interesting to know how the chemical composition of the body changes with age, and it is to be hoped that we shall soon have complete analyses of bodies at various ages.

6. *Size of Adults.*—No available statistics in regard to women are known to me, those referring to men, and taken from armies, are very extensive; the best worked out are the data in regard to the American army, as discussed by Gould and Baxter. The former had the material collected by the Sanitary Commission during the Rebellion; the records were hastily and inaccurately made by the single States, but the number of observations was so large that the errors may have corrected themselves to a considerable extent. Baxter, whose material was much more extensive and reliable, has not thought it worth while to tabulate the weights in proportion to age, but gives good tables of the stature.

Gould's Table of the Mean Weights of White Soldiers.

Age.	No. of observations.	Weight, lbs.	Age.	No. of observations.	Weight, lbs.
16	216	121.03	36	184	149.29
17	456	128.02	37	167	148.81
18	1,100	133.93	38	153	147.22
19	1,150	137.05	39	123	146.38
20	1,357	141.38	40	98	150.01
21	1,446	143.06	41	61	146.30
22	1,351	143.60	42	102	146.97
23	1,108	144.31	43	73	145.62
24	1,059	146.31	44	83	152.79
25	745	146.84	45	67	147.06
26	599	147.05	46	37	146.97
27	551	146.93	47	19	145.05
28	512	147.21	48	35	146.82
29	386	145.51	49	10	145.19
30	395	147.62	50	21	138.06
31	242	147.65	51	12	144.25
32	298	146.00	52	10	139.49
33	225	148.53	53	11	151.15
34	225	148.29	54	8	159.60
35	339	145.57	Over 54	20	143.49

From this table the increase in weight is seen to continue up to about the thirty-fifth year, but the figures of the weights are irregular after the number of observations falls below 600. That the period of growth reaches to this age is more clearly shown by Baxter's table of the height at different ages.

Table of Ages and Corresponding Heights (without Shoes) of 190,621 American-born White Men found Fit for Military Service.

Age.	Number of observations.	Height.	
		Inches.	Metre.
Under 17 years	468	64.11	1.6284
17 years	937	65.67	1.6675
18 years	30,456	66.39	1.6863
19 years	14,994	67.07	1.7036
20 years	11,526	67.51	1.7148
21 years	14,146	67.78	1.7216
22 years	10,479	67.92	1.7252
23 years	8,907	68.01	1.7275
24 years	7,335	68.02	1.7277
25 years	7,940	68.05	1.7285
26 years	6,986	68.09	1.7295
27 years	6,351	68.11	1.7300
28 years	6,033	68.13	1.7305
29 years	4,447	68.17	1.7315
30 years	6,256	68.18	1.7318
31 years	5,562	68.20	1.7323
32 years	4,635	68.20	1.7323
33 years	3,939	68.29	1.7346
34 years	2,782	68.35	1.7361
35 years	4,966	68.47	1.7391
36 years	4,138	68.28	1.7343
37 years	4,172	68.26	1.7338
38 years	4,014	68.24	1.7333
39 years	3,402	68.23	1.7330
40 to 45 years	15,750	68.23	1.7330

These tables show that it is necessary to be extremely cautious in fixing upon any year to mark the adult age, for the cessation of growth is so gradual that its ending cannot be determined. In practice, it is convenient and sufficiently accurate to call twenty-five the adult year; for women it ought probably to be somewhat less. That the tables are far from what we could wish is

true, chiefly owing to the inherent defects of the original observations; we must also regret that Baxter did so much less than his material would have permitted. But, on the other hand, both Baxter and Gould are far in advance of their predecessors. Anthropometry has been much written upon. Baxter gives an excellent review of the subject, with sketches of the many mystical laws announced by older authors upon human proportions, but we still lack a good general treatise upon vital statistics.

IV. The Laws of Mammalian Growth.—Growth is a subject as yet but little investigated, and this section is based on Minot's experiments, made chiefly on guinea-

Growth of Male Guinea-Pigs.

Age.	Number of observations. Grams.	Average weight. Grams.	Increase over last measurement. Grams.	Average daily increase. Grams.	Daily per cent. increase. Grams.
0 day	200	70.8			
1 to 3 days	138	70.8	1.0	0.0	0.0
4 to 6 days	133	82.6	11.8	3.9	5.6
7 to 9 days	142	96.2	13.6	4.5	5.5
10 to 12 days	148	109.7	13.5	4.5	4.7
13 to 15 days	150	126.2	16.5	5.5	5.0
16 to 18 days	152	141.7	15.5	5.2	4.1
19 to 21 days	151	158.4	16.7	5.6	3.9
22 to 24 days	152	173.2	14.8	4.9	3.1
25 to 27 days	145	187.8	14.6	4.9	2.8
28 to 30 days	141	203.8	16.0	5.3	2.8
31 to 33 days	140	215.6	11.8	3.9	1.9
34 to 36 days	136	226.9	11.3	3.8	1.7
37 to 39 days	129	240.2	13.3	4.4	1.9
40 to 50 days	149	272.9	32.7	3.0	1.2
55 to 65 days	155	327.1	54.2	3.6	1.3
70 to 80 days	155	383.9	56.8	3.8	1.2
85 to 95 days	152	434.4	50.5	3.4	.9
100 to 110 days	102	481.6	47.2	3.1	.7
115 to 125 days	75	522.8	41.2	2.7	.6
130 to 140 days	67	529.8	7.0	.5	.1
145 to 155 days	72	562.9	33.1	2.2	.4
160 to 170 days	75	590.5	27.6	1.8	.3
175 to 185 days	76	604.7	14.2	.9	.2
190 to 200 days	70	627.0	22.3	1.5	.2
205 to 215 days	61	663.3	36.3	2.4	.4
8 months	56	672.0	8.7	.3	.05
9 months	53	737.7	65.7	2.2	.3
10 months	56	761.6	23.9	.8	.1
11 months	68	770.3	8.7	.3	.04
12 months	68	793.9	23.6	.8	.1
13 months	66	754.9	− 39.0	− 1.3	− .2

pigs, but including also rabbits and chickens. The preceding table summarizes the most important general results of these experiments; the table refers only to male guinea-pigs, it not being necessary to include the females or other animals.

The last column but one shows that the daily increase during the first three days is zero. This is due to the postnatal retardation, which is very marked in guinea-pigs, as it is also in man. The exact data are:

	Weight. Grams.	Increase.
At birth	70.8	....
One day	68.9	−1.9
Two days	70.0	1.1
Three days	73.4	3.4
Four days	77.3	3.9

The daily gain slowly increases till about the fourteenth day, and then slowly but steadily falls off. The observations are so few in number that there are many irregularities, which need not be heeded in this article. Usually the absolute increment is taken as the measure of the *rate* of growth, which is not justifiable. To show the rate of growth—as well as the observations permit—is intended by the last column, which gives the daily increase for each period, calculated at a *percentage of the weight at the beginning of that period.* We thus secure values for legitimate comparisons, because the absolute increment during any period is the product of the amount of growing material multiplied by the rate of growth; hence, if the rate is to be found, the growing amount and the absolute increment being known, the amount must be divided by the increment; this was done, and the fractions so obtained converted, for readier comparison, into percentages. As regards the guinea-pig, it shows at once that as soon as the animal has recovered from the postnatal retardation its rate of power of growth declines steadily. The observations of Fehling upon the embryos of man and rabbits show that this retardation in the relative rate of growth begins long before birth, and observations on plants make it probable that it has its beginning with the commencement of histological differentiation. This fact leads, of course, to the assumption that the vital powers undergo a steady decline, and that instead of there being a period of development, followed at maturity by a period of decline, there is a continuous decline, of which the final term is the natural death of the organism. We must, in fact, fundamentally change our conceptions of the phases of life. A man builds a wall, which keeps growing, but as the man becomes tired it increases more slowly, and stops when he is worn out. So the vital forces build the body, which develops, but all the while the forces are losing their power. The comparison is somewhat faulty, but may help to a clearer conception of decline during development.

The constant loss in the rate, which appears to be the fundamental law of growth, at least in mammals and probably in all metazoa, may be shown in another manner very strikingly. If we calculate at what age after birth the animal will have added ten per cent. to its original weight, and then the age at which it will have again added ten per cent. to its weight at the end of the first period, and so on, we obtain the following table:

Growth of Male Guinea-Pigs.

Weights increasing at the rate of ten per cent. Grams.	Age at which they fall. Days.	Differences. Days.	Weights increasing at the rate of ten per cent. Grams.	Age at which they fall. Days.	Differences. Days.
70.80	0.0	....	244.34	38.8	5.2
77.88	4.1	4.1	268.77	43.7	4.9
85.66	5.6	1.5	295.64	50.2	6.5
94.22	7.7	2.1	325.20	59.2	9.0
103.64	9.6	1.9	357.72	68.6	9.4
114.00	11.8	2.2	393.49	77.3	8.7
125.40	14.0	2.2	432.83	88.6	11.3
137.94	16.2	2.2	476.11	100.7	12.1
151.73	18.7	2.5	523.72	120.0	19.3
166.90	21.7	3.0	576.09	160.6	40.6
183.59	25.3	3.6	633.69	201.3	40.7
201.94	28.7	3.4	647.05	258.2	56.9
222.13	33.6	4.9	766.75	298.3	40.1

To make the first addition of ten per cent. requires long, 4.1 days, owing to the postnatal retardation; the second addition takes only 1.5 days; the succeeding additions occupy increasing periods, overlooking slight irregularities. In other words, the older the animal the longer it requires to add ten per cent. to its weight. In this table, also, we see the decline progressing during the so-called period of development.

The same law of decline holds true for rabbits and chickens, and also for man. In man there is a very noteworthy modification, produced by the very marked præpubertal acceleration of growth, during which the decline is interrupted, as shown by my calculations from Bowditch's tables; but compared with the whole course of decline the interruption is but slight, and is counterbalanced by an over-rapid postpubertal decline. No essential importance is to be assigned to this phenomenon, since it is well known to embryologists that during development there are often displacements in time and in the growth of individuals. Minot observes that an accidental quickening or slowing of growth is followed by a reverse period, in the first case of slowing, in the second of quickening. There appears, therefore, no objection to the conclusion that in man also the period of apparent development is a period of real decline.

This leads us to the corollary that the stoppage of growth is not due to the reaching of maturity, but is merely the final term of a series of losses. It has been asserted by Herbert Spencer, Carpenter, and others, that there is an inherent opposition between growth and reproduction, because the assimilative processes cannot perform enough to supply material for the growth of mother and offspring both. These authors and their followers see in the commencement of reproduction the beginning of a tax upon the organism which stops its growth; but as Minot has pointed out, the cause is mistaken for the effect, and probably the loss of vital force is the stimulus causing reproduction. Certainly the decline, which goes on from birth, cannot be caused by a phenomenon which begins only when the decline is nearly completed. Direct observations show that Spencer's view is erroneous, for growing guinea-pigs will bear one-third of their own weight of young while growing, and still reach as full an adult size as those producing no young (Hensen). My own experiments suggest that they become even larger. We thus learn that the fundamental conception on which Spencer's theory rests is imaginary—that conception being, that the assimilative power is approximately equal only to the needs of the growing animal. In reality there is a large excess of assimilation possible within normal limits.

The next point to be noticed is that animals tend, as they grow, to approximate to the special size of the species. This shows itself by the fact that the range of variation is less for adults than for the young. The following table shows this: The first column gives the age; the second column gives the average variation above the mean weight for that age, the variation being expressed as a percentage; the third column gives the variation below the mean—averages being based on 4,200 observations in all

MALE GUINEA-PIGS.

Age.	Variation above. Per cent.	Variation below. Per cent.
0 to 0 day	19.51	19.49
1 to 15 days	18.95	18.99
16 to 30 days	17.13	16.87
31 to 65 days	15.68	16.31
70 to 140 days	12.12	13.31
145 to 215 days	7.52	7.48
8 to 12 months	10.66	9.72
13 to 17 months	10.38	11.41
18 to 24 months	12.10	10.82

The variation of adults is barely over half that at birth in range. Remarkable is the low variation from 145 to 215 days, and from 8 to 12 months. The higher values for older periods is perhaps due to variations in obesity, which we know from common observation increases in the human species with age. The growth of an individual also indicates the existence of this tendency to attain the typical adult size; if the growth of the animal is retarded by illness, after recovery the growth is accelerated to make up. This has practical importance, for, unless the illness of a child is very prolonged, no permanent effect upon its size is to be anticipated.

The size of an animal or the limit of its growth depends upon, first, the rate, and second, the duration of its growth. This is well shown by comparing man with the rabbit and the guinea-pig, as to the average daily growth. A man acquires a weight of about 63,000 gm. in twenty-five years; a rabbit, of the larger breeds, about 2,500 gm. in one year, and a guinea-pig about 750 in the same period. For man add 280 days, for rabbits 30 days, for guinea-pigs 68 days, on account of the period of gestation.

Man	63,000 gm. ÷ 9,139 + 280 = 6.69 gm. per diem.
Rabbit	2,500 gm. ÷ 365 + 30 = 6.30 " " "
Guinea-pig	750 gm. ÷ 365 + 68 = 1.73 " " "

Man grows about as fast as a rabbit, but becomes much bigger, because he grows longer; but the rabbit is bigger than the guinea-pig, because he grows much faster. This is matter of common observation; all that we gain from our calculation is a quantitative expression more suited for ready comparison.

Of course, the whole shaping of the organism depends upon variations in the growth rates of the single parts, but what causes such variations is unknown. Many writers have sought to account for the variations by purely mechanical factors, principally strain and pressure; but although such assumptions have been very frequently put forward by His, van Beneden, Kölliker, and a host more, they must all be condemned as more or less ill-considered speculations. A growing trout assumes a certain form; why? because it is its inherited tendency; of the physiological nature of that tendency we know hardly anything, except that it is *not* mechanical, but only an unexplained growth force.

LITERATURE.—The only general works are the very important treatise of Vierordt in Gerhardt's "Handbuch der Kinderkrankheiten," Bd. 1, Abth. 1, pp, 219–290; Davenport's treatise in the second volume of his "Experimental Morphology" (1899); and the useful summaries given by Preyer in his "Physiologie des Embryos," by Hensen in the sixth volume of Hermann's "Physiology," and Daffner, in "Das Wachstum des Menschen" (1897). The number of special papers is very large; a few references are given below; for additional ones consult Vierordt.

Charles Sedgwick Minot.
Revised by *R. P. Bigelow.*

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II. WEIGHT AT BIRTH.—Rumpe: Arch. f. Gyn., xx., 117.—Ahlfeld: *ibid.*, xii., 489.—Lorey: Jahrb. Kinderheilk., N. F., xii., 260.—Ingerslev: Nord. Med. Ark., vii., 1875—Frankenhäuser: Monatschr. Geburtsk., xiii., 170.—Elsässer: Henke's Zeitsch., xxxvii., 2.—Wagner: Centralbl. f. Gynäk., 1885, 359.—Negri: *ibid.*, 1886, p. 58.

III. GROWTH OF INFANTS.—Hesse: Arch. f. Gynäk., xiv., 491, and xvii., 150.—Petersen: Schmidt's Jahrb., Bd. 196, p. 31.—Hofmann: Neue Zeitschr. Geburtsk., xxvi., 145.—Siebold: Monatschr. Geburtsk., xv., 337.—Pfeiffer: Jahrbücher f. Kinderheilk., xix., 142.—Biedert: *ibid.*, xix., 275.—Woronoff: *ibid.*, xxii., 254; abstract in Schmidt's Jahrb., Bd. 205, p. 47.—Wolff: Centralbl. f. Gynäk., 1885, p. 16.—Rezmarozky: Arch. f. Gyn., v. For further literature see Vierordt, *loc. cit.*

IV. GROWTH OF CHILDREN.—Bowditch: The Growth of Children, Boston, 1877; also, The Growth of Children (a supplementary investigation), Boston, 1879; both republished from Reports of the Massachusetts State Board of Health.—Peckham: The Growth of Children, from Sixth Annual Report State Board of Health of Wisconsin.—Pagliani: Lo Sviluppo umano per età, sesso, etc., Milano, 1879; and Sopra alcuni fattori dello Sviluppo umano, Torino, 1876.—Malling Hansen: Gewicht der Kinder, Copenhagen, 1883; and Tägliche Wagungen, etc., Copenhagen, 1884.—Theile: Nova acta, xlvi., 3, 1884.—Ménard: Gazette Méd., Paris, January 9th, 1886.—Roberts, C.: Relative Increase in Size of the Body. Report of Brit. Assn. Adv. Sci., 1881.—Porter, W. T.: Growth of St. Louis School Children. Trans. Acad. Sci. St. Louis, 1893–94; and Pub. Amer. Statis. Assn., 1894–95.—Daffner, F.: Das Wachstum des Menschen, Leipzig, 1897.

V. ANTHROPOMETRY.—See the General Treatise of Roberts; Gould's Statistics, published by the U. S. Sanitary Commission; and Baxter: Statistics of the Provost-General's Office, 2 vols., 4to, Washington, 1876. Baxter gives an extensive bibliography.—Davenport, C. B.: Statistical Methods, New York, 1899.

VI. GROWTH OF ANIMALS.—Minot: Proc. Society of Arts, Boston, p. 50, 1884.—Hensen und Edelfsen: Arbeiten Physiol. Inst. Kiel, pl. i. Kehren: Arch. f. Gyn., i., 224.

GUACAMPHOL, the camphoric acid ester of guaiacol, occurs in white, needle-like crystals or powder, and is tasteless and odorless, and insoluble in the ordinary solvents. It is said to pass unchanged through the stomach, and to split up in the intestines into guaiacol and camphoric acid; so it has been employed as an intestinal antiseptic, particularly in tuberculous diarrhœas. It is especially recommended, however, by Kaminer and Lasker, for combating the night sweats of pulmonary tuberculosis. The dose is 0.5–1 gm. (gr. viij.–xv.) in capsule at bedtime. *W. A. Bastedo.*

GUACO.—The drug at present known by this name is only one of a number of products known by it in tropical America. It is the leaves of *Willoughbæa* Neck, or *Mikania* Willd., probably of more than one species (fam. *Compositæ*). It is a native of South America, and grows also, either wild or introduced, in the West Indies. Guaco has a great reputation among the inhabitants of

many South and Central American countries as an antidote to snake bites, and as a sort of corollary it has been supposed to be useful in hydrophobia, cancer, cholera, epilepsy, syphilis, etc. Fauré separated an amorphous bitter principle (which is probably not chemically pure) which he has called *guacin*. An odorous principle that appears to be present in the fresh, must be mostly dissipated in the dried, leaves. There is nothing in its chemical or evident physical properties that should lead one to regard guaco as other than a mild aromatic bitter, of the Eupatorium order.

In its native regions it is preferably given in the fresh state. Here the dried leaves may be prepared in any of the usual ways, and rather freely administered. *W. P. Bolles.*

GUAIAC, including GUAIAC WOOD, GUAIACI LIGNUM, or *Lignum Vitæ*. "The heart-wood of *Guaiacum officinale* L. and of *G. sanctum* L. (fam. *Zygophyllaceæ*)" (U. S. P.), and GUAIAC, GUAIAC RESIN, GUAIACI RESINA, or "*Gum Guaiac.*" "The resin of the wood of *Guaiacum officinale* L." (U. S. P.). These are small evergreen trees of northern South America and the West Indies, having the habit of a small apple-tree, and forming a brilliant mass of bright blue, when in full bloom.

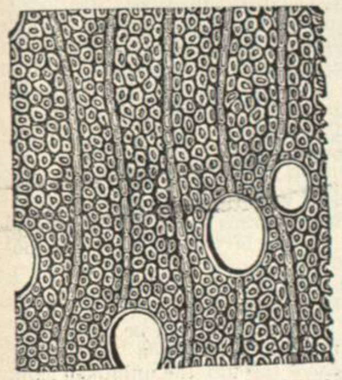

FIG. 2351.—Section of Guaiacum Wood. (Baillon.)

Guaiacum wood was carried to Europe soon after the discovery of the West Indies (early in the sixteenth century), and made a rapid reputation for itself as a remedy for syphilis and gout, a reputation that it unfortunately very soon lost again in great measure. Two products of the tree are imported—the wood, which if of fair size and soundness, goes to the turners to be made into pulley-sheaves, mallets, mortars, tool handles, etc., and the crude resin, rudely obtained from the living tree or fresh wood.

The wood comes in logs several feet in length, and from two to six or eight or more inches in diameter, often irregularly crooked and branching; they consist, excepting the smallest, of a bright yellow, hard *alburnum*, and a very dark greenish-brown, exceedingly hard and heavy heart, consisting of very much thickened wood cells, and an abundance of a peculiar composite resin. This wood is almost as hard and heavy as ivory, and turns the edges of tools not especially sharpened for it. That which reaches the drug market consists principally of the turnings and refuse of what is manufactured for the purposes above named. It should consist only of the brown or green heart-wood, which is heavier than water, to which it does not impart its color. Upon the addition of nitric acid, if it has not been deprived of its resin, it should give a dark, bottle-green color. The resin, of which there should be about 25 per cent., is the only active constituent, so that its properties are also those of the wood.

The resin, which is obtained partly by incising the trees, and partly as a spontaneous exudation, also sometimes forced out from the wood by heat, is a crude and impure substance. The officinal description is as follows: In irregular masses, or subglobular pieces, externally greenish-brown, internally of a glassy lustre, and, in recent guaiac, usually reddish-brown, transparent in thin splinters, fusible, feebly aromatic, the odor becoming stronger on heating; taste somewhat acrid; powder grayish, turning green on exposure to air.

Soluble in potassium or sodium hydrate T. S. and in alcohol; the alcoholic solution is colored blue on the addition of tincture of ferric chloride.

It is very brittle when cold, plastic with slight heat.

COMPOSITION.—It contains about seventy per cent. of *guaiaconic acid*, a yellow or brown, brittle, amorphous resin; ten of *guaiaretic acid*, which is crystalline; nine or ten of *guaiacic acid*, something like guaiaconic acid, and three or four of gum, besides a little volatile oil, ash, coloring matter, and various impurities.

ACTION AND USE.—The reputation of guaiac depends upon clinical evidence entirely, and has had spells of waxing and waning. It is stimulating, or in large doses irritating to mucous membranes and markedly increases their secretions, thus acting as a laxative. The high estimate early placed upon it in syphilis has disappeared since the real efficiency of mercury and iodine has been established. In gout, although perhaps useful, it is certainly no specific; as an emmenagogue it is no better nor worse than many others. In chronic and mild subacute rheumatism, and in rheumatic arthritis, the evidence in its favor is strong. It is perhaps one of the best remedies for these intractable maladies. It is considerably used in inflammatory conditions of the throat and fauces, especially when there is deficient secretion.

ADMINISTRATION.—The dose of guaiac (resin) is from 0.5 to 2 gm. (gr. viij.–xxx.). It may be given in pill or powder, but the tinctures, of which there are two,—one simple (*Tinctura Guaiaci*, U. S. P., strength 20 per cent.), made with alcohol, and one associated with ammonia (*Tinctura Guaiaci Ammoniata*, U. S. P., strength 20 per cent.), made with aromatic spirit of ammonia,—are more generally used in doses of 2 to 4 c.c. (fl ʒ ss.–i.). Both become turbid upon mixing with water, and are oftenest given in milk. Guaiac wood is used as an adjuvant in the Compound Syrup of Sarsaparilla.

W. P. Bolles.

GUAIACETIN, pyrocatechin-mono-acetic acid ($C_6H_4.OCH_2.COOH.OH$), is a white, odorless, crystalline powder, readily soluble in water. Nièd and Meitner have used it with benefit in tuberculosis, claiming for it the special advantages that it promptly lowers temperature, lessens the mucous secretion, and diminishes the night sweats. It is an admirable stomachic (Meitner), and so may be continued even when chronic gastritis exists. The dose is 0.5 gm. (gr. viij.) three times a day in solution or capsule. *W. A. Bastedo.*

GUAIACOL.—*Methyl-pyrocatechin.* $C_6H_4.OCH_3.OH$. Guaiacol constitutes from sixty to ninety per cent. of wood creosote, from which it is separated by fractional distillation, the boiling point of guaiacol being 206° to 207° C. Specific gravity, at 15° C., 1.33. It is a colorless liquid, with a strong aromatic odor, slightly soluble in water, 1 part to 85, readily soluble in alcohol, ether, glycerin, and oil. Guaiacol may also be prepared synthetically from catechin, and by the dry distillation of guaiacum resin. From these sources it is obtained in colorless, prismatic crystals. These are considered to be absolutely pure guaiacol, and are official in the Paris Codex. The guaiacol of commerce is very variable in strength and often very impure, the impurities being such as are common in creosote and are the result of careless distillation. The adulteration is evident by the lower specific gravity, the stronger odor, and by becoming darker upon exposure. The pure guaiacol, with concentrated sulphuric acid, gives a faint yellow coloration which is changed to a cherry-red by the addition of acetone; the impure article gives a more or less red color with the acid alone.

Guaiacol is absorbed from the stomach or intestines, from the unbroken skin, and by inhalation. It is rapidly excreted and may be detected in the urine, saliva, or perspiration within fifteen minutes. In twenty-four hours it is entirely excreted. Guaiacol may be detected by distilling the solution with dilute sulphuric acid, and adding to the distillate a small quantity of a dilute solution of liquor ferri sesquichlorati (two or three drops to a test tube of water). If guaiacol is present a reddish-brown color is developed, the intensity of which depends upon the amount of guaiacol.