106. *The margins* of leaves are also variously formed. They are said to be *entire* when they present one unbroken outline; *sinuated* (15 in fig. 46), like the oak; *repand* (16); *crisped* or curled (17 in fig. 47); *undulated* or waved (18); *runcinate*, as in the dandelion (19 in fig. 48); *ciliated* or fringed like the lashes of the eye (20); *plaited* or folded

Fig. 49.—Plaited (21), Dentate (22), and Bidentate (23) Leaves.

(21 in fig. 49); *dentate* or toothed (22), and *bidentate* (23); *serrated* or sawlike (24 in fig. 50); *crenated* or scolloped

Fig. 50.—Serrated (24), Crenated (25), and Armed (26) Leaves.

(25); and *armed* (26). To these may be added *erose* or gnawed, when the margin appears as if it had been bitten by some animal; *lacinated* or deeply and irregularly cut, and *incised* or regularly cut.

107. *The apex or termination of a leaf* assumes various forms. When drawn out to a long point, the leaf is said to

117. How are the margins of leaves?
118. Marginal variations and names.
119. What of the apex and surface of leaves?

be *acuminate;* when notched in the middle (as in fig. 34, *m*), *emarginate;* when tapering abruptly to a point, *cuspidate;* and when ending in a little bristle, *mucronate.* Sometimes the apex extends in the form of a tendril, as in *Gloriosa superba* (fig. 29 in page 53).

108. *The surface of leaves* is generally covered with hairs, scurf, blisters, or prickles; when smooth, leaves are said to be *glabrous.* A leaf is said to be *glaucous* when its colour is a pale sea-green, and it seems covered with a kind of bloom.

109. *Leaves often vary in shape on the same plant.* In herbaceous plants the *cauline* or stem leaves are generally smaller than, and differently shaped from, the *radical* or root leaves. Sometimes one side of a leaf is larger than the other, as in the case of the elm.

Fig. 51.—Stipules.

110. *Stipules* (see *a* in fig. 51) are leaf-like bodies formed at the base of the petioles of the true leaves, and generally sheathing the stem. When they are membranous, and joined together, so as to form a sheath entirely round the stem, as in the tart rhubarb, they are called *ocreæ*, or *boots.*

111. *The petiole* of a leaf often changes its form consi-

120. Varieties in same plant.
121. What of stipules and petioles?

derably. When the leaf is wanting, it is generally either dilated into a leaf-like body termed a *phyllodium*, or drawn out into a long slender filament called a tendril (see fig. 52). Sometimes these tendrils are metamorphosed branches,

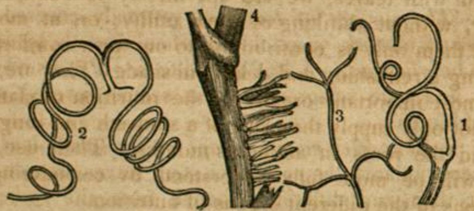

Fig. 52.—Tendrils of the Grape Vine (1), of the Pea (2), of the Clematis Cirrhosa (3), and of the Ivy (4).

as in the grape vine (see 1 in fig. 52); in other cases they are abortive leaves, as in the pea (2); or metamorphosed bracts, as in one of the kinds of clematis (3). In the ivy, the tendrils take the shape of roots (4), and it has been supposed that they bury themselves in the trees to which they are attached; but the fact is, that the ivy is a creeping plant, and uses its tendrils merely to take hold of the objects to which it attaches itself. In a few cases, the petiole is both dilated and drawn out, though the leaf is not wanting, as in the Chinese pitcher-plant (see fig. 53), in which

Fig. 53.—A Leaf of Nepenthes Distillatoria.

the lid of the *ascidium*, or pitcher (*a*), is the true leaf, and all the rest the dilated petiole. The same kind of formation is seen in Venus's fly-trap, the true leaf of which consists only of the small lobes which form the trap.

112. *Many other forms of leaves and their appendages* might be enumerated, but those already given will be sufficient to show the wonderful variety which has been displayed in these beautiful objects. When we look at a tree covered with leaves, we are apt merely to admire their beauty, without thinking of their utility; or, at most, to regard them only as contributing to our own comfort, and affording a refreshing and delightful shade. They are, however, most important organs in the nutrition of plants, as they not only supply the place of a stomach and lungs, but also aid the roots in acting as mouths. Their use, however, will be more fully understood by considering the functions of the different organs of nutrition.

FUNCTIONS OF THE ORGANS OF NUTRITION.

113. The organs of nutrition are essential to the existence of vegetation; as all plants, while in a growing state, require to be regularly supplied with food, to afford matter for their increase and for the other changes which are continually taking place within them during the whole of that season. Early in spring the buds begin to swell and to increase in size; and as soon as they expand into leaves, new buds are formed in their axils, which are continually enlarging, till they in their turn, the following spring, give birth to another race of leaves. The axis round which the leaves were folded in the bud also increases as they expand, till it finally becomes a branch. Even the leaves themselves are always changing; when they first open they are small, but become larger and larger every day, till having attained their full size, they gradually change colour, wither, and fall, leaving buds behind them containing the leaves which are to supply their place the following year. Stems also increase every year in height and thickness, till the period comes for their decay; and even then they do not remain in a permanent state, for chemical changes take place within them, by which they moulder away, and the

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122. Functions of leaves.
123. What of the process of nutrition?

elements which composed them are set free to combine again, and to form a new race of vegetables.

114. *The food of plants* consists partly of the four elementary substances which are found to constitute the organic or living part of all vegetables, and partly of those inorganic matters which are deposited in different proportions in different plants, without being thoroughly assimilated with their substance. The four elements consist of one solid substance, namely, carbon, and three gases—oxygen, hydrogen, and nitrogen. Of these, carbon is by far the most important, as it forms nearly half of every vegetable; oxygen is next, then hydrogen, and lastly, nitrogen, of which the proportion is not more than two and a half or three per cent., but small as this quantity is, it is essential: in fact, no plant can long remain in a vigorous state if it be not regularly supplied with food containing all these four elements. A certain amount of inorganic matter, derived from the soil, is also taken up by the roots through the medium of water; and these substances, though more abundant in some kinds of plants than in others, are also indispensable to perfect vegetation. They are easily detected by burning, as they are not destroyed by the action of fire; and thus, when a rick of hay is burned, a small quantity of flinty matter is found to remain, which is, in fact, the silex absorbed by the plants of which the hay was made, while they were in a living state. The proportion of inorganic matters found in plants is very small; the greatest being about ten per cent., as in the straw of wheat and barley, and other grasses; and the least not exceeding four or even two parts in a thousand, as in the oak and some other forest-trees.

115. *The organic food* of plants consists of carbonic acid gas, water, and nitrogen, the last being generally in the form of ammonia. The carbonic acid gas is obtained partly from decaying vegetable matter in the soil, and partly from the atmosphere. In the former case, the carbon of the soil attracts oxygen from the atmosphere, and the gas so formed,

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124. Describe the food of plants.
125. What of organic food?

being dissolved in water, is absorbed by the spongioles of the root; in the latter, the carbonic acid is derived directly from the atmosphere, and absorbed through the leaves. The water, which yields both oxygen and hydrogen, is obtained chiefly from the soil, but it also enters by the leaves; and the ammonia is absorbed from manure and decaying animal substances, though part of it appears also to be obtained from the atmosphere. Thus, all the elements which form the organic part of plants may be obtained from the atmosphere without any aid from the soil, and probably are so occasionally; though only carbonic acid gas seems in ordinary cases to be habitually derived from that source.

116. *The inorganic matters* taken up by plants are derived entirely from the soil, and must be dissolved in water before they can be absorbed. They consist of the primitive earths, various kinds of salts, and a few minerals. The salts are composed of some kind of acid, and a base with which it can combine; the bases most common in the vegetable kingdom being the three alkalies—potash, soda, and ammonia. Of these, potash is by far the most abundant; and it is indeed so common in almost every plant, that their ashes are used for making ley, a substance composed principally of potash, and used in washing coarse linen. The leaves generally produce more potash than the wood, from the quantity which is lodged in the tubes of woody fibre in their veins. Nitre or saltpetre is a neutral salt, formed by the combination of nitric acid with potash, which has a powerful effect on vegetation. Soda is found abundantly in plants growing near the sea, and it is frequently obtained by burning sea-weed. Ammonia is found in all animal manures, and, combined with the different acids, it forms various salts, which, however, are not so common in plants as the salts of potash and soda. All animal and vegetable substances containing nitrogen evolve ammonia in its volatile state during decomposition. The primitive earths are found in plants either in a pure state, or combined with carbonic, sulphuric, muriatic, or phosphoric acids. Albumen and gluten, which compose the principal substance of

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126. What of the inorganic food of plants?

seeds, always contain a small portion of some kind of phosphate; such as phosphate of lime or phosphate of magnesia. The oxides of iron and manganese are also found in many plants; the latter more rarely, and in less abundance, than the former. Inorganic matters are thus necessary to the development of every perfect vegetable, some species requiring them more largely than others; hence the importance of supplying cultivated soils with those substances, in the form of stimulants and manures.

117. *The absorption of the food of plants* takes place partly through the spongioles of the roots, and partly through the lymphatic hairs of the leaves. All the substances taken up by the roots are mixed with a very large proportion of water, as otherwise they could not pass through the minute passages by which they are conveyed into every part of the plant; but the food absorbed by the leaves appears to be in a more concentrated state, though it also must be either in a liquid or gaseous form. The liquid taken up by the roots is known, as soon as it enters the plant, by the name of *sap;* as is also that imbibed by the leaves.

118. *The assimilation of the food* is a chemical operation, but it differs from ordinary chemical combinations in life being the principal agent. It is called *organic chemistry*, because performed by the organs of living beings. Thus, though a chemist may ascertain that seeds are composed of carbon, with a small proportion of nitrogen, and that wood consists principally of woody fibre, composed of carbon, oxygen, and hydrogen, the tubes of which have been filled up with some kind of inorganic matter, it is not in his power to make either seeds or wood by chemically combining the elements of which they are composed, because life, the principal agent, is wanting.

119. *The sap of plants* is of two kinds; the *ascending sap*, or *lymph*, which rises in spring and early summer, and which consists principally of the liquid taken up by the roots; and the *descending sap*, or *proper juice*, which flows

127. Name the varieties of earths and metals, etc.
128. What of the absorption by plants?
129. What is remarkable in the assimilation?

downwards in the latter part of summer and autumn, and which appears to consist principally of the sap absorbed by the leaves.

120. *The ascending sap and the descending sap* are quite different both in their appearance and qualities. The ascending sap is thin and watery, and somewhat sweet; but it contains no noxious properties, even in the most poisonous plants. The natives of the Canary Islands tear the bark off a poisonous kind of Euphorbia, which grows wild in that country, and find the ascending sap which they obtain from the alburnum a refreshing drink; though the descending sap of the same tree is of so acrid a nature as to act as a caustic, and to burn the flesh of those who may happen to touch it. The ascending sap of the maple and some other trees is sufficiently sweet to make sugar by evaporation; but the descending sap of the same trees does not possess any sweetness.

121. *The sap begins to ascend in spring*, and continues to rise till the leaves are fully developed, and begin to imbibe nourishment from the air. The principal current of the sap then descends by the vessels of the latex, and continues to do so for some time, as the ascending sap had risen, but not with equal rapidity. The force with which the sap ascends is so great, that a bladder tied over the stump of a vine, from which a piece had been cut off early in May, was torn into shreds by the rising of the sap; and by the experiments of some French and German botanists, it is found that the motion of the sap is generally five times greater than that which impels the blood in the principal artery of the horse.

122. *The sap ascends principally through the large dotted ducts in the alburnum*, but partly also by the tubes of the woody fibre, as may be seen by cutting across the branch of a vine in spring, when the sap will be seen oozing out of the mouths of the vessels in large globules from the dotted ducts, and in very small ones from the hollow tubes of

130. Describe the varieties of sap?
131. What of the circulation of the sap?
132. Changes and uses of the sap.

the woody fibre. The ascending sap of all plants is nearly the same; if drawn from the tree just above the collar, it looks and tastes like water, but if drawn from a higher part of the trunk, it appears thick and yellowish, like weak gum water, and tastes of mucilage and sugar. This change is produced by the ascending sap mixing with certain portions of starch (changed into sugar) and gum, which were deposited by the descending sap the previous season.

123. *The lymph or ascending sap* always flows through the soft or sap-wood, and it spreads horizontally as well as rises vertically. It furnishes the cellular tissue for the leaves, stem, and bark, and deposits the earthy matter carried up with it in the woody fibres of the heart-wood, which when these are filled up, becomes dead, and undergoes no further change till it begins to decay. The sap only continues its rapid ascent till the leaves are fully developed, and then, though it continues to ascend, it is with little force, as the principal current of the sap is downwards. The change in the principal current of the sap generally takes place in trees about midsummer, or at any rate before the month of August. In herbaceous plants, it takes place at an earlier period, as the life of the plant is so much shorter; and wherever the summer is hot and short, the sap descends sooner than in countries where the summer is longer and more temperate.

124. *The proper juice or descending sap* always takes its principal current through the bark, though it also spreads horizontally as well as vertically. It contains all the peculiar products of the plants, such as milk, oil, and resin, which it deposits as it descends. It also deposits mucus, to form the first layer of *liber* or inner bark, within the epidermis, which, by similar deposits, becomes changed into the outer bark; and other mucus for the formation of woody fibre and those tissues of which a new layer of wood is composed. It then passes downward to the roots, which it hardens by its various deposits, and to the tip of which it sends matter for fresh cellular tissue, to form new spongioles, while the epidermis creeps over those that formerly existed.

125. *It was at one time supposed* that the lymph changed to proper juice in the leaves, only by throwing off its superfluous air and moisture, and that this was done by light decomposing the carbonic acid sent up to the leaves by the roots—the oxyen being thrown off, and the carbon remaining to be conveyed back into the plant. This was called the *fixation of carbon.* It was now found, however, that the lymph is partially decomposed in its passage upwards, and that the oxygen set free is carried by the spiral vessels to the leaves, where it is exhaled. The superfluous water is also carried there and evaporated; and the greater part of the carbon contained in the descending sap is taken in by the leaves.

126. *The season of growth* is the period of the ascent and descent of the sap; and in those countries where plants have two seasons of growth, there are two periods of this change. This season varies in duration according to the nature of the tree. In the ash it is remarkably short; and though this tree retains its leaves only for a short period, opening them later and losing them sooner than many others, its wood is remarkably tough. The Scotch pine generally finishes its growth in the space of six weeks, and its young shoots are remarkably stiff and erect. The larch, on the contrary, which continues growing all summer, has long shoots, which are very flexible and slender.

127. *The ripening of the wood* of young shoots, is the complete formation of the first layer of wood; and in old trees it is the formation of a new layer of sap-wood, and the hardening of the sap-wood of the previous year.

128. *When the layer of new wood is completed,* mucilage and starch are deposited in its vessels, part of which oozes out in spring between the wood and the bark, which it loosens from each other; hence bark is easily removed in spring. This substance is called *cambium,* and is supposed to be the first form of the matter which afterwards becomes a new layer of sap-wood. The rest of the mucilage

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133. What of the respiration of plants?
134. Peculiarities of growth?
135. Define the technicals.

and starch deposited in the vessels of the alburnum is supposed to mix with the ascending sap, and to change its colour and taste in the manner before mentioned (par. 122).

129. *The sap-wood is always formed* from the descending sap; and thus, if a ring of bark be taken off a branch, the upper part of the wound heals rapidly, and the branch increases above it so much as to bulge out; while the lower part of the wound does not heal, and the branch beneath does not increase in thickness. Even tying a piece of cord tightly round a branch, so as to indent the bark and stop the current of the descending sap which passes through it, will make it swell above the ligature, and prevent its increase below.

130. *Every plant appears to have some matter conveyed to it by the lymph which it cannot assimilate.* When this matter is inorganic, it is deposited principally in the vascular tissue of the petioles and veins of the leaves, till they become choked up with it, and the leaves fall. The organic excrementary matter is, on the contrary, supposed to be exhaled from the leaves, or to be conveyed downwards by the descending sap (by means of the woody tube which passes through every root, even to the tip of the spongioles), and deposited in the soil. The season of growth being finished, the leaves fall off, leaving, however, in the axil of each a little bud, to be developed into leaves the following spring.

131. *The fall of the leaf* is supposed by De Candolle and many modern botanists to be occasioned by the deposition of inorganic matter in the veins and petioles, which in time so completely chokes them up, that the leaves being no longer able to receive nourishment from, or to transmit it to the tree, first lose their succulency and colour, and finally drop off. M. Du Petit Thouars, and others, however, suppose that as the petiole elongates, the spiral vessels it contains unrol, till at last they reach their full extent and break; then the leaf falls. Both opinions have been entertained by eminent botanists, but the former now appears to pre-

136. What of superfluous nutriment?
137. Philosophy of the falling leaf?

vail; and it is confirmed by the fact, that dead leaves, when burned, yield more earthy matter than any other part of the tree.

132. *The motion of the sap has been attributed to various causes* by different botanists. Some suppose that it rises solely by the force of vital action; others that it is drawn up by the leaves; others that its particles are expanded and forced upwards by heat; and others that they rise by capillary attraction. The theory of Endosmose and Exosmose, broached by M. Dutrochet, is founded partly on this last opinion. This celebrated botanist discovered that small bladders of either animal or vegetable membrane, if filled with milk, and securely tied, when thrown into water, absorbed a quantity of that fluid and acquired weight; while on the contrary, if bladders were filled with water, and thrown into milk, they lost weight, from the water being attracted through the membrane into the milk. From these, and other experiments, he concluded, that if two fluids of unequal density be separated by a membrane, the heavier fluid will attract the lighter one through that membrane; and this he applied to the ascent of the sap, as he supposed that the greater density of the sap contained in the tree attracted the thin and liquid lymph taken up by the roots. He also found, that if an empty bladder immersed in water had the negative pole of a Galvanic battery introduced into it, while the positive pole was applied to the water outside, a passage of fluid would take place through the membrane; so that the rise of the sap might be effected in this manner by the agency of electricity. The passage of the water through the membrane he called *endosmose*, when the attraction was from the outside to the inside; and *exosmose*, when it was from the inside to the outside. Applying this theory to trees, it is said to be by endosmose that water is absorbed, either from the atmosphere or the earth, and that the ascending sap is drawn upwards. Another mode of accounting for the ascent of the sap was suggested by Du Petit Thouars, who is of opinion, that as soon as the warmth of spring has expanded the

138. What of Dutrochet's theory?

particles of sap that are contained in the buds, their covering begins to swell; and as their size increases, fresh sap is attracted out of the adjoining parts, to supply the additional cellular tissue that is required. The parts thus emptied of their sap are refilled immediately by sap from those below; and thus the whole fluid is set in motion, from the extremity of the branches down to the roots. In corroboration of this last opinion, is the fact, well known to foresters and gardeners, that in spring the sap always begins to move first at the extremity of the branches. Dutrochet's theory, however, seems to be preferred by the greater number of botanists.

133. *An accumulation of the sap* takes place occasionally without appearing to cause any derangement in the ordinary functions of the organs; thus, nature not only lays up a store of elaborated juice to be ready to descend at the proper time every growing season, but also an accumulation, when necessary, for the production of flowers and fruit. It appears that the sap must be thickened by the various operations it undergoes in the leaves, before it be suitable for these purposes. It is also observed that the thickening of the sap, which is necessary for its accumulation, does not take place without the aid of heat and solar light; and thus, in cold wet situations, plants seldom produce so much fruit as in warm and dry ones. Abundance of carbon and nitrogen is further necessary; and scientific cultivators, having observed these facts, take advantage of them when they wish to throw trees into fruit, by keeping the roots so near the surface, as to be within the reach of atmospheric air, from which they obtain carbonic acid and nitrogen. They also bend the branches in training them against a wall, so as to prevent the too rapid descent of the sap, and to force it to accumulate in those places where they wish flower-buds to be produced. If a ring of bark be taken off a tree in spring, the sap will rise just the same as usual; but when the sap begins to descend, a protuberance will be formed just above the ring, which will be

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139. Define the technicals.
140. What of the quantity and quality of sap?

occasioned by the accumulation of the sap; its further descent being stopped by the removal of the liber, which contain the vessels of the latex. This theory also explains why gardeners sometimes ring the branches of trees in order to throw them into fruit.

134. *The quantity of water thrown off by the leaves* of plants during the process of assimilation is very great. Before sunrise, even in the driest room, water may be seen hanging on the under side of the leaf, like drops of dew; or running down from the point, as though the leaf had been exposed to rain; but the heat of the sun soon dissipates this water, by converting it into vapour. Hailes found that the quantity of water exhaled by the leaves of a sunflower three feet and a half high, was from twenty to thirty ounces in twelve hours, or about seventeen times as much as is lost in the same time by perspiration in a healthy man. Plants exhale most moisture when exposed to the heat of the sun, as this powerful agent excites the vessels to more rapid action; hence newly transplanted plants are always put in the shade, lest their evaporation should be greater than their weakened roots can supply; and hence, also, when plants want water, their leaves flag. The leaves of succulent plants have scarcely any stomata; hence they bear the want of water for a considerable time without injury. In some leaves, such as those which are pinnatifid or pectinate, there is very little cellular tissue; but the principal ribs of the venation are always perfect, and it is through these that the circulation and elaboration of the sap is carried on. It was formerly supposed that in darkness plants gave out nearly as much carbonic acid gas as they had absorbed, and absorbed nearly as much oxygen as they had given out during the day; but the experiments of Professor Daubeny, at Oxford, have proved that this is only the case when plants are in an unhealthy state. There can be no doubt that all the vital actions of a plant are stimulated by heat and solar light; and it is well known that colour is chiefly dependent on light, as plants grown in darkness are nearly white. If air be partially or entirely

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141. What of the exhalation of water from plants?

excluded, the plants become *etiolated*, or blanched; their stems and leaves want firmness, their flowers are imperfectly developed, and their fruits do not ripen.

135. *The progress of a tree from germination to maturity* is comparatively rapid, particularly during the first years of its existence, as it every year increases in size by the deposition of fresh layers of wood and the formation of additional branches. It also increases in height by new matter forming at the extremity of its ascending shoot, though not by the distension of any part already formed. This has been proved by inserting pegs in the trunk of a tree, which, in the course of two or three years, were found to be still at the same distance from each other as at first, though the tree itself had increased considerably in height during that period.

136. *The progress of a tree from maturity to decay* is slow. For some years after it has reached its full growth, very little change is perceptible; but at last the heart-wood begins to decay in the centre, and gradually wastes away, till only a hollow trunk encased by little more than the alburnum and the bark is left. The vigour of the tree is now sensibly diminished; but as the circulation of the sap is carried on in the alburnum and bark, buds are still formed; though the growing point seldom elongates itself into a branch. The flowers and fruit next cease to be produced, and finally, even the leaves disappear. Life is now extinct; but the tree still stands, till it becomes rotten at the base from the moisture of the soil, and then the first storm that comes blows it down. By and by it crumbles into vegetable mould; but this decomposition is strictly a chemical process: it takes place in vegetable just as in mineral substances, and has no connection whatever with organic functions.

142. What of the progress of trees to maturity?
143. Describe the process of decay.

ORGANS OF REPRODUCTION—FLOWER-BUDS, FLOWERS, FRUIT, AND SEED.

137. THE ORGANS OF REPRODUCTION are the flowers, the fruit, and the seed; and these, or some modification of them, must exist in every perfect *Phanerogamous* or flowering plant.

138. FLOWER-BUDS are produced like leaf-buds, from which they differ chiefly in containing one or more incipient flowers within the leaves; the flowers being wrapped up in their own floral leaves, or bracts, within the ordinary leaves, which have their usual outer covering of scales. The growing point is generally developed when the leaves expand, but it is short and stunted, and unlike the branches produced from the leaf-buds. Every flower-bud, as soon

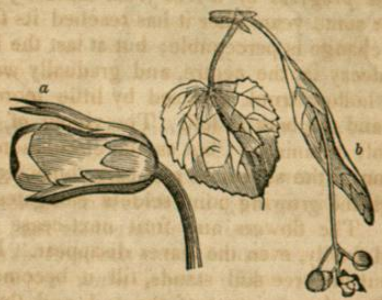

Fig. 54.—Bractea of the Christmas Rose and the Lime-Tree.

as formed in the axil of the old leaf, contains within itself all the rudiments of the future flowers. If a bud be gathered from a lilac or a horse-chestnut very early in spring, all the rudiments of the future leaves and flowers will be found within it, though the bud itself may not be more than half an inch long, and the flowers not bigger than the points of the smallest pins.

144. What of the organs of reproduction?
145. What of rudimental flowers?

139. *Bracts* are leaf-like bodies, which appear to bear the same relation to flowers that stipules do to leaves. In some

Fig. 55.—The Spathes of the Arum and the Narcissus.

cases the bract appears to form a sheath for the flower, as in the lime (see *b* in fig. 54): in others it resembles a *calyx*, as in the Christmas rose (*a*). In some plants the bract takes a tube-like shape, when it is called a *spathe*, as in the Arum (*a*) and the Narcissus (*b*, see fig. 55); in others it supplies the place of a floral envelope, as in the *glume* of the oat (fig. 56). When two or more bracts are joined together, they form an *involucre* (see *a b* in fig. 57); and when very numerous, they form a *cupule*, or cup, as in the husk of the chestnut and the beech, the cup of the acorn, &c. Bracts, when very

Fig. 56.—Glume of the Oat.

146. Describe the bracts.
147. What are varieties of bracts?

small and membranous, are called *palea*, as those of the florets of the dahlia; and when imbricated, *scales*, as in the globular involucre of the cotton thistle. The small leaves found growing on a flower-stalk below the smaller tufts of flowers are called *bractioles* or *bractlets* (*c* in fig. 57).

Fig. 57.—Involucres of the Phlox (*a*), and Chinese Primrose (*b*); and Bractioles of the Phlox (*c*).

140. *The stalk* of a single flower is called the *peduncle*; but if several flowers be clustered together, the axis, or central stalk, is called a *rachis*, and the stalks of the separate flowers *pedicels*. When a flower has no peduncle, but is directly attached by its base, it is said to be *sessile*.

141. *The æstivation* of flowers signifies the manner in which they are folded in the bud, and this differs in different plants; as, for example, the petals are *crumpled* in the poppy, *plaited* in the *petunia*, *convolute* in the pink, and *twisted* in the *convolvulus*.

142. *The position of flowers on the branch* is either *terminal* or *axillary*, and they are produced either singly or in clusters.

143. *The form of inflorescence*, or manner in which flowers are arranged when several are produced together,

148. Define the technicals of this page.
149. What of the diversity in flowers?