Illustrating the parts of a compound microscope. (From Stevens.)
PHARMACEUTICAL BOTANY

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ILLUSTRATED

PHILADELPHIA
P. BLAKISTON'S SON & CO.
1012 WALNUT STREET
PREFACE

The aim has been to eliminate from this book all those topics that are of minor importance to the student and practitioner of Pharmacy. As a pharmacist and teacher, the writer feels that the botanical preparation for Pharmocognosy and Materia Medica, in those colleges where Botany is given for one year, should include mainly the structural and systematic aspects of the science. In the Medico-Chirurgical College, of Philadelphia, Botany is taught the first year, extending over a period of 155 hours. The author has introduced in this concise volume the important subject matter of his lectures given to first year students, and has omitted laboratory directions for the obvious reason that fixed subjects for laboratory study are unnecessary. It is not a book on Pharmacognosy, however, since it does not describe how one drug differs from another of the same group in all of its details.

The work is included in two parts. Part I is largely devoted to the morphology (gross and minute) and, to a less extent, the physiology of the Angiosperms. Part II deals with the taxonomy of plants, mainly but not wholly of medicinal value, together with the parts used and the names of the official and non-official drugs obtained from these.

The author does not claim sole originality for the facts presented, but has consulted many sources of information, mention of which will be found in the bibliography of the text.

Acknowledgment is here made to his esteemed friends, Dr. Francis E. Stewart of the Medico-Chirurgical College and Dr. John M. Macfarlane of the Univ. of Penna., for valuable assistance in the reading of the proofs and preparation of the index.

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FOREWORD

In a monograph entitled "An Old System and a New Science," published in 1882, I advocated a return to the classification in which knowledge relating to the Materia Medica is embraced under the general head "Pharmacology"; in my address as Chairman of the Section on Materia Medica, Pharmacy and Therapeutics, delivered at the forty-seventh annual meeting (1896) of the American Medical Association, the same was again suggested; and in numerous papers on the subject since contributed to medical and pharmaceutical societies and press, the same plea was repeated. It is therefore gratifying to note the adoption of this classification by the National Committee Representing the Boards and Schools of Pharmacy of the United States for its "Pharmaceutical Syllabus," and also to note its incorporation into the New York State Pharmacy Law and adoption by the Board of Regents of the State of New York for the guidance of teachers of pharmacy in that state.

Pharmacology in its widest scope embraces the study of drugs from every possible point of view. As limited to the study of the changes incited in living organisms by the administration of drugs, we have excellent text books by Cushney, Sollman and others. But these works demand for their proper study more extended education than required by the national syllabus or the needs of the pharmaceutical student. The object of the Stewart Pharmacologic Manuals is to supply text books suitable for pharmacists and pharmaceutical colleges, and prepared in accordance with the national syllabus.

F. E. S.
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ERRATA

Page 2 line 34 for “Cystology” read “Cytology.”
Page 55 line 1 for “Ezaluminous” read “Exalbuminous.”
Page 60 Figs. 32 and 33 for “Clasiceps” read “Claviceps.”
Page 83 line 21 for “pinnahsfed” read “pinnatifid.”
Page 91 line 22 for “prostate” read “prostrate.”
Page 93 line 4 for “carolla” read “corolla.”
TEXT-BOOK OF
PHARMACEUTICAL BOTANY

PART I

TERMINOLOGY AND MORPHOLOGY

DIVISIONS OF BOTANY

1. Structural Botany or Plant Morphology treats of the various organs or parts of a plant, as root, stem, flower, fruit, etc., with their special forms and modifications. It also includes Vegetable Histology, that part of structural botany which considers the minute or microscopical structure of plant tissues and Vegetable Cytology, which treats of plant cells and their contents.

2. Physiological Botany explains how the various parts of the plant perform their work of growth, reproduction and the preparation of food for the support of animal life from substances not adapted to that use.

3. Geographical Botany treats of the distribution of plant life on the globe. The centre of distribution for each plant is the habitat or original source from which it spreads, often over widely distant regions.

4. Economic or Applied Botany deals with the science from a practical standpoint, showing the special adaptation of the vegetable kingdom to the needs of everyday life.

5. Geological Botany treats of the plants of former ages, traceable in their fossil remains.

6. Systematic Botany or Vegetable Taxonomy considers the classification or arrangement of plants in groups or ranks according to their resemblances or differences.

7. Vegetable Ecology treats of plants in relation to their environment.

CLASSIFICATION OF PLANTS

By grouping together those plants which are in some respects similar and combining these groups with others, it is possible to form some-
thing like an orderly system of classification. Such a system based upon natural resemblances is called a "natural system."

Types represent general plans of structure.

A Class is formed by special modification of a type. Classes resembling each other are called Series.

An Order is a group of the same class, related by a common structure.

A Family is a group of the same order, related by a common structure.

A Genus is a still smaller group having the same essential structure.

A Species is the smallest group whose structure is constant.

An Individual is a unit of organic life, forming a complete animate existence.

A Variety is a peculiarity of Race. Races and varieties are both sub-divisions of species.

A Hybrid is a cross-breed of two varieties or species, rarely of two genera.

SUBDIVISIONS OF THE VEGETABLE KINGDOM

The two great sub-divisions of the vegetable kingdom are:

Phanerogams or flowering plants and Cryptogams or flowerless plants.

The Phanerogams are further divided into:

Angiosperms, characterized by having their seeds enclosed within a box-like covering.

Gymnosperms, which have their seeds borne naked. (They are polycotyledonous.)

The Angiosperms are classified according to the number of their cotyledons, or seed leaves in the embryo, into:

Monocotyledonous plants, which have one cotyledon, as Indian Corn and Ginger, and

Dicotyledonous plants, which have two cotyledons, as Burdock, and Ipecacuanha.

VEGETABLE CYSTOLOGY

CELLULAR STRUCTURE

The bodies of all plants are made up of one or more units of structure called cells.
A **cell** is a mass of protoplasm containing a nucleus.

**Protoplasm** is the more or less semi-fluid, viscid, foamy, and granular substance in which life resides. It is the "physical basis of life." Vegetable cells generally have cell walls of cellulose surrounding the living protoplasm of the cell (protoplast).

Cells divide to form tissues.

**Protoplasmic Cell Contents**

Protoplasm consists of four well-differentiated portions:

(a) **Cytoplasm**, or the foamy, often granular matrix of protoplasm outside of the nucleus.

(b) **Nucleus** or **Nuclearplasm**, a denser region of protoplasm containing chromatin, a substance staining heavily with certain basic dyes.

(c) **Nucleolus**, a small body of dense protoplasm within the nucleus.

(d) **Plastids**, composed of plastid plasm, small discoid bodies scattered about in the cytoplasm. Sometimes, as in the cells of lower plants like the Spirogyra, plastids are large and are then called **chromatophores**.

---

**Fig. 1.—Diagram of a cell.** (From Hegner's Zoölogy, after Wilson, published by the Macmillan Co.)
According to the position of the cells in which plastids occur and the work they perform, they differ in color, viz.:

**Leucoplasts** are colorless plastids found in the underground portions of a plant and also in seeds, and the egg cell. Their function is to build up reserve starch from sugar and other carbohydrates as well as to change the reserve starch back into sugar when it is needed for the growth of the plant.

**Chloroplasts** are plastids found in cells exposed to light and contain the green pigment, chlorophyll.

**Chromoplasts** are plastids found in cells independent of their relation to light or darkness and contain the yellow or orange pigment called chromophyll.

During cell division another protoplasmic body appears called a **centrosome**.

**NON-PROTOPLASMIC CELL CONTENTS**

1. **Starch**
   - Assimilation.
   - Reserve.

2. **Inulin**.

3. **Sugars** such as dextrose, levulose, saccharose, maltose, gentianose, mannitol.

4. **Cell-sap colors** (in solution of cell sap).

5. **Alkaloids**.

6. **Glucosides**.

7. **Neutral Principles**.

8. **Feebly basic substances**.

9. **Aleurone grains**.

   - Rosette aggregates.
   - Monoclinic prisms.

10. **Calcium Oxalate**
    - Crystal fibres.
    - Raphides.
    - Micro-crystals.

11. **Cystoliths**.

12. **Tannin**.

13. **Gums and Mucilage**.

14. **Oils**.

15. **Resins**.

16. **Enzymes**
    - Proteolytic.
    - Diastases.
    - Invertases.
PLANT TISSUES

A tissue is an aggregation of cells of common source, structure and function in intimate union.

According to structure the following tissues are found in various forms of higher plants:

1. Meristem
2. Parenchyme
3. Collenchyme
4. Sclerenchyme
5. Epidermis
6. Endodermis
7. Cork
8. Laticiferous tissue
9. Cribiform or sieve tissue
10. Woody fibre tissue
11. Hard bast
12. Tracheary tissue
13. Medullary rays

A mass of tissue so united in the plant as to constitute a distinct unit is called a tissue system. Three systems of tissues are commonly distinguished in higher forms of plants:

THE EPIDERMAL OR TEGUMENTARY SYSTEM
THE FUNDAMENTAL SYSTEM
THE FIBROVASCULAR SYSTEM

Meristem, frequently called embryonic tissue, is undifferentiated tissue composed of cells in the state of rapid division.

Parenchyme or Fundamental Tissue is the soft ground tissue of plants consisting of cells about equal in length, breadth and thickness (isodiametric) with thin cellulose cell walls enclosing protoplasm and a nucleus. Three important kinds of parenchyme, viz.: Chlorophyll parenchyme, containing chloroplasts and found in green parts of plants; reserve parenchyme occurring in seeds, and underground parts of plants and containing starch, aleurone grains, fixed oils, etc.; conducting parenchyme found distributed in various parts of plants and serving for the transferral of food.

Collenchyme consists of elongated prismatic cells whose walls are of cellulose. The angles of the cells are thickened with a colloidal substance. It is found beneath the epidermis of many plants, rarely alongside the endodermis and forms the "ribs" of stems such as in Burdock, Caraway, etc. Its function is that of support.

Sclerenchyme or "stony tissue" is made up of stone cells variously shaped. These were formerly parenchyme cells whose walls became...
thickened by deposits of lignin, layer within layer until the cells are often nearly filled with this substance. A lumen is found within the centre of a stone cell which is in communication with radial pore canals leading outward and in communication with the pore canals of adjacent stone cells. Stone cells are distributed in fruits as gritty particles, in barks and seeds. They are supporting structures.

![Diagram of stone cells from different sources](image)

**Fig. 2.**—Stone cells from different sources. 1, From coffee; 2, 3 and 4, from stem of clove; 5 and 6, from tea leaf; 7, 8 and 9, from powdered star-anise seed. (From Steiens after Moeller.)

**Epidermis** is the outer covering tissue of a plant and is protective in function. Its cells may be brick-shaped, polygonal, equilateral or wavy in outline. Their outer walls are cutinized (infiltrated with a waxy-like substance called cutin). Among the epidermal cells of leaves and young green stems may be found numerous pores or stomata (sing. stoma) surrounded by pairs of crescent-shaped cells, called guard cells. The stomata are in direct communication with air chambers beneath them which in turn are in communication with intercellular spaces of the tissue beneath. The function of the stomata is to give off watery vapor and take in or give off carbon dioxide, water and
Woody Fibers are elongated, thick-walled, and taper-ended lignified elements found in the xylem region of the fibrovascular bundle accom-

oxygen. In addition to stomata some leaves possess groups of water stomata which differ from transpiration stomata in that they always remain open, are circular in outline, give off water in droplets directly, and lie over a quantity of small-celled glandular material which is in connection with one or more fibrovascular bundles.

**Endodermis** is the starch sheath layer of cells, constituting the innermost layer of cortex whose radial walls are more or less suberized.

**Cork** or suberous tissue is composed of cells of tabular shape, whose walls possess suberized layers. Its cells are mostly filled with air containing a yellow or brownish substance. It is derived from the phellogen or cork cambium which cuts off cork cells outwardly. Cork tissue is devoid of intercellular air spaces. It is protective in function.

**Laticiferous tissue** is to be seen in many groups of plants principal among which are the Asclepiadaceae, Euphorbiaceae, Apocynaceae, Urticaceae and Papaveraceae. Its cells are elongated, tubular, often branched and penetrate all the organs of plants in which they are found. They contain a milky-white or colored emulsion of gum-resins, fat, wax, caoutchouc, and in some cases, alkaloids, tannins, salts, ferments, etc.

**Cribiform or Sieve tissue** consists of superimposed, elongated, tubular, thin-walled cells whose transverse walls, called sieve plates, are perforated, permitting of the passage of albuminous substances from one cell to another.

Fig. 3.—1, Epidermis of oak leaf; 2, epidermis of Iris leaf, both viewed from the surface; 3, group of cells from petal of Viola tricolor; 4, two epidermal cells in cross-section showing thickened outer wall differentiated into three layers, namely, an outer cuticle, cutinized layer (shaded), and an inner cellulose layer; 5 and 6, epidermal outgrowths in the form of scales and hairs. (3 after Strasburger, 4 after Sachs, and 5 after de Bary.)
panying the tracheae (ducts). The walls of these fibres show oblique pores. Woody fibres are the supporting elements of the xylem.

**Hard Bast** is composed of elongated, spindle-shaped, thick-walled elements called bast fibres. The characteristic thickening of the walls

![diagram](image_url)

Fig. 4.—Laticiferous vessels from the cortex of root of Scorzonera hispanica. A, as seen under low power, and B, a smaller portion under high power. *From Steens after Sachs.*

of these fibres is due to deposits of lignin upon the inner surface of the cellulose cell wall. Like the woody fibres the lumina of these contain air and the fibre walls are provided with oblique pores. Bast is the supporting tissue of the phloem.
Tracheary tissue consists of tracheae (ducts or vessels) and tracheids, both of which are found in the xylem region of the fibrovascular bundle and have as their function the conduction of water with mineral salts in solution from the roots upward. The tracheae or ducts are elongated, slightly lignified tubes with occasional cross-walls and having characteristic thickenings on their inner surface. Tracheae are classified as:

- **Annular**, with ring-like thickenings.
- **Spiral**, with spiral thickenings.
- **Reticulate**, with reticulate thickenings.
- **Porous or Pitted** with spherical or oblique slit pores.

![Diagram of root structure](image)

Fig. 5.—Cross-section through a portion of a root of *Acorus calamus*. A. Cortical parenchyma; B. endodermis; C. pericycle; E. phloëm F. xylem. At Y, Y, are large tracheal tubes, which were formed last, the narrow tubes near the periphery of the xylem being formed first. At the center of the root, within the circle of vascular bundles, occur thin-walled parenchymatous pith cells. *(From Sayre after Frank.)*

Tracheids are undeveloped ducts having bordered pores and frequently scalariform thickenings.

Medullary Rays are bands of parenchymatous cells extending radially from the cortex to the pith (primary med. rays) or from a part of the xylem to a part of the phloem (secondary med. rays).
Fig. 6.—Closed bundle of stem of Zea mays. VG, Bundle sheath; L, intercellular space; A, ring from an annular tracheal tube; SP, spiral tracheal tube; M, pitted vessels; V, sieve tubes; S, companion cells; CP, crushed primary sieve tubes; F, thin-walled parenchyma of the ground or fundamental tissue. (From Sayre after Strasburger.)

Fig. 7.—Transverse section of a concentric bundle from the rhizome of Iris. Xylem surrounding the phloem. t, Tracheae; t', protoxylem; s, sieve tubes; g, companion cells of the internal phloem portion. (From Sayre after Vines.)
Fig. 8.—Transverse section of central part of the root of *Acorus calamus*. c, Cortex; e, endodermis; p, pericycle; s, primary xylem or wood-bundles, with small spiral vessels of the protoxylem externally; v, phloem portion of vascular bundles; m, pith. (*From Sayre after Strasburger.*)

Fig. 9.—Cross-section of a typical dicotyledon stem from the pith to the epidermis and comprising one vascular bundle. (*From Hamaker.*)
Fig. 10.—Stages in the development of the elements of the xylem.  A, progressive steps in the development of a tracheal tube.  1, Row of procambial or cambial cells that are to take part in the formation of a tube; 2, the same at a later stage enlarged in all dimensions; 3, the cells in 2 have grown larger, their cross-walls have been dissolved out, and the wall has become thickened and pitted; 4, the walls in 3 have become more thickened, the pits have an overhanging border, the walls have become lignified as indicated by the stippling, and finally the protoplasts have disappeared, and the tube is mature and dead.  B, Stages in the formation of tracheids from procambial or cambial cells.  The steps are the same as in A, excepting that the cross-walls remain and become pitted.  C, steps in the development of wood fibers from cambial cells.  1, Cambial cells; 2, the same growth larger in all dimensions with cells shoving past each other as they elongate; 3, a
**Fibrovascular Bundles** are groups of fibres, vessels and cells coursing through the various organs of a plant and serving for conduction and support. According to the relative structural arrangement of their xylem and phloem masses they may be classed as follows:

I. **Closed Collateral**, consisting of a mass of xylem lying alongside of a mass of phloem, the xylem facing toward the centre, the phloem facing toward the exterior. Stems of most Monocotyledons and Horsetails.

II. **Open Collateral**, consisting of a mass of xylem facing toward the pith and a mass of phloem facing toward the exterior and separated from each other by a cambium. Stems and leaves of Dicotyledons and roots of Dicotyls and Gymnosperms of secondary growth.

III. **Bicollateral**, characterized by a xylem mass being between an inner and an outer phloem mass. There are two layers of cambium cells, one between the xylem and inner phloem mass, the other between the xylem and outer phloem mass. Seen chiefly in stems of the Cucurbitaceae.

IV. **Concentric**, characterized by a central xylem mass surrounded by a phloem mass or vice versa. No cambium present.

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Fig. 11.—Stages in the development of sieve tubes, companion cells, and phloëm parenchyma. A, a and b, Two rows of procambial cells; in c and d, a has divided longitudinally and c is to become companion cells; d, a sieve tube, and b, phloëm parenchyma. B, c, Companion cells, and d, a beginning sieve tube from c and d, respectively in A. The cross-walls in d are pitted; b, phloëm parenchyma grown larger than in A. C, The same as B with the pits in the cross-walls of the sieve tubes become perforations, and the nuclei gone from the cells composing the tube. *(From Stevens.)*

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later stage with cells longer and more pointed and walls becoming thickened and pitted; 4, complete wood fibers with walls more thickened than in the previous stage and lignified, as shown by the stippling. The protoplasts in this last stage have disappeared and the fibers are dead. D, steps in the formation of wood parenchyma from cambial or procambial cells. 1, Group of cambial or procambial cells; 2, the same enlarged in all dimensions; 3, the same with walls thickened and pitted; 4 and 5 show the same stages as 2 and 3, but here the cells have enlarged radially or tangentially more than they have vertically. The walls of these cells are apt to become lignified, but the cells are longer lived than the wood fibers. *(From Stevens.)*
(a) Concentric, with xylem central in bundle. Seen in stems and leaves of nearly all ferns and the Lycopodiaceae.

(b) Concentric, with phloem central in bundle. Seen in stems and leaves of some Monocotyledons. Ex.: Calamus.

V. RADIAL, characterized by a number of xylem and phloem masses alternating with one another. Seen in the roots of all Spermatophytes and Pteridophytes.

XYLEM is that part of a fibrovascular bundle that contains wood cells and fibres. It may also contain tracheae, tracheids, seldom sieve tubes.

PHLOEM is that part of a fibrovascular bundle that contains sieve tubes, phloem cells, and often bast fibres.

Classification of Tissues According to Function.—According to their particular function, tissues may be classified as follows:

I. Conducting Tissue
   - Parenchyme (Fundamental tissue).
   - Xylem cells.
   - Tracheae (ducts).
   - Phloem cells.
   - Sieve tubes.

II. Protective Tissues
   - Epidermis (outer cell walls cutinized).
   - Cork (suberized tissue).

III. Mechanical Tissues
   - Bast fibres.
   - Wood fibres.
   - Stone cells.

PLANT ORGANS AND ORGANISMS

An organ is a part of an organism made up of several tissues and capable of performing some special work.

An organism is a living entity composed of different organs or parts with functions which are separate, but mutually dependent, and essential to the life of the individual.

The organs of flowering plants are either Vegetative or Reproductive. The vegetative organs of higher plants are Plant hairs, roots, stems, and leaves. They are concerned in the absorption and elaboration of food materials either for tissue-building or storage.

The reproductive organs of higher plants include those structures whose function it is to continue the species, viz., the flower, fruit and seed.
The ripened seed is the product of reproductive processes, and the starting point in the life of all Phanerogams. The living part of the seed is the *embryo*, which, when developed, consists of four parts, the caulicle, or rudimentary stem, the lower end of which is the beginning of the root, or radicle. At the upper extremity of the stem are two thickened bodies, closely resembling leaves, known as cotyledons, and between these a small bud or plumule.

The function of the cotyledon is to build up nourishment for the rudimentary plantlet until it develops true leaves of its own.

**The Root**

The root is that part of the plant that grows into or toward the soil, that never develops leaves, rather rarely produces buds, and whose growing apex is covered by a cap.

The functions of a root are absorption, storage and support. Its

![Cross-section of rootlet in the region of the root hairs. (From Steens.)](image)

principal function is the absorption of nutriment and to this end it generally has branches or rootlets covered with root hairs which largely increase the absorbing surface. These root hairs are of minute and simple structure, being merely elongations of the epidermis of the root back of the root cap into slender tubes with thin walls.

The tip of each rootlet is protected by a sheath- or scale-like covering known as the *root cap*, which not only protects the delicate growing point, but serves as a mechanical aid in pushing its way through the soil. The generative tissues in the region of the root cap are: *plerome*, producing fibrovascular tissue; *periblem*, producing cortex; *dermatogen*, producing epidermis; and *calyptrogen*, producing the root cap.
DIFFERENCES BETWEEN ROOT AND STEM

The Root
1. Descending axis of plant.
2. Growing point sub-apical.
3. Contains no chlorophyll.
4. Branches arranged irregularly.
5. Does not bear leaves or leaf rudiments.

The Stem
1. Ascending axis of plant.
2. Growing point apical.
3. Chlorophyll sometimes present.
4. Branches with mathematical regularity.
5. Bears leaves and modifications.
6. Structure better defined.

Classification of Roots as to Form.—1. PRIMARY or FIRST root, a direct downward growth from the seed, which, if greatly in excess of the lateral roots, is called the MAIN or TAP root. Ex.: Taraxacum, Radish.

2. SECONDARY roots are produced by the later growths of the stem, such as are covered with soil and supplied with moisture. Both primary and secondary roots may be either fibrous or fleshy.

The grasses are good examples of plants having fibrous roots. Fleshy roots may be multiple, as those of the Dahlia, or may assume simple forms, as follows:

Fusiform, or spindle-shaped, like that of the radish or parsnip.

Napiform or turnip-shaped, somewhat globular and becoming abruptly slender then terminating in a conical tap root, as the roots of the turnip.

Conical, having the largest diameter at the base then tapering, as in the Maple.

3. ANOMALOUS roots are of irregular or unusual habits, subserving other purposes than the normal.

4. ADVENTITIOUS roots are such as occur in abnormal places on the plant. Ex.: Roots developing on Bryophyllum leaves.

5. EPIPHYTIC roots, the roots of epiphytes, common to tropical forests, for example, never reach the soil at all, but cling to the bark of trees and absorb nutriment from the air. Ex.: Roots of Vanilla.

6. The roots of parasitic plants are known as HAUSTORIA. These penetrate the bark of plants upon which they find lodgment, known as hosts, and absorb nutritious juices from them. The Mistletoe, Dodder and Geradía are typical parasites.

Duration of Root.—Plants are classified according to the duration of the root, as follows:

1. ANNUAL plants are herbs with roots containing no nourishment for future use. They complete their growth, producing flower, fruit and seed in a single season, then die.
2. Biennial plants develop but one set of organs the first year, and as in the beet and turnip, etc., a large amount of reserve food material is stored in the root for the support of the plant the following season when it flowers, fruits, and dies.

3. Perennial plants live indefinitely, as trees.

**Root Histology. Monocotyledons.**—The histology of monocotyledonous roots varies, depending upon relations to their surroundings, which may be aquatic semi-aquatic, mesophytic, or xerophytic.

![Sarsaparilla, Mexican. Cross-section of root.](image)

In this connection we will discuss only the type of greatest pharmacognic importance, *i.e.*, the mesophytic type as seen in its most typical form in the transverse section of an Onion root.

Examining such a section from periphery toward the centre, one notes the following:

1. Epidermis with thin cuticle.
2. Cortex, consisting of broad zone of rounded cells getting larger
and then smaller in calibre. These store starch and enable sap to pass through.

3. Endodermis, or innermost layer of cells in the cortex with lenticularly thickened radial walls.

4. Pericambium, a zone of one, two, or three layers of rounded, thin-walled, actively dividing cells, which may give rise to side rootlets.

5. Radial fibrovascular bundle, which in most monocotyledons consists of eight, twelve, or fifteen alternating patches of phloem with radiating xylem arms between. Phloem tissue consists of phloem cells and sieve tubes. Xylem at tips of arms, made of spiral tracheae the first xylem elements to mature. Internal to these are small pitted vessels, later, striking pitted vessels and considerable wood fibre.

6. Pith.

**DICOTYLEDONS.—** The typical dicotyl root is a tetrarch one, four xylem alternating with four phloem patches. These roots have an unlimited power of growth.

A. *Of Primary Growth.*

A trans-section of a dicotyl root in its young growth shows the following structure from periphery toward centre.

1. Epidermis with cutinized outer walls.

2. Hypodermis.

3. Cortex with usually small intercellular spaces.

4. Endodermis, or innermost layer of cells of the cortex with radially thickened walls.

5. Pericambium of one to two layers of actively growing cells which may produce side rootlets.

6. Radial fibrovascular bundle of four, rarely two or three or five or six phloem patches alternating with as many xylem arms. Not uncommon to find bast or phloem fibre along outer face of each phloem patch. Xylem has spiral tracheae, internal to these a few pitted vessels. Then, as root ages, more pitted vessels, also xylem cells and wood fibres make their appearance.

B. *Of Secondary Growth.* (Most official roots.)

At about six weeks one notes cells dividing by tangential walls in the inner curve of phloem patches. This is intrafascicular cambium. A single layer of flattened cells starts to cut off on its inner side a quantity of secondary xylem and pushes out the patches of bast fibres, adds a little secondary phloem on the outer side. Secondary xylem finally fills up the patches between the arms. The patches of bast fibres get
THE BUD

Buds are rudimentary stems with rudimentary leaves compactly arranged upon them.

The COTYLEDONS and PLUMULE represent the first bud on the initial stem or caulicle.

SCALY BUDS are such as have their outer leaf rudiments transformed into scales, often coated with a waxy or resinous substance without and a downy lining within, to protect them from sudden changes in climate. Ex.: Hickory.

Naked BUDS are those whose leaf rudiments are destitute of coverings.

Fig. 14.—Cross-section of a young root of Phaseolus multiflorus. A, pr, cortex; m, pith; x, stele (all tissues within the endodermis collectively); g, g, g, g, primary xylem bundle; b, b, b, b, primary phloëm bundle. B, cross-section through older portion of root of the same plant. b', b', Secondary bast; k, k, periderm. The remaining letters stand for the same tissues as in A. Notice that the cambium has laid down medullary rays in front of the primary xylem, but has made secondary xylem behind the primary phloëm. (From Stevens after Vines.)
Leaf buds develop leaves.
Flower buds are unexpanded blossoms.
Mixed buds contain both flower and foliage.
As to position buds are either terminal or axillary, either located at the apex of the stem or branch or in the axils of the leaves. If they occur on other situations on the stem, or upon roots or leaves they are termed adventitious buds. If, as often happens, more than one bud forms in or near the axil of the leaf, it is called an accessory bud.

The Stem

The stem is that part of the plant axis which bears leaves or modifications of leaves and its branches are usually arranged with mathematical regularity.
The functions of a stem are to bear leaves or branches, connect roots with leaves, and conduct sap.
When the stem rises above ground and is apparent, the plant is said to be caulescent.
When no stem is visible, but only flower or leaf stalks, the plant is said to be acaulescent.
Stems vary in size from scarcely one-twenty-fifth of an inch in length, as in certain mosses, to a remarkable height of 400 ft. upward. The giant Sequoia of California attains the height of 420 ft.

Direction of Stem Growth.—Generally the growth of the stem is erect. Very frequently it may be:
Ascending, or rising obliquely upward.
Reclining, or at first erect but afterward bending over and trailing upon the ground. Ex.: Raspberry.
Procumbent, lying wholly upon the ground.
Decumbent, when the stem trails and the apex curves upward. Ex.: Vines of the Cucurbitaceae.
Repent, creeping upon the ground and rooting at the nodes, as the Strawberry.

Stem Elongation.—At the tip of the stem there is found a group of very actively dividing cells (meristem) which is the growing point of the stem. All the tissues of the stem are derived from the cells of the growing point whose activity gives rise in time to three generative regions which are from without, inward:

1) Dermatogen, forming epidermis;
(2) Periblem, forming the cortex; and
(3) Plerome, forming the fibrovascular elements.

**Duration of Stems.**—Herbaceous, dying down to the ground at the close of the season.

Annual, an herb whose life terminates with the season.

Biennial, where the stem dies at the end of the first season, the underground parts perfecting themselves and retaining their vitality to the next season, when seeds are produced and the plant dies completely.

Perennial, when the underground parts retain their vitality indefinitely.

**Above-ground Stems.**—A twining stem winds around a support, as the stem of a bean or Morning Glory.

A culm is a jointed stem of the Grasses and Sedges.

A climbing or scandent stem grows upward by attaching itself to some support by means of aerial rootlets, tendrils or petioles.

The scape is a stem rising from the ground and bearing flowers but no leaves, as the dandelion, violet, or blood root.

A tendril is a modification of some special organ, as of a leaf stipule or branch, capable of coiling spirally and used by a plant in climbing. Present in the Grape, Pea, etc.

A spine or thorn is the indurated termination of a stem tapering to a point, as the thorns of the Honey Locust.

Prickles are outgrowths of the bark only and are seen in the roses.

A stolon is a prostrate branch, the end of which, on coming in contact with the soil, takes root, so giving rise to a new plant. Ex.: Currant and Raspberry.

An undershrub or suffruitcose stem is a stem of small size and woody only at the base.

A shrubby or fruitcose stem is a woody stem larger than the preceding and freely branching near the ground.

**Herb and Tree**

A tree is a perennial woody plant of considerable size (20 ft. or more in height) and having as the above-ground parts a trunk and a crown of leafy branches.

An herb is a plant whose stem does not become woody and permanent, but dies, at least down to the ground, after flowering.
Underground Stems.—A **rhizome** is a creeping underground stem, more or less scaly, sending off roots from its lower surface and stems from its upper. The rhizome grows horizontally, vertically or obliquely, bearing a terminal bud at its tip. Its upper surface is marked with the scars of the bases of aerial stems of previous years.

The **tuber** is a short and excessively thickened underground stem, borne usually at the end of a slender, creeping branch, and having numerous eyes or buds. Ex.: Tubers of the Potato, Aconite, and Jalap.

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**FIG. 15.**

Photomicrograph of cross-section of very young cornstalk, where the procambium strands have just gone over into vascular bundles. For comparison with Fig. 16. *(From Steitens.)*

**FIG. 16.**

Photomicrograph of cross-section of cornstalk somewhat older than in Fig. 15. Compare with Fig. 15, and notice that the number of vascular bundles is approximately the same in both, and the number of cells in the fundamental tissue is approximately the same. Growth in Fig. 16 has been accomplished by the enlargement of the cells already present in Fig. 15. *a,* epidermis; *b,* cortex and pericycle; *c, c,* fundamental or ground tissue corresponding to pith and medullary rays with vascular bundles interspersed through it. *(From Steitens.)*

The **corm** is an underground stem excessively thickened and solid and characterized by the production of buds from the centre of the upper surface and rootlets from the lower surface.

A **bulb** is a very short and scaly stem, producing roots from the lower face and leaves from the upper.

**Tunicated bulbs** are completely covered by broad scales which form concentric coatings. Ex.: Onion, Squill, Daffodil.
Scaly bulbs have narrow imbricated scales, the outer ones not enclosing the inner. Ex.: Lily.

Tubers and corms are annual. Bulbs and Rhizomes are perennial.

Exogenous and Endogenous Stems.—Exogenous stems are typical of Gymnosperms and Dicotyledons and can increase materially in thickness due to presence of a cambium. Such stems show differentiation into an outer or cortical region and an inner or central cylinder region.

Endogenous stems are typical of Monocotyledons and cannot increase materially in thickness due to absence of cambium. Such stems show no differentiation into cortical and central regions.

Histology of Annual Dicotyl Stem.—(In both annual and perennial dicotyledonous stems endodermis and pericambium are rarely seen since each has become so similar to cortex through passage of food, etc.)

1. Epidermis, cutinized, with hairs.

2. Cortex composed of three zones: an outer or exocortex, whose cells are thin walled and contain chloroplasts; a middle or mediocortex, consisting of cells of indurated walls giving extreme pliability and strength, an inner or endocortex, a very broad zone of thin and thickened-walled parenchyma cells.

3. The innermost layer of cells of the cortex called the endodermis. (Not generally distinguishable.)

4. Pericambium. (Not generally distinguishable.)

5. Fibrovascular bundles of open collateral type arranged in a circle with primary medullary rays between the bundles.

6. Pith.

**Fig. 17.**—Photomicrograph of cross-section of stem of Aristolochia sipho, where cambial activity is just beginning. a, Epidermis; b, collenchyma; c, thin-walled parenchyma of the cortex, the innermost cell layer of which is the starch sheath or endodermis; d, sclerenchyma ring of the pericycle; e, thin-walled parenchyma of the pericycle; f, primary medullary ray; g, phloëm; h, xylem; i, interfascicular cambium; j, medulla or pith. X 20. (From Stevens.)
Fig. 18.—A diagram to show the character of the tissues and their disposition in a young stem of the typical dicotyledon type. (From Stevens.)
Growth of Perennial Dicotyl Stem and its Histology.—A perennial dicotyl stem in the first year does not differ in structure from an annual. By the close of the year a cork cambium (phellogen) has originated be-

![Diagram](image_url)

**Fig. 19.**—Diagram similar to the preceding but representing a later stage and showing the tissues formed by the cambium. *(From Stevens.)*

side the epidermis. In origin of cork cambium—one of two methods: (a) either the epidermis may divide into an outer layer of cells that remains epidermis and an inner layer of cells that becomes cork cambium,
or, (b) the outermost layer of cortex cells underneath the epidermis becomes active after being passive for one year, and lays down walls, the inner layer becoming cork cambium, the outer becoming a layer of cork. The cork cuts off water and food supplies from epidermis outside and so epidermis separates and falls off as stringy layer. The cork cambium produces cork on its outer face and secondary cortex on its inner.

Between the bundles certain cells of the primary medullary rays become very active and form interfascicular cambium which joins the cambium of the first-formed bundles (intrafascicular cambium) to form a complete cambium ring. By the rapid multiplication of these cambial cells new (secondary) xylem is cut off internally and new (secondary) phloem externally, pushing inward the first-formed, or protoxylem, and outward the first-formed, or protophloem, thus increasing the diameter of the stem. The primary medullary rays are deepened. Cambium may also give rise to secondary medullary rays.

Sometimes, as in Grape Vines, Honeysuckles, and Asclepias, instead of cork cambium arising from outer cortex cells it may arise at any point in cortex. It is the origin of cork cambium at varying depths that causes extensive sheets of tissue to separate off. That is what gives the stringy appearance to the stems of climbers.

At close of first year in Perennial Dicotyl Stem we note:

- Epidermis—development of dermatogen or periblem—in process of peeling off, later on entirely absent.
- Cork tissue or periderm.
- Cork cambium or phellogen.
- Sometimes zone of thin-walled cells containing chloroplasts cut off by cork cambium on inner face known as phelloderm.
- Cortex—in perennial stem cells of cortex may undergo modification into mucilage cells, into tannin receptacles, crystal cells, spiral cells, etc.

- Fibrovascular bundles of open collateral type which are now arranged into a compact circle, and between which are found primary and often secondary medullary rays.

From without inward the following tissues make up f. v. bundles.

- Hard Bast—long tenacious bast fibres.
- Soft Bast—phloem cells and sieve tubes.

Cambium—active layer giving rise to secondary phloem on outer and secondary xylem on inner face, and adding to depth of med. rays.

Secondary xylem—wood fibres, pitted vessels, tracheids.

Protoxylem—spiral tracheae.

Pith.
Lenticels and Their Formation — The epidermis in a great majority of cases produces stomata, apertures, surrounded by a pair of guard cells, which function as passages for gases and watery vapor from and to the active cells of the cortex beneath.

There very early originate in the region beneath the stomata loosely arranged cells from cork cambium which swell up during rain and rupture, forming convex fissures in the cork layer, called lenticels.

The function of lenticels is similar to that of stomata, namely, to permit of aeration of delicate cells of the cortex beneath.

Annual Thickening.—In all woody exogenous stems such as trees and shrubs the persistent cambium gives rise to secondary xylem thickening every spring, summer and autumn. Soon a great cylinder of xylem arises which constitutes the wood of the trunk and branches. In the spring, growth is more active, and large ducts with little woody fibre are produced while in summer or autumn growth is

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**Fig. 20.**—Cross-section through a lenticel of *Sambucus nigra*. *E*, Epidermis; *PH*, phellogen; *L*, loosely disposed cells of the lenticel; *PL*, cambium of the lenticel; *PS*, phelloderm; *C*, cortical parenchyma containing chlorophyll. (*From Sayre after Strasburger.*)

**Fig. 21.**—Part of a transverse section of a twig of the lime, four years old. *m*, Pith; *ms*, medullary sheath; *x*, secondary wood; *Ph*, phloén. 2, 3, 4, annual rings; *c*, cambium; *pa*, dilated outer ends of medullary rays; *b*, blast; *pr*, primary cortex; *k*, cork. (*From Sayre after Vines.*)
lessened and small ducts and much mechanical woody fibre are formed. Thus the open, loosely arranged product of the spring growth abuts on the densely arranged product of the last summer and autumn growth and the sharp contrast marks the periods of growth.

To the two different regions of growth is given the term of "annual ring." By counting the number of these rings it is possible to estimate the age of the tree or branch.

**Bark.**—Bark or bork is a term applied to all that portion of a woody exogenous plant axis outside of the cambium line.

In pharmacognic work, bark is divided into three zones, these from without inward being:

1. **Outer Bark of Cork.**
2. **Middle Bark of Cortical Parenchyme.**
3. **Inner Bark or Phloem.**

Commercially, bark is divided into two zones, which are, passing from without inward:

1. **Outer Bark (Cork).**
2. **Inner Bark (Cortical Parenchyme and Phloem).**

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*Fig. 22.—Part of a cross-section through branch of Cytisus lobsurnum. (The branch was cut from the tree at the end of October.) From A to E the last annual ring of wood; from A to B the spring growth with large tracheal tubes (T, T, T); between B and C and D and D are wood-fibers; between C and D and D and E, wood parenchyma; from E to F, cambium; F to G, phloem portion; G to H, cortical parenchyma; M medullary ray. Below A the last wood-fibers and wood parenyma formed the previous year. *(From Sayre after Haberlandt.)**
Periderm.—Periderm is a name applied to all the tissue produced externally by the cork cambium (phellogen). This term appears often in pharmacognic and materia medica texts.

Histology of Typical Monocotyl Stems (Endogenous).—Passing from exterior toward centre the following structures are seen:

1. Epidermis whose cells are cutinized in their outer walls.
2. Hypodermis, generally collenchymatic.
3. Cortex.
4. Endodermis or innermost layer of cortex generally with greatly suberized cell walls.
5. A large central zone of parenchyma matrix in which are found scattered fibrovascular bundles of the closed collateral or rarely concentric type (amphivasal). In this latter type, which is typical of old monocotyl stems, the xylem grows completely around phloem so that phloem is found in the centre and xylem without and surrounding it.

Plant Hairs or Trichomes

These are out-growths of the epidermal cells which have become greatly elongated and may be unicellular or multicellular. They may be of various forms: simple, consisting of a single row of cells; branching; clavate, or club-shaped; stellate or star-shaped; barbed, hooked, forked, etc.

The terminal cell is often modified into a secretion sac for gummy, resinous or odorous products. Such hairs are called glandular. Ex.: Glandular hairs from strobiles of Humulus lupulus.

The cotton of commerce which is the hairs of the seed of the cotton plant, Gossypium herbaceum, is a good example of simple hairs.
Branched hairs can be seen upon the leaves of the common field weed, Mullein. Geranium and the Stinging nettle afford examples of glandular hairs.

Plant hairs are adapted to many different purposes. They absorb nourishment in the form of moisture and mineral matter in solution. Those which serve as a protection to the plant may be barbed and silicified, rendering them unfit for animal food, or, as in the nettle, charged with an irritating fluid, penetrating the skin when touched, injecting the poison into the wound. A dense covering of hairs also prevents the ravages of insects and the clogging of the stomata by an accumulation of dust. They fill an important office in the dispersion of seeds and fruits, as with their aid such seeds as those of the milkweed are readily scattered by the wind.

The reproductive organs of many Cryptogams are modified hairs, as the sporangia of Ferns.

**THE LEAF**

Leaves (folia) are stem appendages which have their origin just back of the apex of the stem, are regularly arranged upon it, and consist of expansions of its tissues.

The functions of a leaf are photosynthesis, assimilation, respiration and transpiration.

The most essential function of plants is the conversion of inorganic into organic matter; this takes place ordinarily in the green parts, containing chlorophyll, and in these when exposed to sunlight. Foliage is an adaptation for increasing the extent of green surface.

The leaf when complete consists of three parts, LAMINA, PETIOLE, and STIPULES. The lamina or blade is the expansion of the stem into a more or less delicate framework, made up of the branching vessels of the petiole.

The petiole is the leaf stalk. The stipules are leaf-like appendages appearing at the base of the petiole.
The leaf of the Tulip Poplar or Liriodendron affords a good example of a Complete Leaf.

Sometimes the lamina or blade is attached directly to the stem by its base and is then said to be sessile. If the petiole is present, petiolate.

When leaf stipules are absent, the leaf is said to be exstipulate, when present, stipulate.

The petiole is seldom cylindrical in form, but usually channelled on the upper side, flattened, or compressed. The stipules are always in pairs and closely resemble the leaf in structure.

The blade of the leaf consists of the framework, made up of branching vessels of the petiole, which are woody tubes pervading the soft tissue called mesophyll, or leaf parenchyme, and serve not only as supports but as veins to conduct nutritive fluids. Veins are absent in simple leaves such as many of the Mosses.

**Leaf Venation.**—**Furcate or Forked Venation** is characteristic of many Cryptogams.

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**Fig. 25.**—Stereogram of leaf structure. Part of a veinlet is shown on the right. Intercellular spaces are shaded. *(From Stelens.)*
Parallel Venation is typical of the Monocotyledons, as Palms, Lilies, Grasses, etc.

Reticulate or Netted Veins characterize the Dicotyledons, as the Poplar or Oak.

Pinni-veined or Feather-veined leaves consist of a mid-vein with lateral veinlets extending from mid-vein to margin at frequent intervals and in a regular manner. Ex.: Calla.

Palmately Veined leaves consist of a number of veins of nearly the same size, radiating from petiole to margin. Ex.: Maple leaf.

The Forms of Leaves.—Simple leaves are those having a single blade, either sessile or petiolate.

Compound leaves are divided into two or more distinct subdivisions called leaflets, which may be either sessile or petiolate.

Simple leaves and the separate blades of compound leaves are described as to general outline, apex, base, marginal indentations, surface and texture.

(a) General Outline (form viewed as a whole without regard to indentations of margin). Dependent upon kind of venation.

When the lower veins are longer and larger than the others, the leaf is Ovate, or Egg-shaped. Parallel-veined leaves are usually linear, long and narrow of nearly equal breadth throughout, or lanceolate, like the linear with the exception that the broadest part is a little below the centre.

Elliptical, somewhat longer than wide, with rounded ends and sides. Ex.: Leaf of Pear.

Oblong, when longer than broad, margins parallel. Ex.: Matico.

Oblique, margin longer on one side than the other, as the Hamamelis and Elm.

Orbicular, circular in shape. Ex.: Nasturtium.

Peltate, or shield-shaped, having the petiole inserted at the centre of the lamina. Ex.: the Nasturtium, Podophyllum.

Filiform, or Thread-like, very long and narrow, as Asparagus leaves.

Ovate, broadly elliptical. Ex.: Digitalis. Obovate, reversely ovate.

Oblanceolate, reversely lanceolate. Ex.: Chimaphila.

Cuneate, shaped like a wedge with the point backward.

Spatulate, like a spatula, with narrow base and broad rounded apex. Ex.: Uva Ursi.
Acerose or acicular, tipped with a needle-like point, as *Juniper*. Deltoid, when the shape of the Greek letter Δ, as Chenopodium.

(b) Apex of Leaf.—Acute, when the margins form an acute angle at the tip of the leaf. Ex.: Eriodictyon.

Acuminate, when the point is longer and more tapering than the acute. Ex.: Pellitory.

Obtuse, blunt or round. Ex.: Buchu.

Truncate, abruptly obtuse, as if cut square off.

Mucronate, terminating in a short, soft point.

Cuspidate, like the last, except that the point is long and rigid.

Aristate, with the apex terminating in a bristle.

Emarginate, notched. Ex.: Pilocarpus.

Retuse, with a broad, shallow sinus at the apex.

Obcordate, inversely heart-shaped.

(c) Base of Leaf.—Cordate, heart-shaped. Ex.: Lime.

Reniform, kidney-shaped. Ex.: Ground Ivy.

Hastate, or halbert-shaped, when the lobes point outward from the petiole. Ex.: Aristolochia Serpentaria.

Auriculate, having ear-like appendage at the base.

Sagittate, arrow-shaped. Ex.: Bindweed.

(d) Margin of Leaf.—Entire, when the margin is an even line.

Serrate, with sharp teeth which incline forward like the teeth of a hand-saw. Ex.: Peppermint.

Dentate, or toothed, with outwardly projecting teeth. Chestnut.

Crenate, or Scalloped, similar to the preceding forms, but with the teeth much rounded. Ex.: Digitalis, Salvia.

Repand, or Undulate, margin—a wavy line.

Sinuate, when the margin is more distinctly sinuous than the last.

Incised, cut by sharp, irregular incisions. Ex.: Hawthorn.

Runcinate, the peculiar form of pinnately incised leaf observed in the Dandelion and some other Compositae in which the teeth are recurved.

A lobed leaf is one in which the indentations extend nearly to the mid-vein, or mid-rib, as it is usually called, the segments or sinuses, or both, being rounded. Ex.: Sassafras.

Cleft is the same as lobed, except that the sinuses are deeper, and commonly acute. Ex.: Dandelion.

A parted leaf is one in which the incisions extend nearly to the mid-rib. Ex.: Geranium maculatum.
In the Divided leaf the incisions extend to the mid-rib, but the segments are not stalked. Ex.: Watercress.

If the venation is pinnate, the preceding forms may be described as pinnately incised, lobed, parted, or divided. If the venation is radiate, then the terms radiately or palmately lobed, incised, etc., are employed.

The transition from Simple to Compound Leaves is a very gradual one, so that in many instances it is difficult to determine whether a given form is to be regarded as simple or compound. The number and arrangement of the parts of a compound leaf correspond with the mode of venation, and the same descriptive terms are applied to outline, margin, etc., as in simple leaves.

Leaves are either pinnately or radiately compounded. They are said to be abruptly pinnate or paripinnate when the leaf is terminated by a pair of leaflets; odd pinnate or imparipinnate when it terminates with a single leaflet. When the leaflets are alternately large and small, the leaf is interruptedly pinnate, as the Potato leaf. When the terminal leaflet is the largest, and the remaining ones diminish in size toward the base the form is known as lyrate, illustrated in the leaf of the Turnip.

Radiately or palmately compound leaves have the leaflets attached to the apex of the petiole. When these are two in number the leaf is bifoliate, or binate; if three in number, trifoliate, or ternate; when four in number, quadrifoliate, etc. If each of the leaflets of a palmately compound leaf divides into three, the leaf is called bi-ternate; if this form again divides, a tri-ternate leaf results. Beyond this point the leaf is known as decompound. Example of decompound leaf seen in Cimicifuga.

Leaf Texture.—Leaves are described as:

Membranous, when thin and pliable, as Coca.
Succulent, when thick and fleshy, as Aloes, and Live Forever.
Scarious, when dry and scaly.
Coriaceous, when thick and leathery, as Eucalyptus, Uva Ursi and Magnolia.

Leaf Color.—Petaloid, when of some brilliant color different from the usual green, as the Coleus and Begonia, and other plants which are prized for the beauty of their foliage rather than their blossoms.

Leaf Surface.—Any plant surface is:
Glabrous, when perfectly smooth and free from hairs or protuberances. Ex.: Tulip.

Glaucous, when covered with bloom, as the Cabbage leaf.

Pellucid-puncate, when dotted with oil glands, as the leaves of the Orange family.

Scabrous leaves have a rough surface with minute, hard points.

Pubescent, covered with short, soft hairs. Ex.: Strawberry.

Villose, covered with long and shaggy hairs. Ex. Forget-me-not.

Serious, silky. Ex.: Silverleaf.

Hispid, when covered with short, stiff hairs. Ex.: Borage.

Tomentose, densely pubescent and felt-like, as the Mullein leaf.

Spinose, beset with spines, as in the Thistle.

Rugose, when wrinkled. Ex.: Sage.

Verrucose, covered with protuberances or warts.

Duration of Leaves.—Leaves vary as to their period of duration. They are: Persistent, or evergreen, if they remain green on the tree for a year or more.

Deciduous, if unfolding in spring and falling in autumn.

Caducous, or fugacious, if falling early in the season.
Like roots, they differ greatly as to duration in different latitudes. Evergreen trees are most common in the tropics, and it is probable that many of our deciduous trees have become such by adaptation to the colder climate.

**Leaf Insertion.**—The point of attachment of the leaf to the stem is called the insertion. A leaf is:
- **Radical**, when inserted upon an underground stem.
- **Cauline**, when upon an aërial stem.
- **Ramal**, when attached directly to a branch.

When the base of a sessile leaf is extended completely around the stem it is **perfoliate**, the stem appearing to pass through the blade. Ex.: Urularia perfoliata or Mealy Bellwort.

When a sessile leaf surrounds the stem more or less at the base, it is called **clasping**. Ex.: Poppy (Papaver somniferum).

When the bases of two opposite leaves are so united as to form one piece, they are called **connate-perfoliate**, as Eupatorium or Boneset.

Leaves are called **equitant** when they are all radical and successively folded on each other, as the Iris.

**Phyllotaxy.**—Phyllotaxy is the study of leaf arrangement upon the stem or branch, and this may be either alternate, opposite, whorled, or verticillate, or fascicled. It is a general law in the arrangement of leaves and of all other plant appendages that they are spirally disposed, or on a line which winds around the axis like the thread of a screw. The spiral line is formed by the union of two motions, the circular and the longitudinal, and its most common modification is the circle.

In the **alternate** arrangement there is but one leaf produced at each node.

- **Opposite**, when a pair of leaves is developed at each node, on opposite sides of the stem. Ex.: Mints, Lilac.
- **Whorled** or **Verticillate**, when three or more form a circle about the stem. Ex.: Canada Lily and Culver’s root.
- **Fascicled** or **Tufted**, when a cluster of leaves is borne from a single node, as in the Larch and Pine.

The spiral arrangement is said to be two-ranked when the third leaf is over the first, as in all Grasses; three-ranked, when the fourth is over the first. Ex.: Sedges. The five-ranked arrangement is the most common, and in this the sixth leaf is directly over the first two turns being made around the stem to reach it. Ex.: Cherry, Apple, Peach,
Oak and Willow, etc. As the distance between any two leaves is two-fifths of the circumference of the stem, the five-ranked arrangement is expressed by the fraction $2/5$. In the eight-ranked arrangement the ninth leaf stands over the first, and three turns are required to reach it, hence the fraction $3/8$ expresses it. Of the series of fractions thus obtained, the numerator represents the number of turns to complete a cycle, or to reach the leaf which is directly over the first; the denominator, the number of perpendicular rows on the stem, or the number of leaves, counting along the spiral, from any one to the one directly above it.

**Vernation.**—Prefoliation or **Vernation** relates to the way in which leaves are disposed in the bud. A study of the individual leaf enables us to distinguish the following forms. When the apex is bent inward toward the base, as in the leaf of the Tulip Tree, it is said to be **inflexed or reclinate vernation**; if doubled on the midrib so that the two sides are brought together as in the oak, it is **conduplicate**; when rolled inward from one margin to the other, as in the Wild Cherry, it is **convolute**; when rolled from apex to base, as in Ferns, it is **circinate**; when folded or plaited, like a fan, it is **plicate**; if rolled inward from each margin, as the leaf of the common Violet, **involute**; when rolled outward from each margin as Rumex, **revolute**. The inner surface is always that which will form the upper surface when expanded.

**Inflorescence or Anthotaxy.**—A typical flower consists of four whorls of leaves modified for the purpose of reproduction, and compactly placed on a stem. The term Inflorescence, Anthotaxy, is applied to the arrangement of the flowers and their position on the plant, both of which are governed by the same law which determines the arrangement of leaves. For this reason flower buds are always either terminal or axillary. In either case the bud may develop a solitary flower or a compound inflorescence consisting of several flowers.

**Determinate, cymose, descending, or centrifugal** inflorescence is that form in which the flower bud is terminal, and thus determines or completes the growth of the plant. Ex.: Ricinus communis.

**Indeterminate, ascending, or centripetal inflorescence** is that form in which the flower buds are axillary, while the terminal bud continues to develop and increase the growth of the plant indefinitely. Ex.: the Geranium.

**Mixed Inflorescence** is a combination of the other two forms. Ex.: Horse Chestnut.
The flower stalk is known as the peduncle, and its prolongation the rachis, or axis of the inflorescence.

The flower stalk of a single flower of an inflorescence is called a pedicel. When borne without such support the flower is sessile.

A peduncle rising from the ground is called a scape, previously mentioned under the subject of stems.

The modified leaves found on peduncles are termed bracts. These vary much the same as leaf forms, are described in a similar manner, and may be either green or colored. When collected in a whorl at the base of the peduncle they form an involucre, the parts of which are sometimes imbricated or overlapping, like shingles. This is generally green, but sometimes petaloid, as in the Dogwood. The modified leaves found on pedicels are called bracteolar leaves.

The spathe is a large bract enveloping the inflorescence and often colored, as in the Calla, or membranous, as in the Daffodil.

In the indeterminate or axillary anthotaxy, either flowers are produced from base to apex, those blossoming first which are lowest down on the rachis or from margin to centre. The principal forms of this type are: A solitary indeterminate is one in which the flowers occur singly in the axils of the leaves.

Raceme, or simple flower-cluster in which the flowers on pedicels of nearly equal length are arranged along an axis. Ex.: Convallaria, Cimicifuga, and Currant.
Corymb, a short, broad cluster, differing from the raceme mainly in its shorter axis and longer lower pedicels, which give the cluster a flat appearance by bringing the individual florets to nearly the same level. Ex.: Cherry.

Umbel, which resembles the raceme, but has a very short axis and the nearly equal pedicels radiate from it like the rays of an umbrella. Many examples of this mode of inflorescence are seen in the order Umbelliferae, as indicated by the name, including Anise, Fennel and other official plants.

A Spike is a cluster of flowers, sessile or nearly so, borne on an elongated axis. The Mullein and common Plantain afford good illustrations.

The Catkin or Ament resembles the Spike, but differs in that it has scaly instead of herbaceous bracts, as the staminate flowers of the Oak, Hazel, Willow, etc.

The Head or Capitulum is like a spike, except that it has the rachis shortened so as to form a compact cluster of sessile flowers, as in the Dandelion, Marigold, Clover, and Burdock.

The Strobile is a compact flower cluster with large scales concealing the flowers, as the inflorescence of the Hop.

The Spadix is a thick, fleshy rachis with flowers closely sessile or embedded on it, usually with a spathe or sheathing bract. Ex.: Calla, Acorus, Calamus, Arum triphyllum.

The compound raceme particularly if irregularly compounded is called a PANICLE.

Determinate Anthotaxy is one in which the first flower that opens is the terminal one on the axis, the others appearing in succession from apex to base or from centre to margin. The principal varieties are:

The Solitary Determinate, in which there is a single flower borne on the scape, as in the Anemone, or Windflower, and Hydrastis.

The Cyme, a flower cluster resembling a corymb, except that the buds develop from center to circumference. Ex.: Elder. If the cyme be rounded, as in the Snowball, it is a globose cyme.

A scorpioid cyme imitates a raceme, having the flowers pedicelled and arranged along a lengthened axis.

A Glomerule is a cymose inflorescence of any sort which is condensed into a head, as the so-called head of Cornus florida.

A VERTICILLASTER is a compact, cymose flower cluster which resembles a whorl, but really consists of two glomerules situated in the
axils of opposite leaves. Clusters of this kind are seen in Catnip, Horehound, Peppermint and other plants of the Labiatae.

The raceme, corymb, umbel, etc., are frequently compounded. The compound raceme, or raceme with branched pedicels, is called a panicle. Ex.: Yucca and paniculate inflorescence of the oat.

A Thyrsus is a compact panicle, of a pyramidal or oblong shape. Ex.: Lilac, Grape and Rhusglabra.

A Mixed Anthotaxy is one in which the determinate and indeterminate plans are combined, and illustrations of this are of frequent occurrence.

The order of flower development is termed ascending when, as in

![Diagram of cymose inflorescences](image)

Fig. 29.—Cymose inflorescences. F, A terminal flower. G, A simple cyme. H, A compound cyme. (From Hamaker.)

the raceme, the blossoms open first at the lowest point on the axis and continue to the Apex. Ex.: White Lily, and many other plants of the same family. In the cyme the development is centrifugal, the central florets opening first, while in the corymb it is centripetal, or from margin to center.

Prefloration.—By prefloration is meant the arrangement of the floral envelopes in the bud. It is to the flower bud what vernation is to the leaf bud, the same descriptive terms being largely employed, as convolute, involute revolute, plicate, imbricate, etc.

In addition to those already defined, the following are important.

Valvate Prefloration, in which the margins meet but do not overlap. Of this variety the induplicate has its two margins rolled inward
as in Clematis. In the reduplicate they are turned outward, as the sepals of Althea.

Vexillarv, the variety shown in the corolla of the Pea, where the two lower petals are overlapped by two lateral ones, and the four in turn overlapped by the larger upper ones.

Contorted, where one margin is invariably exterior and the other interior, giving the bud a twisted appearance, as in the Oleander and Phlox.

THE FLOWER

The flower is a shoot which has undergone a metamorphosis so as to serve as a means for the propagation of the individual.

The parts of the flower are Sepals, Petals, Stamens, and Carpels, all of which are inserted upon a shortened axis called the Receptacle or Torus. This is usually flat or convex, but may be conical and fleshy as in the Strawberry; concave as in the Rose and Fig; or show a disc-like modification, as in the Orange. The axis of a flower cluster, if short, is sometimes called a common receptacle, as in the floral axes of the Dandelion and Lettuce.
A Complete Flower possesses the four whorls of floral organs arranged upon the torus.

The stamens and pistils constitute the essential organs, and a flower is said to be Perfect when these are present and functional.

A Regular Flower possesses parts of the same shape and size.

It is Symmetrical when the parts of each whorl are of the same number, or multiples of the same number.

An Imperfect Flower shows one set of essential organs wanting.

When either petals or sepals, or both, are present in more than the usual number, the flower is said to be "double," as the cultivated Aster, Rose, and Carnation.

If the pistils are present and stamens wanting, the flower is called pistillate, or female; if it possesses stamens but no pistil, it is described as staminate, or male; if both are absent, neutral, as marginal flowers of Viburnum. Some plants, as the Begonias and Castor oil bear both staminate and pistillate flowers, and are called Monoecious. When the staminate and pistillate flowers are borne on different plants of the same species, they are termed Dioecious, as the Sassafras and Willow. When staminate, pistillate and hermaphrodite flowers are all borne on one plant, as on the Maple trees, they are polygamous.

The Perigone.—The perigone or perianth is the floral envelope consisting of calyx and corolla (when present).

When both whorls, i.e., calyx and corolla, are present the flower is said to be dichlamydeous; if only calyx is present, monochlamydeous.

The Calyx.—The Calyx is the outer whorl of modified leaves. Its parts are called Sepals, and may be distinct (Chorisepalous, from a Greek word meaning disjoined) or more or less united (Gamosepalous). They are usually green—foliaceous or leaf-like—but may be brilliantly colored, hence the term petaloid (like the petals) is applied. Ex.: Tulip, Larkspur and Columbine.

In a Gamosepalous Calyx, when the union of sepals is incomplete, the united portion is called the tube, the free portion, the limb, the orifice of the tube, the throat.

In form the calyx may be regular or irregular; regular if its parts are evenly developed, and irregular if its parts differ in size and shape. The more common forms are tubular, resembling a tube; rotate, or wheel-shape; campanulate, or bell-shape; urceolate, or urn-shape; hypocrateriform, or salver-shape; bilabiate, or two-lipped; corresponding to the
different forms of corolla, under which examples illustrating each will be given.

The calyx usually remains after the corolla and stamens have fallen, sometimes even until the fruit matures—in either case it is said to be persistent. If it falls with the corolla and stamens, it is deciduous, and if when the flower opens, caducous, as in the Poppy and May-apple. It is often more or less adherent to the ovary or base of the pistil, and it is important, in plant analysis, to note the presence or absence of such adhesion, which is indicated in a description by the terms inferior, or non-adherent (hypogynous), when free from the ovary and wholly beneath it; half-superior, or half-adherent (perigynous), when it partially envelops the ovary, as in the Cherry; superior or adherent (epigynous), when it completely envelops it, as in the Colocynth.

**The Corolla.**—The Corolla is the inner floral envelope, usually delicate in texture, and showing more or less brilliant colors and combinations of color. Its parts are called Petals, and when the calyx closely resembles the corolla in structure and coloring they are together called the Perianth. The purpose of these envelopes is to protect the reproductive organs within, and also to aid in the fertilization of the flower, as their bright colors, fragrance and saccharine secretions serve to attract pollen-carrying insects.

**Forms of the Corolla and Perianth.**—When the petals are not united with each other, the corolla is said to be Choripetalous, often called Polypetalous. When more or less united, they are Gamopetalous, often called Sympetalous.

When the distinct petals are four in number, and arranged in the form of a cross, the corolla is called Cruciform. Ex.: Mustard and other plants belonging to the order Cruciferae.

The Papilionaceous corolla is so called because of a fancied resemblance to a butterfly. The irregularity in this form is very striking, and the petals bear special names: the largest one is the vexillum, or standard; the two beneath it the alæ, or wings; the two anterior, the carina or keel. Ex.: Locust, Pea, and Clover.

Orchidaceous flowers are of peculiar irregularity, combining calyx and corolla. The petal in front of stamen and stigma, which differs from the others in form and secretes nectar, is called the Labellum. Ex.: Cypripedium and other Orchids.

When calyx and corolla each consist of three parts closely resem-
bling each other in form and color, as in the Tulip and Lily, the flower is called Liliaceous.

A Galeate corolla is one in which the upper petal is arched in the shape of a helmet, called the Galea, as in Aconite.

The Ligulate or Strap-shaped corolla is nearly confined to the family Compositæ. It is usually tubular at the base, the remainder resembling a single petal. Ex.: Marigold, and Arnica Flowers.

Labiate, or Bi-labiate, having two lips, the upper composed of two petals, the lower one of three. This form of corolla gives name to the Labiatae, while in the family Leguminosæ this arrangement is sometimes reversed. The corolla may be either ringent, or gaping, as in Sage, or personate, when the throat is nearly closed by a projection of the lower lip, as in Snapdragon.

Rotate, Wheel-shaped, when the tube is short and the division of the limb radiate from it like the spokes of a wheel. Ex.: The Potato blossom.

Crateriform, Saucer-shaped, like the last, except that the margin is turned upward or cupped. Ex.: Kalmia latifolia (Mt. Laurel).

Hypocrateriform, or Salver-shaped (more correctly, hypocrateri-morphous), when the tube is long and slender, as in Phlox or Trailing Arbutus and abruptly expands into a flat limb. The name is derived from that of the ancient Salver, or hypocraterium with the stem or handle beneath.

When of nearly cylindrical form the corolla is Tubular, as in the Honeysuckle, and Stramonium.

Funnel-form (Infundibuliform), such as the corolla of the common Morning Glory, a tube gradually enlarging from the base upward into an expanded border or limb.

Campanulate, or Bell-shaped, a tube whose length is not more than twice the breadth, and which expands gradually from base to apex. Ex.: Canterbury Bell, Harebell.

Urceolate, or Urn-shaped, when the tube is globose in shape and the limb at right angles to its axis, as in the official Uva Ursi, Chimaphila and Gaultheria.

The Androecium, or Stamen System.—The Stamens or microsporophylls are the male organs of reproduction, and each complete stamen consists of a filament, or stalk, and an anther, or pollen sac, which is the essential portion and contains a powdery substance called pollen.
When few in number, stamens are said to be definite; when very numerous, and not readily counted, they are indefinite. The following terms are in common use to express their number:

- **Monandrous**, for a flower with but one stamen.
- **Diandrous**, with two stamens.
- **Triandrous**, with three.
- **Tetrandrous**, with four.
- **Pentandrous**, having five.
- **Hexandrous**, six.
- **Polyandrous**, an indefinite number.

As to insertion, they are:

- **Hyogynous**, situated on the receptacle.
- **Perigynous**, on the calyx tube or disc.
- **Epigynous**, on the top of the ovary.
- **Gynandrous**, borne upon the pistil, as in the Orchids.

The stamens may be of equal length; unequal, or of different length.

- **Didynamous**, when there are two pairs, one longer than the other.
- **Tetradynamous**, three pairs, two of the same length, the third shorter.

Terms denoting connection between stamens are:

- **Monadelphous** (in one brotherhood), coalescence of the filaments into a tube.
- **Diadelphous** (in two brotherhoods), coalescence into two sets.
- **Triadelphous**, with filaments united into three sets.
- **Polyadelphous**, when the sets are numerous.
- **Syngenesious**, when the anthers cohere.

Stamens may be erect, extending directly upward, spreading, proceeding upward and outward; connivent brought close together and turned inward; reflexed, turned downward.

The attachment of the anther to the filament may be in one of several ways, as follows:

- **Innate**, attached at its base to the apex of the filament.
- **Adnate**, adherent throughout its length.
- **Versatile**, when the anther is attached near its center to the top of the filament, so that it swings freely. The adnate and versatile are introrse when they face inward, extrorse when they face outward.

In order that the pollen may be discharged at the proper time, the anther opens along a line or suture called the line of dehiscence, either longitudinal or transverse, or the pollen escapes through apical or val-
vular openings. The pollen is usually a powdery substance which shows under the microscope distinct grains of characteristic forms, sizes and markings. Like starch grains, each represents a particular source, hence the variety that may be examined is limited only by the number of kinds of flowers available for the purpose. In order to study pollen grains, take up by means of forceps a stamen whose anther is just dehiscing, or letting free its contents, and tap upon a sheet of white paper; then examine with a Compound Microscope.

The following are some of the forms of pollen grains:

Four Spore Daughter cells hanging together as in the Cat Tail forming a pollen grain.

Elongated simple pollen grains as in Zostera.

Dumb-bell shaped as the pollen of the Pines.

Triangular, as in the Mexican Primrose.

Echinate, as in the Malvaceae.

Spherical, as in Geranium.

Lens shaped as in the Lily.

The Gynoeicum, or Pistil System.—The Carpel or megasporophyll is the female organ of reproduction of flowering plants. In the Spruce, Pine, etc., it consists of an open leaf or scale which bears but does not enclose the ovules. In angiosperms it forms a closed sac which envelops and protects the ovules, and when complete is composed of three parts, the ovary or hollow portion at the base enclosing the ovules or rudimentary seeds, the stigma or apical portion which receives the pollen grains, and the style, or connective which unites these two. The last is non-essential and when wanting the stigma is called sessile. The carpel clearly shows its relations to the leaf, though greatly changed in form.

The lower portion of a leaf, when folded lengthwise with the margins incurved, represents the ovary; the unfolded surface upon which the ovules are borne is the placenta, a prolongation of the tip of the leaf, the stigma, and the narrow intermediate portion, the style. A leaf thus transformed into an ovule-bearing organ is called a carpel. The carpels of the Columbine and Pea are made up of single carpels. In the latter the young peas occupy a double row along one of the sutures (seams) of the pod. This portion corresponds to the infolded edge of the leaf, and the pod splits open along this line, called the ventral suture.

Dehiscence, or the natural opening of the carpel to let free the contained seeds, takes place also along the line which corresponds to the mid-rib of the leaf, the dorsal suture.
Compound Pistils are composed of carpels which have united to form them, and therefore will have just as many cells as carpels. When each simple ovary has its placenta, or seed-bearing line, at the inner angle the resulting compound ovary has as many axile or central placentaæ as there are carpels, but all more or less consolidated into one. The partitions are called diesselments and form part of the walls of the ovary. If, however, the carpels are joined by their edges, like the petals of a gamopetalous corolla, there will be but one cell, and the placenta will be parietal, or on the wall.

The ovules are transformed buds, destined to become seeds in the mature fruit. Their number varies from one to hundreds. In position, they are erect, growing upward from the base of the ovary, as in the Compositæ; ascending turning upward from the side of the ovary or cell; pendulous, like the last except that it turns downward; horizontal when directed straight outward; suspended, hanging perpendicularly from the top of the ovary.

In Gymnosperms the ovules are naked; in Angiosperms they are enclosed in a seed vessel.

A complete angiospermous seed ovule consists of a nucellus or body; two coats, the outer or primine, and the inner or secundine; and a funiculus, or stalk. Within the nucellus is found the embryo sac containing the ovum or female reproductive cell.

The coats do not completely envelop the nucellus, but an opening at the apex, called the foramen or micropyle admits the pollen tube. The point where the coats are attached to each other and to the nucellus is called the chalaza. The hilum marks the point where the funiculus is joined to the ovule, and if attached to the ovule through a part of its length, the adherent portion is called the raphe. The shape of the ovule may be orthotropous, or straight; campylotropous, bent or curved; amphitropous, partly inverted; and anatropous, inverted. The last two forms are most common. A campylotropous ovule is one whose body is bent so that the hilum and micropyle are approximated.

The Placenta

The placenta is the nutritive tissue connecting the ovules with the wall of the ovary. The various types of placenta arrangement (placentation) are grouped according to their relative complexity as follows:
1, Basilar. 2, Sutural. 3, Parietal. 4, Central. 5, Free Central.

Basilar placentation is well illustrated in the Polygonaceae (Smart Weed, Rhubarb, Etc.) in Piper and Juglans. Here at the apex of the axis and in the center of the ovarian base arises a single ovule from a small area of placental tissue.

Sutural placentation is seen in the Leguminosae (Pea, Bean, Etc.). Here each carpel has prolonged along its fused edges two cord-like placental twigs, from which start the funiculi or ovule stalks.

Parietal placentation is seen in Gloxinia, Gesneria, Etc. Here we find two or more carpels joined and placental tissue running up along edges of the fused carpels bearing the ovules.

Central or axile placentation is seen in Campanulaceae (Lobelia), where the two, three, or more carpels have folded inward until they meet in the center and in the process have carried the originally parietal placenta with them. This then may form a central swelling bearing the ovules over the surface.

Free Central placentation occurs perfectly in the Primulaceae, Plantaginaceae and a few other families. In this the carpels simply cover over or roof in a central placental pillar around which the ovules are scattered.

Pollination.—Pollination is the transfer of pollen from anther to stigma and the consequent germination thereon. It is a necessary step to fertilization.

When the pollen is transferred to the stigma of its own flower the process is called CLOSE OR SELF POLLINATION; if to a stigma of another flower, CROSS POLLINATION. If fertilization follows, these processes are termed respectively, Close or Self Fertilization and Cross Fertilization. Close Fertilization means in time ruination to the race and happily is prevented in many cases by (a) the stamens and pistils standing in extraordinary relation to each other, (b) by the anthers and pistils maturing at different times, (c) by the pollen in many cases germinating better on the stigma of another flower than its own.

The agents which are responsible for cross pollination are the wind, insects, water currents, small animals, and birds.

Wind-pollinated flowering plants are called ANEMOPHILOUS; their pollen is dry and powdery, flowers inconspicuous and inodorous, as in the Pines, Wheat, Walnut, Hop, etc.

Insect-pollinated plants are called ENTOMOPHILOUS. These, being dependent upon the visits of insects for fertilization, possess bril-
liantly colored corollas, have fragrant odors, and secrete nectar, a sweet liquid very attractive to insects which are adapted to this work through the possession of a pollen-carrying apparatus. Ex.: Orchids.

Plants pollinated through the agency of water currents are known as hydrophilous. To this class belong such plants as live under water and which produce flowers at or near the surface of the same. Ex.: Sparganium.

Some plants as the Honeysuckle and Nasturtium are fertilized by humming birds.

Before the pollen grain has been deposited upon the stigma a series of events affecting both the pollen grain and the embryo sac occur. The microspore (pollen grain) divides into two cells, the mother and tube cells of the male gametophyte. The nucleus of the mother cell divides to form two generative nuclei. The nucleus of the megaspore or embryo sac undergoes division until eight daughter nuclei are produced which are separated into the following groups:

(a) Three of these nuclei occupy a position at the apex, the lower nucleus of the group being the egg or ovum, the other two nuclei being the synergids or assisting nuclei.

(b) At the opposite end of the sac are three nuclei known as the antipodals which apparently have no special function.

(c) The two remaining nuclei (polar nuclei) form a group lying near the centre of the embryo sac which unite to form a single nucleus from which, after fertilization, the endosperm of nourishing material is derived. This stage of the embryo sac constitutes the female gametophyte.

Fertilization.—After the pollen grain reaches the stigma the viscid moisture of the stigma excites the outgrowth of the male gametophyte which bursts through the coats of the pollen grain forming a pollen tube. The pollen tube carrying within its walls two generative and one tube nucleus penetrates through the loose cells of the style until it reaches the micropyle of the ovule, then piercing the nucellus it enters the embryo sac. The tip of the tube breaks and one of the generative nuclei unites with the egg to form the oospore. The oospore develops at once into an embryo or plantlet, which lies passive until the seed undergoes germination. The other generative nucleus unites with the previously fused polar nuclei to form the endosperm nucleus which soon undergoes rapid division into a large number of nuclei scattered about through the protoplasm of the embryo sac. These accumulate proto-
plasm about them, cells walls are laid down, endosperm resulting.

Germination is the beginning of growth in a seed or plant. The conditions favorable to germination are warmth, moisture and presence of air.

The Fruit

The fruit consists of the matured ovary and contents, and may include other organs of the flower external to the pistil, but connected with it, as in Clematis, where the long, feathery style renders the fruit buoyant, and, like the fruits of the Thistle and Dandelion, in which the modified calyx serves a similar purpose, is easily scattered by the wind. In the Strawberry and Quince the receptacle becomes thick and succulent, and constitutes the edible portion of the fruit. Other modifications are seen in the hooks or spines, by means of which certain fruits compel animals to assist in their dispersion. Ex.: Cocklebur, Burdock, Bidens, Etc.

Distribution of Fruits and Seeds.—Some fruits, as the cocoanut, are transported by water currents, and are adapted to withstand for a long period the action of salt water. Another of the peculiar means provided by nature for the dissemination of seeds and fruits is that shown in the Sandbox Tree, the fruit of which is hygroscopic, and by absorption of water bursts the pericarp with such explosive force as to cause a loud report and to scatter the seeds in every direction. Birds and fruit-eating mammals, including man, also play a part in the work of distribution.

Fruit Structure

The Pericarp, or seed vessel, is the ripened wall of the ovary, and in general the structure of the fruit wall resembles that of the ovary, but undergoes numerous modifications in the course of development.

The number of cells of the ovary may increase or decrease, the external surface may change from soft and hairy in the flower to hard, and become covered with sharp, stiff prickles, as in the Datura Stramonium or Jamestown weed. Transformations in consistence may take place and the texture of the wall of the ovary may become hard and bony, leathery, as the rind of the Orange, or assume the forms seen in the Gourd, Peach, Grape, etc.
CLASSIFICATION OF FRUITS

Where the pericarp consists of two layers of different texture, as in the Plum, the outer layer is called EXOCARP, the inner, ENDOCARP. When the external layer is thin, it is sometimes termed the EPICARP, when the middle or inner layers are fleshy or pulpy they constitute the SARCOCARP.

When the endocarp within the sarcocarp is hard, forming a shell or stone, this is termed a putamen. When three concentric layers are distinguishable in a pericarp, the middle one is called mesocarp.

Fruits are either DEHISCENT or INDEHISCENT according as they discharge or retain their seeds. Dehiscent fruits open regularly, or normally. When the pericarp splits vertically through the whole or a part of its length, along sutures or lines of coalescence of contiguous carpels. Legumes usually dehisce by both sutures. Irregular or abnormal dehiscence has no reference to normal sutures, as where it is transverse or circumscissile, extending around the capsule either entirely or forming a hinged lid, as in Hyoscyamus, or detached.

Dehiscence is called porous or apical when the seeds escape through pores at the apex, as in the Poppy; valvular, when valve-like orifices form in the wall of the capsule. Valvular dehiscence is SEPTICIDAL when the constituent carpels of a pericarp become disjoined, and then open along their ventral suture; LOCULICIDAL, DEHISCENCE into loculi, or cells, in which each component carpel splits down its dorsal suture, and the dissepiments remain intact; SEPTIFRAGAL DEHISCENCE, a breaking away of the valves from the septa or partitions.

Classification of Fruits (according to structure).—Simple Fruits result from the ripening of a single pistil in a flower.

Aggregate Fruits are the product of several distinct pistil ripenings in one flower, the cluster of carpels being crowded on the receptacle ing one mass, as in the Raspberry, Blackberry, and Strawberry.

Multiple Fruits are those which are the product of a flower cluster instead of a single flower.

Simple Fruits are either Dry or Fleshy. The first may be divided into Dehiscent, those which split open when ripe; and Indehiscent, those which do not.

Dry, Dehiscent, Simple and Aggregate Fruits.—The Follicle is a pod formed by a simple pistil and dehiscent by one suture, as Aconite and Staphisagria.

A Legume is a pod formed by a simple pistil and dehiscent by both sutures. The name legume is restricted to the fruits of the natural family Leguminosae, and includes all the modifications which it represents.
A jointed, indehiscent legume, called a loment, breaks up naturally into transverse, one-seeded divisions. The Cochlea is a coiled or spiral legume. Ex. of Loment: Cassia fistula.

A CAPSULE is a dry dehiscent fruit of two or more united carpels, and shows several forms of dehiscence, as in the Poppy, Cardamon, etc.

The Pyxis is a modification of the capsule which opens transversely, the upper half forming a lid, as in Portulaca or Hyoscyamus.

A SILIQUE is a long slender capsule with two parietal placentæ, the valves opening from below upward, as in the Cruciferae.

**Dry Indehiscent Fruits** (often erroneously regarded as seeds).—The **Akene** is a dry one-chambered, indehiscent fruit, in which the pericarp is firm and may or may not be united with the seed, the style remaining in many cases as an agent of dissemination, and may be winged, feathery, or hooked. Ex.: Fruits of the Compositæ, Anemone and Ranunculus.

The **Samara** is a winged akene-like fruit, as in the Birch, Elm, Ash, Box Elder and Maple.

The **Utricle** is like the akene, except that the pericarp is loose and bladder-like. Ex.: Chenopodium.

A **Caryopsis**, or Grain, differs from the last in having the cell completely filled by the seed and the pericarp very thin. This fruit is more likely than any other to be mistaken for a seed. Ex.: Wheat, Rice, Barley, Oat, etc.

A **Nut** is a hard, one-celled, one-seeded fruit, like the akene but larger, and usually produced from a compound ovary. The nut is often enclosed in a kind of involucre termed a Cupule, as the cup of the acorn or the leaf-like covering of the Hazel-nut.

A **Cremocarp** is the characteristic fruit of the Umbelliferae family. It consists of two inferior akenes or mericarps separated from each other by a stalk called a carpophore. The mericarps separate as soon as the fruit ripens and are seen to be longitudinally ribbed with numerous oil glands between the ribs.

**Fleshy Indehiscent Fruits.**—The **Drupe** is a one-carpelled fruit, such as the Plum, Peach, Prune, Sabal, Rhus, etc., and called “stone fruit,” because the endocarp or putamen is composed wholly of stone cells.

An **Etærio** consists of a collection of little drupes on a torus as the Raspberry.
The **Berry** is fleshy fruit with a thin membranous epicarp and a succulent interior in which the seeds are imbedded. Ex.: Capsicum, Tomato, Belladonna, Grape, Currant, etc.

The **Hesperidium** is a variety of the berry, and the name is applied only to members of the Orange family. It is a fleshy fruit with leathery rind which contains numerous oil glands.

The **Pepo** or **Gourd-fruit**, of which the Squash and Gourd are types, is the characteristic fruit of the order Cucurbitaceæ, fleshy internally, and having a tough or very hard rind. Fruits of this family are true berries.

The **Pome** is a fleshy fruit the chief bulk of which consists of the adherent torus. Quince, Apple and Pear are examples. The carpels constitute the core, and the fleshy part is developed from the torus.

**Multiple Fruits.**—The **Syconium** is a multiple fruit consisting of a succulent hollow torus enclosed within which are akene-like bodies, products of many flowers. Ex.: Fig.

The **Sorosis** is represented by the Mulberry, the grains of which are not the ovaries of a single flower, as in the Blackberry, but belong to as many separate flowers. In the Pine-apple all the parts are blended into a fleshy, juicy, seedless mass, and the plant is propagated by cuttings.

The **Strobile** or **Cone** is a scaly, multiple fruit consisting of a scale-bearing axis, each scale enclosing one or more seeds. The name is applied to the fruit of the Hop, and also to the fruit of the Coniferae in which the naked seeds are borne on the upper surface of the woody scales.

**The Seed**

The seed is the fertilized and matured ovule, having the embryo formed within it. Like the ovule, it consists of a nucellus or kernel enclosed by integuments, and the descriptive terms used are the same. The seed coats, corresponding to those of the ovule, are two in number, the **Testa** and **Tegmen**. The testa, or outer seed shell, differs greatly in form and texture. If thick and hard, it is crustaceous; if smooth and glossy, it is polished; if roughened, it may be pitted, furrowed, hairy, reticulate, etc.

The testa may often present outgrowths or seed appendages whose functions are to make the seeds buoyant, whereby they may be dis-
seminated by wind currents. Examples of these are seen in the Milkweed, which has a tuft of hairs at one end of the seed called a Coma, and in the official Strophanthus, which has a long bristle-like appendage attached to one end of the seed and called an awn. The wart-like appendage at the hilum or micropyle, as in Castor Oil Seed, is called the Caruncle.

The tegmen or inner coat surrounds the nucellus closely and is generally soft and delicate.

A third integument, or accessory seed covering, is occasionally present and is called the Aril. Ex.: Euonymus (succulent).

When such an integument arises at the micropyle of the seed, as in the Nutmeg, it is known as an arillode.

The Nucellus or Kernel consists of tissue containing albumen, when this substance is present, and the embryo. Albumen is the name given the nutritive matter stored in the seed.

MODE OF FORMATION OF DIFFERENT TYPES OF ALBUMEN

If the egg cell within the embryo sac segments and grows into the embryo and, stretching, fills up the cavity without food material laid down around it, it happens that the nutritive material lingers in the cells of the nucellus pressing around the embryo. This is called Perispermic Albumen. Seen in the Polygonaceae.

In by far the greater number of Angiosperms, the endosperm nucleus, after double fertilization, divides and redivides, giving rise to numerous nuclei imbedded in the protoplasm of the embryo sac outside of the developing embryo. Gathering protoplasm about themselves and laying down cell walls they form the endosperm tissue outside of the embryo. Into this tissue food is passed constituting the Endospermic albumen.

In the Marantaceae, Piperaceae, etc., nutritive material is passed into the nucellar cells causing them to swell up, while to one side a small patch of endosperm tissue accommodates a moderate amount of nourishing substance, thus resulting in the formation of abundant perisperm and a small reduced endosperm.
Ezalbuminous seeds are those in which the albumen is stored in the embryo during the growth of the seed.

Albuminous seeds are those in which the nourishment is not stored in the embryo until germination takes place.
PART II

TAXONOMY

DIVISION I.—THALLOPHYTA

Plants consisting of a thallus, a body undifferentiated into root, stem or leaf. The group nearest to the beginning of the plant kingdom presenting forms showing rudimentary structures which are modified through division of labor, differentiation, etc., in higher groups.

SUBDIVISION I.—MYXOMYCETES, OR SLIME MOLDS

Terrestrial or aquatic organisms, frequently classified as belonging to the animal kingdom and found commonly on decaying wood, leaves, or humous soil in forests. Their vegetative body consists of a naked mass of protoplasm, called the plasmodium which has a creeping and rolling motion, putting out and retracting regions of its body called pseudopodia.

SUBDIVISION II.—SCHIZOPHYTA

This group comprises the “fission plants” whose members possess a common method of asexual reproduction whereby the cell cleaves or splits into two parts, each of which then becomes a separate and independent organism.

1. CYANOPHYCEÆ

Plants which are sometimes termed blue-green algae. They contain chlorophyll, a green pigment and phycocyanin, a blue pigment, a combination giving a blue-green aspect to the plants of this group. Found everywhere in fresh and salt water and also on damp logs, rocks, bark of trees, stone walls, etc. Ex.: Oscillatoria, Gloecapsa, and Nostoc.

2. SCHIZOMYCETES—BACTERIA

Bacteria are minute, unicellular vegetable organisms destitute of chlorophyll. They serve as agents of decay and fermentation and are
frequently employed in industrial processes. According to the various phenomena they produce they may be classified as follows: a. Zymogens producing fermentation; b. Aerogens producing gas; c. Photogens producing light; d. Chromogens producing color; e. Sapro-gens, producing putrefaction; f. Pathogens, producing disease.

**Physical Appearance of Bacterial Colonies and Individual Forms**

Because of their minute size—a space the size of a pinhead may hold 8 billion of them—the student commences his study of bacterial growths in colonies or cultures, each kind possessing characteristics by which they may be distinguished and differentiated.

The individuals in the colony, depending upon the kind of bacteria under examination, may be globular, rod-shaped, or spiral. Bacteria are classed according to shape, as:

- **Cocci** (singular coccus), globular or berry-shaped.
- **Bacilli** (singular, bacillus—a little rod), rod-shaped.
- **Spirilla** (singular, spirillum), spiral or corkscrew-shaped.

**Sporulation.**—A large number of bacteria possess the power of developing into a resting stage by a process known as sporulation or spore formation. Sporulation is regarded as a method of resisting unfavorable environment. This is illustrated by the anthrax bacilli which are readily killed in twenty minutes by a 10 per cent. solution of carbolic acid, and able, when in the spore condition, to resist the same disinfectant for a long period in a concentration of 50 per cent. And, while the vegetative forms show little more resistance against moist heat than the vegetative form of other bacteria, the spores will withstand the action of live steam for as long as ten to twelve minutes or more.

Whenever the spores are brought into favorable condition for bacterial growth, as to temperature, moisture and nutrition, they return to the vegetative form and then are capable of multiplication by fission in the ordinary way.

**Reproduction.**—Bacteria multiply and reproduce themselves by cleavage or fission. A young individual increases in size up to the limits of the adult form, when by simple cleavage at right angles to the long axis, the cell divides into two individuals.

**Morphology Due to Cleavage.**—According to limitations imposed by cleavage directors, the cocci assume a chain appearance, or a grape-like appearance, or an arrangement in packets or cubes having three diameters. This gives rise to the

- **Staphylococcus** (plural, staphylococci), from a Greek word referring to the shape of a bunch of grapes.
- **Streptococcus** (plural, streptococci), from a Greek word meaning chain-shaped.
- **Sarcina**, package shaped or cubical.

**Form of Cell Groups after Cleavage.**—The individual bacteria after cleavage may separate, or cohere. The amount of cohesion, together with the plane of cleavage, determines the various forms of the cell groups. Thus among the cocci diplo- or double forms may result giving rise to distinguishing morphological character-
istics. Similarly among the bacilli characteristic forms result as single individuals and others which form chains of various lengths.

Rapidity of Growth and Multiplication.—The rapidity with which bacteria grow and multiply is dependent upon species and environment. The rapidity of the growth is surprising. Under favorable conditions they may elongate and divide every 20 or 30 minutes. If they should continue to reproduce at this rate for twenty-four hours a single individual would have 17 million descendants. If each of these should continue to grow at the same rate, each would have in twenty-four hours more, 17 million offspring, and then the numbers would develop beyond conception. However, such multiplication is not possible under natural or even artificial conditions, both on account of lack of nutritive material and because of the inhibition of the growth of the bacteria by their own products. If they did multiply at this rate in a few days there would be no room in the world but bacteria.

Chemical Composition of Bacteria.—The quantitative chemical composition of bacteria is subject to wide variations, dependent upon the nutritive materials furnished them. About 80 to 85 per cent. of the bacterial body is water; proteid substances constitute about 50 to 80 per cent. of the dry residue. When these are extracted, there remain fats, in some cases wax, in some bacteria traces of cellulose appear, and the remainder consists of 1 to 2 per cent. ash.

The proteids consist partly of nucleo-proteids, globulins, and protein substances differing materially from ordinary proteids. Toxic substances known as endotoxins to distinguish them from bacterial poisons secreted by certain bacteria during the process of growth, also occur.

SUBDIVISION III.—ALGÆ

Low forms of thallophytes of terrestrial and aquatic distribution consisting for the most part of single cells or rows of single cells joined end to end to form filaments. They contain chlorophyll or some other pigment, and so can use the CO₂ and H₂O in the same manner as higher plants, e.g., in assimilating and providing for their own nutrition.

CLASS I.—CHLOROPHYCEÆ, THE GREEN ALGÆ

In this group the cells are observed to possess distinct nuclei and bodies, whose pores contain an oil-like pigment called chlorophyll, the chloroplasts. The following forms are typical: Spirogyra, Diatoms, Pleurococcus, Volvox, Conferva, and Chara.

CLASS II.—PHÆOPHYCEÆ, THE BROWN ALGÆ

Mostly marine forms showing great diversity in the form of their vegetative bodies. Their bodies are usually fixed to some support in the
water and are often highly differentiated both as to form and tissues. Some reach hundreds of feet in length as, for example, Macrocystis which grows in the Pacific Ocean off the coast of California. Other forms typical of the group are Ectocarpus, Laminaria, and Fucus.

**Class III.—Rhodophyceae, The Red Algae**

A greatly diversified group comprising the majority of marine algae. Their vegetative bodies vary from simple branching filaments through all gradations to forms differentiated into branching stems, holdfasts and leaves. Their color may be red, purple, violet, or reddish brown and is due to the presence of phycoerythrin, a red pigment. Among this group are classed Chondrus, Nemalion, Corallina, etc. Chondrus is the sole official alga in the U. S. P. and belongs to the family Gigartinaceae.

**Subdivision IV.—Fungi**

This great assemblage of thallophytes is characterized by the total absence of chlorophyll and so its members possess no independent power of manufacturing food materials such as starches, sugars, etc., from CO₂ and H₂O. Consequently they are either parasites, depending for their nourishment upon other living plants or animals, called hosts; or saprophytes, depending upon decaying animal or vegetable matter in solution. Some forms are able to live either as saprophytes or parasites while others are restricted to either the parasitic or saprophytic habit. The vegetative body of a fungus is known as a mycelium. It consists of interlacing and branching filaments called hyphae, which ramify through decaying matter or invade the tissues of living organisms and derive nourishment therefrom. In the case of parasites, the absorbing connections which are more or less specialized and definite are called haustoria. In the higher forms the hyphae become consolidated into false tissues, and assume definite shapes according to the species. Of this character are the fructifying organs which constitute the above ground parts of Puff Balls, Cup Fungi, Mushrooms, etc.

**Class I.—Phycomycetes, or Alga-like Fungi**

The Phycomycetes represent a small group of fungi showing close affinity with the green algae. Their mycelium is composed of coenocytic
hyphae which suggests a close relation with the Siphonales group of green algae. Their sexual organs are likewise similar in structure.

Fig. 32.—Clasiceps purpurea. A. Young sclerotium, s, with old sphaecelia, s.p. The apex of the dead ovary of rye. B. Upper part of A, in longitudinal section, showing sphaecelia, s. C. Transverse section through the sphaecelia, more highly magnified. m. The mycelium, surrounded with the hyphae; b, bearing conidia; p. conidia fallen off; w, the wall of the ovary. D. Germinating conidia, forming sporidia, x. (From Sayre after Bachs.)

Fig. 33.—Portion of Horn-shaped sclerotium of Clasiceps purpurea, bearing four stalked receptacles. (From Sayre.)

Fig. 34.—Longitudinal section of a receptacle, magnified, showing the perithecia. (From Sayre.)

Sub-class A.—Oomycetes

(Sexual apparatus heterogamous)

Order 1. Chytridiales.—Ex.: Synchytrium, a form parasitic on seed plants and forming blister-like swellings.

Order 2. Saprolegniales.—Water molds which attack fishes, frogs, water insects, and decaying plants and animals. Ex.: Saprolegnia.
Order 3. *Peronosporales.*—Mildews, destructive parasites, living in the tissues of their hosts and effecting pathologic changes. Ex.: Albugo, the blister blight, a white rust attacking members of the Cruciferæ and Phytophthora, producing potato rot.

**SUB-CLASS B.—ZYGOMYCETES**

(Sexual apparatus shows isogamy)


Class II.—Ascomycetes, the Sac Fungi

Mycelium composed of septate filaments and life history character-

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Fig. 35.—A single perithecium of *Claviceps purpurea,* magnified, showing the contained asci. (From Sayre.)

Fig. 36.—Asci containing the long, slender ascospores. (From Sayre.)

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ized by the appearance of a sac called an ascus in which ascospores are formed. The largest class of fungi.

Order 1. *Protoascales,* the yeasts (Saccharomycetes) (position doubtful).

Order 2. *Pezizales* or cup fungi. Ex.: Peziza and Ascobolus.


Order 5. Pyrenomycetales, the mildews and black fungi common as superficial parasites on various parts of plants. To the black fungi division of this order the Ergot fungus, Claviceps purpurea, belongs.

Life History of Claviceps Purpurea

Through the agency of winds or insects the spores (ascospores or conidia) of this organism are brought to the young ovaries of the rye (Secale cereale). They germinate into long filaments called hyphae which, becoming entangled to form a mycelium, spread over the rye, enter it superficially, secrete a ferment, and cause decomposition of its tissue and the resultant formation of a yellow-mucus substance called honey-dew, which surrounds chains of moniliform reproductive bodies known as conidia. The honey-dew attracts certain insects which disseminate the disease to other heads of grain.

The mycelial threads penetrate deeper and deeper into the ovary and soon form a dense tissue which gradually consumes the entire substance of the ovary and hardens into a purple somewhat curved body called a sclerotium, or official ergot—the resting stage of the fungus, Claviceps.

The ergot falls to the ground and in the following spring sprouts into several stalked heads. Each (fruiting) head or ascocarp has imbedded in its surface numerous flask-shaped invaginations called perithecia from the bases of which several sacs or asci develop. Within each ascus are developed eight filiform spores (ascospores) which, when the ascus ruptures, are discharged and are carried by the wind to other fields of grain, there to begin over a new life cycle.

Class III.—Basidiomycetes, or Basidia Fungi

This large class of fungi including the smuts, rusts, mushrooms, gill and tooth fungi, etc., is characterized by the occurrence of a basidium in the life history. A basidium is the swollen end of a hypha consisting of one or four cells and giving rise to branches called sterigmata, each of which cuts off at its tip a spore.

Sub-class A.—Protobasidiomycetes

(Basidium four-celled, each cell bearing a spore)

Order 1. Ustilaginales, the smuts. Destructive parasites which attack the flowers of various cereals, occasionally other parts of these plants. Ex.: Ustilago Maydis, the corn smut.

Order 2. Uredinales, the rusts. Ex.: Puccinia graminis, one of the wheat rusts, living in the intercellular spaces of young wheat.
Lichens are variously colored, usually dry and leathery plants, consisting of symbioses of algae and fungi. They are found on the bark of trees, on rocks, logs, old fences, etc.

According to structure and mode of growth of the thallus, the
Lichenes are, like the Fungi, divided into several sub-groups. A perfect lichen usually consists of a thallus, or vegetable apparatus; apothecia, or organs of fructification, and spermogonia, or organs of fertilization.

**DIVISION II.—BRYOPHYTA**

Plants showing a beginning of definite alternation of generations, i.e., gametophyte (sexual phase) alternating with sporophyte (asexual phase of development) in their life history, the two phases being combined in one plant.

**SUBDIVISION I.—HEPATICÆ OR LIVERWORTS**

Plants of aquatic or terrestrial habit whose bodies consist of a rather flat, furchate branching thallus or leafy branch which is dorsiventral (having distinct upper and lower surface); the upper surface consists of several layers of cells containing chlorophyll, which gives the green color to the plants; the lower surface gives origin to hair-like outgrowths of the epidermal cells serving as absorptive parts and called rhizoids. Upon the dorsal surface of this thalloid body (the gametophyte) cup-like structures are produced called cupules which contain special reproductive bodies called gemmae, these being able to develop into new gametophytes. The sex organs are of two kinds, male and female. The male organs are termed antheridia, the female, archegonia. The antheridia are more or less club-shaped, somewhat stalked organs consisting of an outer layer of sterile cells investing a mass of sperm mother cells from which are formed the spirally curved biciliate antherozoids, or male sexual cells. The archegonia are flask-shaped organs consisting of an investing layer of sterile cells surrounding an axial row of cells, the neck canal cells, ventral canal cells and the egg or female sexual cell. Every cell of the axial row breaks down in the process of maturation with the exception of the egg which remains in the basal portion. Both antheridia and archegonia generally arise on special stalks above the dorsal surface. After the egg is fertilized by an antherozoid, the young embryo resulting grows into a sporogonium (the sporophyte) consisting of a stalk portion partly imbedded in the archegonium surmounting a sporangium or capsule in which spores are produced. When mature the capsule splits open discharging the spores. The spores on germination develop into a protonema or filamentous outgrowth which later develops the thallus.
Order 1. Marchantiales, including Marchantia and Riccia.
Order 2. Jungermaniales, the leafy liverworts, including Porella.
Order 3. Anthocerotales, having the most complex sporophyte generations among liverworts, including Anthoceros, and Megaceros.

SUBDIVISION II.—MUSCI OR MOSSES

Plants found on the ground, on rocks, trees and in running water. Their life histories consist of two generations, gametophyte and sporophyte similar to the liverworts but differ from liverworts, generally, by the ever-present differentiation of the gametophyte body into distinct stem and simple leaves, and the formation of the sexual organs at the end of an axis of a shoot. They are either monoecious, when both kinds of sexual organs are borne on the same plant, or dioecious, in which case the antheridia and archegonia arise on different plants.

Order 1. Sphagnales, or Bog Mosses, including the simple genus, Sphagnum. Pale mosses of swampy habit whose upper extremities repeat their growth periodically while their lower portions die away gradually and form peat, hence their frequent name of Peat Mosses.

Order 2. Andreeales, including the single genus Andreaea, a xerophytic habit occurring on siliceous rock.

Order 3. Bryales, or true mosses comprising the most highly evolved type of bryophytes. Ex.: Polytrichum, Funaria, Hypnum, and Minium.

LIFE HISTORY OF POLYTRICHUM COMMUNE (A TYPICAL TRUE MOSS)

Polytrichum commune is quite common in woods, forming a carpet-like covering on the ground beneath tall tree canopies. It is dioecious, the plants being of two kinds, male and female.

Beginning with a spore which has fallen to the damp soil, we note its beginning of growth (germination) as a green filamentous body called a protonema. This protonema soon becomes branched, giving rise to hair-like outgrowths from its lower portion called rhizoids and lateral buds above these which grow into leafy stems commonly known as “moss plants.” At the tips of some of these leafy stems antheridia (male sexual organs) are formed while on others archegonia (female sexual organs) are formed. These organs are surrounded at the tips by delicate hairy processes called paraphyses as well as leaves for protection. The antheridia bear the antherozoids, the archegonia, the eggs or ova, as in the liverworts. When an abundance of moisture is present the antherozoids are liberated from the antheridia, swim through the water to an archegonium and descend the neck canal, one fertilizing the egg by uniting with it. This completes the sexual or gametophyte generation. The fertilized egg now undergoes division until an elongated stalk bearing upon its summit a capsule is finally produced, this being known as the sporo-
gonium. The base of the stalk remains imbedded in the basal portion of the archegonium at the tip of the leafy stalk and forms a foot or absorbing process. In growing upward the sporogonium ruptures the neck of the archegonium and carries it upward as the covering of the capsule, or calyptra. The calyptra is thrown off before the spores are matured within the capsule. The upper part of the capsule becomes converted into a lid or operculum at the margin of which an annulus or ring of cells forms. The cells of the annulus are hygroscopic and expand at maturity, throwing off the lid and allowing the spores to escape. This completes the asexual or sporophyte generation. The spores falling to the damp soil germinate into protonemata, thus completing the life cycle in which is seen an alteration of generations, the two phases, gametophyte alternating with sporophyte.

DIVISION III.—PTERIDOPHYTA

The most highly developed cryptogams showing a distinct alternation of generations in their life history. They differ from the Bryophytes in presenting independent, leafy, vascular, root-bearing sporophytes.

SUBDIVISION I.—LYCOPODIALES OR CLUB MOSSES

Small perennial vascular, dichotomously branched herbs with stems thickly covered with awl-shaped leaves. The earliest forms of vascular plants differing from ferns in being comparatively simple in structure, of small size, leaves sessile and usually possessing a single vein. Except in a few instances the sporangia are borne on leaves, crowded together and forming cones or spikes at the ends of the branches. Homosporous.

Family 1. Lycopodiaceæ, including the single genus Lycopodium with widely distributed species. The spores of Lycopodium clavatum are official.

Family 2. Selaginellaceæ, including the single genus Selaginella, with species for the greater part tropical. Plants similar in habit to the Lycopodiaceæ but showing heterospory.

Family 3. Isoetaceæ, including the single genus Isoetes whose species are plants with short and tuberous stems giving rise to a tuft of branching roots below and a thick rosette of long, stiff awl-shaped leaves above. Heterosporous.

SUBDIVISION II.—EQUISETALES

(The Horsetails or Scouring Rushes)

The Equisetales, commonly known as the Horsetails or Scouring rushes are perennial plants with hollow, cylindrical, jointed and fluted
stems, sheath-like whorls of united leaves and terminal cone-like fructifications. Their bodies contain large amounts of silicon, hence the name scouring rushes.

In some varieties the fruiting cone is borne on the ordinary stem, in others on a special stem of slightly different form. In the latter the spores are provided with elaters, which, being hygroscopic, coil and uncoil with increase or decrease in the amount of moisture present, thus aiding in the ejection of spores from the sporangia. The number of species is small and included under one genus Equisetum.

SUBDIVISION III.—FILICALES

The group Filicales is the largest among the vascular cryptogams and includes all the plants commonly known as Ferns. The main axis of a typical fern is a creeping underground stem or rhizome which at its various nodes bears rootlets below and fronds above. These fronds are highly developed, each being provided with a petiole-like portion called a stipe which is extended into a lamina usually showing a forked venation. Some ferns possess laminae which are lobed, each lobe being called a pinna. If a pinna be further divided, its divisions are called pinnules. The unfolding of a frond is circinate and it increases in length by apical growth. On the under surface of the laminae, pinnæ, or pinnules may be seen small brown patches each of which is called a sorus, and usually covered by a membrane called the indusium. Each sorus consists of a number of sporangia (spore cases) developed from epidermal cells. In some ferns the entire leaf becomes a spore-bearing organ (sporophyll). Most sporangia have a row of cells around the margin, the whole being called the annulus. Each cell of the annulus has a U-shaped thickened cell wall. Water is present within these cells and when it evaporates it pulls the cell walls together, straightening the ring and tearing open the weak side. The annulus then recoils and hurls the spores out of the sporangium. Upon coming in contact with damp earth each spore germinates, producing a green septate filament called a protonema. This later becomes a green heart-shaped body called a prothallus. It develops on its under surface antheridia or male organs and archegonia or female organs as well as numerous rhizoids. Within the antheridia are developed motile sperm, while ova are produced within the archegonia. The many ciliate sperms escape from the antheridia of one prothallus during a wet season and
moving through the water are drawn by a chemotactic influence to the archegonia of another prothallus, pass down the neck canals of these and fuse with the ova, fertilizing them. The fertilized egg or

Fig. 37.—Dryopteris fílix-mas—Plant and section through sorus. (From Sayre.)

œspore divides and redvides and soon becomes differentiated into stem bud, first leaf, root, and foot. The foot obtains nourishment from the prothallus until the root grows into the soil, when it atrophies and the sporophyte becomes independent. Unequal growth and divi-
sion of labor continue until a highly differentiated sporophyte results, the mature “fern plant.”

**CLASS 1. FILICINEÆ OR TRUE FERNS (HOMOSPOROUS)**

**FAMILY POLYPODIACEÆ.**—Sporangia with annulus vertical and incomplete.

The rhizomes of Dryopteris filix-mas and Dryopteris marginalis are official in the U. S. P. The fibrovascular bundles of these are concentric in type but differ from the concentric f. v. bundles of some monocotyledons in that xylem is innermost and phloem surrounds the xylem.

**CLASS 2. HYDROPTERIDINEÆ, OR WATER FERNS (HETEROSPOROUS)**

**FAMILY SALVINIACEÆ,** floating ferns with broad floating leaves and submerged dissected leaves which bear sporocarps. Ex.: Salvinia and Azolla.

**DIVISION IV.—SPERMATOPHYTA (PHANEROGAMIA)**

Plants producing real flowers and seeds. The highest evolved division of the vegetable kingdom.

**SUBDIVISION I.—ANGIOSPERMIA OR ANGIOSPERMS**

(Plants with covered seeds)

**CLASS A.—MONOCOTYLEDONS**

A class of Angiospermia characterized by the following peculiarities:

One cotyledon or seed leaf in the embryo.
Stems endogenous with closed collateral or concentric fibrovascular bundles, which are scattered.
Leaves generally parallel veined.
Flowers trimerous (having the parts of each whorl in 3’s or multiple thereof).
Secondary growth in roots generally absent.
Medullary rays generally absent.
Family 1. Araceæ or Arum Family.—Perennial herbs with fleshy rhizomes or corms, and long petioled leaves, containing an acrid or pungent juice. Flowers crowded on a spadix, which is usually surrounded by a spathe. Fruit a berry. Seeds with large fleshy embryo.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calamus</td>
<td>Unpeeled rhizome</td>
<td>Acorus calamus</td>
</tr>
<tr>
<td>Skunk cabbage</td>
<td>Rhizome</td>
<td>Symplocarpus foetidus</td>
</tr>
<tr>
<td>Indian turnip</td>
<td>Corm</td>
<td>Arisæma triphyllum</td>
</tr>
</tbody>
</table>

Family 2. Graminaceæ or Grass Family.—Mostly herbs with cylindric, hollow jointed stems whose nodes are swollen. The leaves are alternate, with long split sheaths and a ligule. Flowers generally hermaphroditic and borne in spikelets making up a spicate inflorescence. Lowest floral leaves of each spikelet are called glumes, which are empty and paired. Fruit, a caryopsis or grain. Embryo with scutellum.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triticum</td>
<td>Rhizome</td>
<td>Agropyron repens</td>
</tr>
<tr>
<td>Saccharum</td>
<td>Refined sugar</td>
<td>Saccharum officinarum</td>
</tr>
<tr>
<td>Maltum</td>
<td>Seed, partially germinated</td>
<td>Hordeum distichum and dried</td>
</tr>
<tr>
<td>Zea</td>
<td>Styles and stigmas</td>
<td>Zea mays</td>
</tr>
</tbody>
</table>

Family 3. Palmeæ or Palm Family.—Tropical or sub-tropical arborescent plants, having unbranched trunks which are terminated by a crown of leaves, in the axils of which the flowers are produced. The leaves are well developed with pinnate or palmate blades and a fibrous sheathed clasping petiole. Inflorescence lateral with small flowers. Fruit a berry or drupe.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabal</td>
<td>Fruit</td>
<td>Serenoa serrulata</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cocoanut oil</td>
<td>Fixed oil</td>
<td>Cocos nucifera</td>
</tr>
<tr>
<td>Carnauba wax</td>
<td>Wax from leaves</td>
<td>Copernica cerifera</td>
</tr>
<tr>
<td>Areca nut</td>
<td>Seed</td>
<td>Areca Catechu</td>
</tr>
</tbody>
</table>

Family 4. Liliaceæ or Lily Family.—Herbs with regular and symmetrical almost always six-androus flowers. The perianth is parted into six segments, the calyx and corolla being alike in color. Anthers introrse. Ovary three-locular with a single style. Fruit a capsule or berry.
**ORCHID FAMILY**

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarsaparilla</td>
<td>Root</td>
<td>Smilax medica</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smilax ornata</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smilax papyraceae</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smilax officinalis</td>
</tr>
<tr>
<td>Convallaria</td>
<td>Rhizome and roots</td>
<td>Convallaria majalis</td>
</tr>
<tr>
<td>Veratrum</td>
<td>Rhizome and roots</td>
<td>Veratrum viride</td>
</tr>
<tr>
<td>Colchici Cormus</td>
<td>Corm</td>
<td>Colchicum autumnale</td>
</tr>
<tr>
<td>Colchici semen</td>
<td>Seed</td>
<td>Colchicum autumnale</td>
</tr>
<tr>
<td>Aloe</td>
<td>Inspissated juice of leaves</td>
<td>Aloe vera</td>
</tr>
<tr>
<td>Scilla</td>
<td>Bulb</td>
<td>Aloe Perryi</td>
</tr>
<tr>
<td>Veratrrina</td>
<td>Mixture of alkaloids</td>
<td>Aloe chinensis</td>
</tr>
<tr>
<td>Garlic</td>
<td>Bulb</td>
<td>Urginea maritima</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asagraea officinalis</td>
</tr>
</tbody>
</table>

**Unofficial**

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orris</td>
<td>Rhizome</td>
<td>Iris florentina</td>
</tr>
<tr>
<td>Saffron</td>
<td>Stigmas</td>
<td>Iris pallida</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iris germanica</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crocus sations</td>
</tr>
</tbody>
</table>

**FAMILY 5. IRI DACEÆ OR IRIS FAMILY.**—Perennial herbs with equitant two-ranked leaves and regular or irregular flowers which are showy. Fruit a three-celled, loculicidal, many-seeded capsule. Root-stocks, tubers, or corms mostly acrid.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orris</td>
<td>Rhizome</td>
<td>Iris florentina</td>
</tr>
<tr>
<td>Saffron</td>
<td>Stigmas</td>
<td>Iris pallida</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iris germanica</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crocus sations</td>
</tr>
</tbody>
</table>

**FAMILY 6. ORCHIDACEÆ OR ORCHID FAMILY.**—Perennial herbs having grotesque flowers. The perianth consists of six segments, the outer three of which correspond to sepals and are similar. Two segments of the inner circle resemble petals while the third is known as the Labellum or Lip. This is generally larger than the rest and is directed downward and forward. Usually only one stamen is developed, bearing anther. Leaves parallel veined and alternate. Ovary unilocular with many ovules on three parietal placentæ. Fruit a capsule, three-valved and one-celled. Seeds minute.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanilla</td>
<td>Fruit</td>
<td>Vanilla planifolia</td>
</tr>
<tr>
<td>Cypripedium</td>
<td>Rhizome and roots</td>
<td>Cypripedium hirsutum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cypripedium parviflorum</td>
</tr>
</tbody>
</table>
Family 7. Zingiberaceae or Ginger Family.—Tropical plants, perennial herbs with fleshy rhizomes and large elliptical pinnately veined leaves. The leaf sheaths are folded tightly around each other so as to give the appearance of a stem. Flowers, zygomorphic.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zingiber</td>
<td>Rhizome</td>
<td>Zingiber officinale</td>
</tr>
<tr>
<td>Cardamomum</td>
<td>Fruit</td>
<td>Elettaria repens</td>
</tr>
</tbody>
</table>

Class B.—Dicotyledons

Plants having the following characteristics:  
Two-seed leaves (cotyledons) in embryo.  
Netted veined leaves.  
Open collateral fibrovascular bundles, radially arranged about pith.  
Exogenous stems.  
Medullary rays present.  
Cambium.  
Roots developing secondary structure.  
Flowers tetra- or pentamerous (parts of each whorl, four or five or multiple thereof).

Sub-class a.—Archichlamydeæ

Those dicotyledonous plants in which the petals are distinct and separate from one another or are entirely wanting. That group of the Archichlamydeæ whose flowers show the absence of petals and frequently of sepals is called the Apetalæ. The group whose plants have flowers showing the parts of their corolla (petals) separate and distinct is called the Chloripetalæ.

The Apetalæ

Family 1. Piperaceæ or Pepper Family.—A family of aromatic herbs and shrubs with jointed stems, opposite, verticillate, or sometimes alternate leaves without stipules, and spiked or racemose flowers.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubeba</td>
<td>Unripe fruit</td>
<td>Piper Cubeba</td>
</tr>
<tr>
<td>Piper</td>
<td>Unripe fruit</td>
<td>Piper nigrum</td>
</tr>
<tr>
<td>Matico</td>
<td>Leaves</td>
<td>Piper angustifolium</td>
</tr>
<tr>
<td>Methysticum</td>
<td>Root</td>
<td>Piper methysticum</td>
</tr>
</tbody>
</table>
FAMILY 2.  **Fagaceæ or Beech Family** (Cupuliferæ).—Apetalous trees or shrubs having alternate pinnately veined leaves, monœcious flowers, the male in drooping aments, the female solitary, clustered, or in scaly catkins. Fruit a one-celled one-seeded nut. The beech, oak and chestnut, are the principal genera.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galla</td>
<td>Excrecence</td>
<td>Quercus infectoria</td>
</tr>
<tr>
<td>Creosotum</td>
<td>Product of distillation</td>
<td>Fagus ferruginea</td>
</tr>
<tr>
<td>Quercus</td>
<td>Bark</td>
<td>Fagus sylvatica, etc.</td>
</tr>
</tbody>
</table>

**Unofficial**

| Castanea      | Leaves           | Quercus alba                        |

|                |                  | Castanea dentata                    |

The cork of commerce is obtained from the bark of Quercus Suber and Quercus occidentalis, plants indigenous to Spain and France.

FAMILY 3. **Betulaceæ or Birch Family.**—A family of trees or shrubs distinguished by monœcious flowers with scaly bracts and astringent resinous bark. Differs from Fagaceæ by superior ovary and absence of cupule. To this family belong the hazelnuts, birches, alders, the ironwood, and the hornbean.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum Betulae</td>
<td>Volatile oil</td>
<td>Betula lenta</td>
</tr>
</tbody>
</table>

FAMILY 4. **Juglandaceæ.**—A family of apetalous exogenous trees—the walnut family—with alternate odd-pinnate leaves and monœcious flowers, the sterile in catkins, the fertile solitary or in a small cluster or spike. The fruit is a dry drupe with a bony nut-shell and a four-lobed seed. It embraces five genera, of which Cary (Hicoria) and **Juglans** are represented in the United States, and about 35 species.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juglans</td>
<td>Root bark</td>
<td><strong>Juglans cinerea</strong></td>
</tr>
</tbody>
</table>

FAMILY 5. **Salicaceæ or Willow Family.**—A family of apetalous shrubs or trees—the willow family—having alternate undivided leaves and dioecious flowers (one to each bract) in catkins. It embraces two genera—Salix, the willows, and **Populus**, the poplars—and from 180 to 300 species, found chiefly in northern temperate and frigid regions, there being none in Australia or the South Pacific islands.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salicin</td>
<td>Glucoside</td>
<td>Several species of Salix and Populus</td>
</tr>
</tbody>
</table>
Family 6. Myristicaceæ.—An order of apetalous trees—the nutmeg family—comprising the single genus Myristica, of about 80 species.

Myristica.—A large tropical genus of fragrant, apetalous trees—the nutmegs—coextensive with the nutmeg family, having alternate, entire, often punctate leaves, small dioecious regular flowers, and a succulent, two-valved one-celled fruit with a solitary seed usually covered by a lanceate aril.

M. fragrans, a handsome tree, 20 to 30 feet high, of the Malay archipelago, supplies the nutmegs and mace of commerce.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myristica</td>
<td>Kernel of seed</td>
<td>Myristica fragrans</td>
</tr>
<tr>
<td>Oleum Myristicaæ</td>
<td>Volatile oil</td>
<td>Myristica fragrans</td>
</tr>
</tbody>
</table>

Family 7. Lauraceæ or Laurel Family.—A family of aromatic trees or shrubs with alternate, coriaceous, pellucid punctate leaves containing considerable volatile oil; flowers polygamous, each having a calyx of four or six colored sepals.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camphora</td>
<td>Stearopten</td>
<td>Cinnamomum Camphora</td>
</tr>
<tr>
<td>Sassafras</td>
<td>Bark of root</td>
<td>Sassafras variifolium</td>
</tr>
<tr>
<td>Sassafras Medulla</td>
<td>Pith</td>
<td>Sassafras variifolium</td>
</tr>
<tr>
<td>Cinnamomum Zeylanicum</td>
<td>Bark</td>
<td>Cinnamomum zeylanicum</td>
</tr>
<tr>
<td>Cinnamomum Saigonicum</td>
<td>Bark</td>
<td>Undetermined species of cinnamon</td>
</tr>
<tr>
<td>Oleum Cinnamomi</td>
<td>Volatile oil</td>
<td>Cinnamomum cassia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unofficial</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coto</td>
<td>Bark</td>
<td>Drimys winteri</td>
</tr>
<tr>
<td>Laurus</td>
<td>Leaves</td>
<td>Laurus nobilis</td>
</tr>
</tbody>
</table>

Family 8. Myricaceæ, or Bayberry Family.—A family of evergreen or deciduous, apetalous, mostly dioecious shrubs and trees included within the single genus, Myrica. Flowers in mostly single, seldom closely set aments, leaves single, occasionally (Myrica asplenifolia) pinnately cleft. Fruit, a waxy drupe.

The outer waxy layer of the fruit is used in making a superior candle while an infusion or fluid extract of the bark and leaves is used as a specific in various affections of the mucous membranes, diarrhœa, dysentery, etc.

Family 9. Polygonaceæ or Buckwheat Family.—Apetalous herbs, shrubs, or rarely trees with alternate entire leaves, the stipules
forming a sheath above the swollen joints of the stem; flowers, small and with a two- to six-parted perianth; fruit, an angled akene.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheum</td>
<td>Rhizome</td>
<td>Rheum officinale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rheum palmatum and the variety tanguticum</td>
</tr>
<tr>
<td>Rumex</td>
<td>Root</td>
<td>Rumex crispus</td>
</tr>
</tbody>
</table>

**FAMILY 10. PHYTOLACCACEÆ.**—A family of apetalous trees, shrubs, or woody herbs—the pokeweed family—with alternate entire leaves and flowers resembling those of the goosefoot family (Chenopodiaceae), but differing in having the several-celled ovary composed of carpels united in a ring, and forming a berry in fruit. It embraces 21 genera, and 55 species, tropical and sub-tropical.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytolacca</td>
<td>Root</td>
<td>Phytolacca decandra</td>
</tr>
</tbody>
</table>

**FAMILY 11. CHENOPODIACEÆ.**—A family of more or less succulent apetalous annual or perennial herbs—the goosefoot family—with usually alternate exstipulate leaves and minute greenish flowers. It embraces about 80 genera and over 500 species, among them being several garden vegetables and a number of weeds.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum Chenopodii</td>
<td>Volatile oil</td>
<td>Chenopodium anthelminticum</td>
</tr>
<tr>
<td>Saccharum</td>
<td>Refined sugar</td>
<td>Beta vulgaris</td>
</tr>
</tbody>
</table>

**FAMILY 12. ARISTOLOCHIACEÆ.**—A small family of apetalous plants—the birthwort family—chiefly climbers or twiners and tropical, with irregular, dingy, often offensively smelling flowers. There are five genera and about 200 species.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serpentaria</td>
<td>Rhizome and roots</td>
<td>Aristolochia serpentaria</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aristolochia reticulata</td>
</tr>
<tr>
<td>Asarum</td>
<td>Rhizome and roots</td>
<td>Asarum canadensis</td>
</tr>
</tbody>
</table>

**FAMILY 13. ULMACEÆ OR ELM FAMILY.**—Forest trees indigenous to the temperate and tropical zones, characterized by being woody plants, with pinnately veined leaves and caducous stipules and without
milky juice. Their flowers are unisexual or hermaphroditic with six or four parts to the perianth. Fruit, a samara.

**Family 14. Moraceae or Mulberry Family.**—Mostly shrubs or trees, rarely herbs, perennials, with small axillary, clustered or solitary unisexual flowers, variously colored; leaves ovate with serrate margin and having caducous stipules; fruit an akene enclosed by the perianth. Milky juice present.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulmus</td>
<td>Inner bark</td>
<td>Ulmus fulva</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannabis Indica</td>
<td>Flowering tops of pistil-</td>
<td>Cannabis sativa</td>
</tr>
<tr>
<td>Ficus</td>
<td>Fruit</td>
<td>Ficus carica</td>
</tr>
<tr>
<td>Humulus</td>
<td>Strobile</td>
<td>Humulus lupulus</td>
</tr>
<tr>
<td>Lupulinum</td>
<td>Glandular trichome</td>
<td>Humulus lupulus</td>
</tr>
</tbody>
</table>

**Family 15. Euphorbiaceae or Spurge Family.**—A vast group of apetalous trees, shrubs, or herbs mainly natives of warm countries, with milky acrid juice, normally alternate, entire leaves; fruit, a three-locular capsule containing seeds with oily endosperm. Some plants furnish rubber.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastica</td>
<td>Concrete juice</td>
<td>Hevea species</td>
</tr>
<tr>
<td>Stillingia</td>
<td>Root</td>
<td>Stillingia sylvatica</td>
</tr>
<tr>
<td>Oleum Ricini</td>
<td>Volatile oil</td>
<td>Ricinus communus</td>
</tr>
<tr>
<td>Oleum Tiglii</td>
<td>Volatile oil</td>
<td>Croton tiglium</td>
</tr>
<tr>
<td><strong>Unofficial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cascarilla</td>
<td>Bark</td>
<td>Croton elutteria</td>
</tr>
<tr>
<td>Tapioca</td>
<td>Starch</td>
<td>Manihot utilissima</td>
</tr>
<tr>
<td>Kamala</td>
<td>Hairs of capsule</td>
<td>Mallotus philipinensis</td>
</tr>
</tbody>
</table>

**The Chloripetalæ (Polypetalæ)**

Flowers have both calyx and corolla, the latter being composed of distinct petals.

**Family 16. Magnoliaceæ or Magnolia Family.**—Trees and shrubs having alternate leaves and single large flowers with calyx and corolla colored alike. Sepals and petals deciduous, anthers adnate. Pistils and stamens numerous. Bark aromatic and bitter.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum anisi</td>
<td>Volatile oil</td>
<td>Illicium verum</td>
</tr>
</tbody>
</table>
FAMILY 17. **Rosaceæ.**—A family of polypetalous plants—the rose family—with alternate simple or compound stipulate leaves, and regular flowers with usually numerous distinct stamens inserted on the urn-shaped calyx. It embraces 80 genera, and nearly 2000 species, found in all parts of the world.

Trees, shrubs and a few herbs. The flowers bear comparatively many petals. The fruits vary greatly and may be fleshy, an akene, berry or a drupe. Many of the fruits are edible.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum Rosæ</td>
<td>Volatile oil</td>
<td>Rosa damascena</td>
</tr>
<tr>
<td>Amygdala Amara</td>
<td>Seed</td>
<td>Prunus amygdalus variety amara</td>
</tr>
<tr>
<td>Amygdala Dulcis</td>
<td>Seed</td>
<td>Prunus amygdalus variety dulcis</td>
</tr>
<tr>
<td>Prunus Virginiana</td>
<td>Bark</td>
<td>Prunus serotina</td>
</tr>
<tr>
<td>Rubus</td>
<td>Bark</td>
<td>Rubus villosus, R. cuneifolius, and R. nigrobaccus</td>
</tr>
<tr>
<td>Quillaja</td>
<td>Bark</td>
<td>Quillaja saponaria</td>
</tr>
<tr>
<td>Cusso</td>
<td>Panicles of pistillate flowers</td>
<td>Hagenia abyssinica</td>
</tr>
<tr>
<td>Rosa Gallica</td>
<td>Petals</td>
<td>Rosa gallica</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laurocerasus</td>
<td>Leaves</td>
<td>Prunus laurocerasus</td>
</tr>
<tr>
<td>Cydonium</td>
<td>Seed</td>
<td>Cydonia vulgaris</td>
</tr>
</tbody>
</table>

FAMILY 18. **Anacardiaceæ, or Cashew Family.**—A family of chloripetalous trees or shrubs, with resinous, acrid, milky juice, alternate leaves, small flowers, and a mostly drupaceous fruit. Exhalations of many members frequently poisonous especially from the Rhus venenata, and R. Toxicodendron (Poison Ivy).

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastiche</td>
<td>Resinous exudation</td>
<td>Pistacia lentiscus</td>
</tr>
<tr>
<td>Rhus glabra</td>
<td>Fruit</td>
<td>Rhus glabra</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhus Toxicodendron</td>
<td>Leaves</td>
<td>Rhus toxicodendron</td>
</tr>
<tr>
<td>Rhus Aromatica</td>
<td>Bark of root</td>
<td>Rhus aromatic</td>
</tr>
</tbody>
</table>

FAMILY 19. **Ranunculaceæ.**—An order of herbaceous or woody plants—the crowfoot or buttercup family—with radical or alternate palmately veined leaves, and terminal, racemose, or panicled flower clusters, the flowers regular or irregular, with all parts distinct and unconnected. There are 30 genera and 1350 species.

Medium-sized shrubs or herbs with acrid juices. Fruit is an akene,
pod or berry. Chiefly temperate or cold climates. Seeds contain albuminous matter.

<table>
<thead>
<tr>
<th><strong>Official drug</strong></th>
<th><strong>Part used</strong></th>
<th><strong>Botanical name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrastis</td>
<td>Rhizome and roots</td>
<td>Hydrastic canadensis</td>
</tr>
<tr>
<td>Aconitum</td>
<td>Tubercous root</td>
<td>Aconitum napellus</td>
</tr>
<tr>
<td>Staphisagria</td>
<td>Seed</td>
<td>Delphinium Staphisagria</td>
</tr>
<tr>
<td>Cimicifuga</td>
<td>Rhizome and root</td>
<td>Cimicifuga racemosa</td>
</tr>
</tbody>
</table>

**Unofficial**

<table>
<thead>
<tr>
<th><strong>Official drug</strong></th>
<th><strong>Part used</strong></th>
<th><strong>Botanical name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulsatilla</td>
<td>Entire herb</td>
<td>Anemone pulsatilla</td>
</tr>
<tr>
<td>Coptis</td>
<td>Entire herb</td>
<td>Anemone pratensis</td>
</tr>
<tr>
<td>Helleborus</td>
<td>Rhizome and roots</td>
<td>Coptis trifolia</td>
</tr>
<tr>
<td>Adonis</td>
<td>Entire herb</td>
<td>Helleborus niger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adonis vernalis</td>
</tr>
</tbody>
</table>

**Family 20. Leguminosae.**—A vast family of polypetalous herbs, shrubs and trees—the bean family—with alternate, stipulate, usually compound leaves and papilionaceous or sometimes regular flowers, with usually 10 monadelphous, diadelphous, or rarely distinct stamens, and a simple pistil becoming generally a legume in fruit. It embraces three well-marked groups, 24 tribes, 427 genera, and 7000 species.

<table>
<thead>
<tr>
<th><strong>Official drug</strong></th>
<th><strong>Part used</strong></th>
<th><strong>Botanical name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia</td>
<td>Gummy exudation</td>
<td>Acacia Senegal and other species</td>
</tr>
<tr>
<td>Tragacantha</td>
<td>Gummy exudation</td>
<td>Astragalus gummifer and other species</td>
</tr>
<tr>
<td>Balsamum Peruvianum</td>
<td>Balsam</td>
<td>Toluifera pereire</td>
</tr>
<tr>
<td>Balsamum Tolutanum</td>
<td>Balsam</td>
<td>Toluifera Balsamum</td>
</tr>
<tr>
<td>Hæmatoxylon</td>
<td>Heartwood</td>
<td>Hæmatoxylon campechianum</td>
</tr>
<tr>
<td>Santalum Rubrum</td>
<td>Heartwood</td>
<td>Pterocarpus santalinus</td>
</tr>
<tr>
<td>Glycyrrhiza</td>
<td>Rhizome and root</td>
<td>Glycyrrhiza glabra</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glycyrrhiza glandulifera</td>
</tr>
<tr>
<td>Senna</td>
<td>Leaflets</td>
<td>Cassia acutifolia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cassia angustifolia</td>
</tr>
<tr>
<td>Cassia Fistula</td>
<td>Fruit</td>
<td>Cassia fistula</td>
</tr>
<tr>
<td>Tamarindus</td>
<td>Pulp of fruit</td>
<td>Tamarindus indica</td>
</tr>
<tr>
<td>Copaiba</td>
<td>Oleoresin</td>
<td>Copaiba species</td>
</tr>
<tr>
<td>Chrysarobinus</td>
<td>Neutral principle</td>
<td>Vouacapoua araroba</td>
</tr>
<tr>
<td>Physostigma</td>
<td>Seed</td>
<td>Physostigma venenosum</td>
</tr>
<tr>
<td>Kino</td>
<td>Inspissated juice</td>
<td>Pterocarpus Marsupium</td>
</tr>
<tr>
<td>Scoparius</td>
<td>Tops</td>
<td>Cytisus Scoparius</td>
</tr>
</tbody>
</table>

**Unofficial**

<table>
<thead>
<tr>
<th><strong>Official drug</strong></th>
<th><strong>Part used</strong></th>
<th><strong>Botanical name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fænnum græcum</td>
<td>Seed</td>
<td>Trigonella fenum-græcum</td>
</tr>
<tr>
<td>Piscidia</td>
<td>Bark</td>
<td>Piscidia erythrina</td>
</tr>
<tr>
<td>Indigo</td>
<td>Coloring matter</td>
<td>Indigofera tinctoria</td>
</tr>
<tr>
<td>Trifolium</td>
<td>Flower heads</td>
<td>Trifolium pratense</td>
</tr>
<tr>
<td>Dipteryx</td>
<td>Fruit</td>
<td>Dipteryx odorata</td>
</tr>
</tbody>
</table>
FAMILY 21. CRUCIFERÆ OR MUSTARD FAMILY.—A large family of annual or perennial polypetalous herbs with pungent watery juice and cruciform corollas; stamens tetradydymous; fruit a siliqua.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Sinapis Alba | Seed | Sinapis alba
Sinapis Nigra | Seed | Brassica nigra

FAMILY 22. BURSERACEÆ.—A small family of tropical balsamiferous or resinous polypetalous trees or shrubs—the myrrh family—with alternate compound leaves and three to five parted usually perfect flowers. It includes 18 genera and 150 species.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Myrrha | Gum resin | Commiphora Myrrha
Olibanum | Gum resin | Boswellia carterii

FAMILY 23. CACTACEÆ.—A family of American polypetalous plants—the cactus family—green and fleshy, and mostly leafless, having globular or columnar, tuberculated or ribbed, or jointed and often flattened stems, usually armed with bundles of spines, and bearing large and often showy flowers with numerous sepals, petals and stamens, and the fruit a pulpy berry. It embraces 13 genera and about 1000 species.

**Unofficial drug** | **Part used** | **Botanical name**
---|---|---
Cactus | Fresh branches | Cereus grandiflorus

FAMILY 24. BERBERIDACEÆ OR BARBERRY FAMILY.—Herbs and woody plants with watery juices and alternate, or radical, simple or compound leaves often bearing spines or barbs, which give them a barbed appearance. Fruit a berry or capsule.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Berberis | Rhizome and roots | Berberis aquifolium and other species
Podophyllum | Rhizome | Podophyllum peltatum

FAMILY 25. CELASTRACEÆ.—A family of polypetalous trees or shrubs—the staff-tree or spindle-tree family—mostly tropical, having simple, coriaceous leaves, small regular flowers with imbricated sepals and petals, and four or five perigynous stamens inserted on a fleshy disc alternately with the petals; seed in a succulent aril.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Euonymus | Bark | Euonymus atropurpureus
Family 26. Canellaceae.—A small family of tropical American polypetalous, aromatic trees—the canella family—with alternate, exstipulate, entire leaves and axillary, cymose, perfect flowers. It embraces two genera, *Canella* and *Cinnamodendron*, and about four species.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canellae cortex</td>
<td>Bark</td>
<td>Canella alba</td>
</tr>
</tbody>
</table>

Family 27. Cornaceae.—A family of polypetalous shrubs or trees—the dogwood or comel family—of all parts of the world, with usually alternate coriaceous entire leaves, and terminal or axillary cymose clusters of small flowers. It embraces 15 genera and 80 species.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornus</td>
<td>Bark</td>
<td>Cornus florida</td>
</tr>
</tbody>
</table>

Family 28. Thymeleaceae.—A family of trees or shrubs, the spurge laurel or mezereum family, having very tough bark, opposite entire leaves and small, perfect, regular flowers.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mezereum</td>
<td>Bark</td>
<td>Daphne Mezereum</td>
</tr>
</tbody>
</table>

Family 29. Geraniaceae.—A family of polypetalous herbs, shrubs or trees—the geranium family—usually with lobed or dissected leaves and axillary peduncles of often showy, perfect flowers. It embraces seven tribes, 25 genera, and about 980 species, widely scattered in temperate and sub-tropical regions.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geranium</td>
<td>Rhizome</td>
<td>Geranium maculatum</td>
</tr>
</tbody>
</table>

Family 30. Hamamelidaceae.—A family of polypetalous shrubs or trees—the witch-hazel family—with alternate simple leaves, two deciduous stipules, and heads or spikes of monocious or polygamous flowers. It includes 19 genera and about 40 species.

The leaves and twigs contain highly aromatic volatile oils.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamamelidis folia</td>
<td>Leaves</td>
<td>Hamamelis virginiana</td>
</tr>
<tr>
<td>Hamamelidis cortex</td>
<td>Bark and twigs</td>
<td>Hamamelis virginiana</td>
</tr>
<tr>
<td>Styrax</td>
<td>Balsam</td>
<td>Liquidambar orientalis</td>
</tr>
</tbody>
</table>

Family 31. Linaceae.—A family of polypetalous herbs, shrubs, or rarely trees—the flax family—with alternate simple and usually entire
leaves, and regular, symmetrical, hypogynous flowers which are four- to five-membered throughout, the petals blue, yellow, or white, and fugacious. It embraces 15 genera and about 235 species, distributed over the world.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Linum | Seed | Linum usitatissimum

**Family 32. Guttiferae.**—A family of polypetalous trees or shrubs—the gamboge family—with resinous juice, opposite, coriaceous leaves, and terminal or axillary clusters of regular dicocious flowers. It embraces 26 genera and about 370 species, all natives of the tropics.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Cambogia | Gum resin | Garcinia hanburii

**Family 33. Malvaceae or Mallow Family.**—A family of chlori- petalous herbs, shrubs, or trees abounding in mucilage and usually with the above-ground portion covered with trichomes; the leaves are alternate and palmately nerve d; the flowers regular, the corolla beautifully colored, funnel or bell-shaped, stamens monadelphous; fruit a several-celled pod.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Althea | Root (peeled) | Althaea officinalis
Gossypii Cortex | Bark of root | Gossypium herbaceum
Gossypium Purificatum | Hairs of seed | Gossypium herbaceum
Oleum Gossypii seminis | Oil of seed | Gossypium herbaceum

**Family 34. Papaveraceae.**—A family of polypetalous plants—the poppy family—usually with milky or colored juice, alternate e-stipulate leaves, and long one-flowered peduncles, the flowers usually with two caducous sepals and four cruciate petals. It embraces about 20 genera and 80 species.

Herbs or low shrubs with milky or colored, narcotic juices. Flowers showy. Fruit usually a many-sided capsule. Temperate and tropical regions.

**Official drug** | **Part used** | **Botanical name**
---|---|---
Opium | Concrete milky exudate | Papaver somniferum
Sanguinaria | Rhizome | Sanguinaria canadensis

**Family 35. Passifloraceae.**—A family of polypetalous shrubs, trees, or rarely herbs—the passion-flower family—often climbing, with alternate, palmately lobed or compound leaves and solitary or racemose,
often handsome, flowers with five monadelphous stamens. It embraces
five tribes, 27 genera, and 235 species, all tropical or sub-tropical.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papain</td>
<td>Ferment</td>
<td>Carica papaya</td>
</tr>
<tr>
<td>Passiflora</td>
<td>Rhizome</td>
<td>Passiflora incarnata</td>
</tr>
</tbody>
</table>

**Family 36. Menispermaceæ, or Moonseed Family.**—Chlori-
petalous woody, climbing tropical plants with alternate simple leaves;
flowers green to white; fruit a one-seeded succulent drupe. They
usually contain tonic, narcotic or poisonous bitter principles.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calumba</td>
<td>Root</td>
<td>Jateorhiza palmata</td>
</tr>
<tr>
<td>Pareira</td>
<td>Root</td>
<td>Chondodendron tomentosum</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cocculus</td>
<td>Fruit</td>
<td>Anamirta paniculata</td>
</tr>
<tr>
<td>Menispermum</td>
<td>Rhizome and roots</td>
<td>Menispermum canadense</td>
</tr>
</tbody>
</table>

**Family 37. Myrtaceæ or Myrtle Family.**—Evergreen trees or
shrubs of warmer climates, with opposite, entire exstipulate leaves of an
elliptical shape and having a vein running close to the margin. All the
organs provided with roundish glands containing hydrocarbon prin-
ciples, giving them an aromatic odor. Flowers with imbricate calyx
lobes, numerous stamens and an inferior ovary.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus</td>
<td>Leaves</td>
<td>Eucalyptus globulus</td>
</tr>
<tr>
<td>Eucalyptol</td>
<td>Organic oxide</td>
<td>Eucalyptus globulus</td>
</tr>
<tr>
<td>Caryophyllus</td>
<td>Flower bud</td>
<td>Eugenia aromatica</td>
</tr>
<tr>
<td>Eugenol</td>
<td>Aromatic phenol</td>
<td>Eugenia aromatica</td>
</tr>
<tr>
<td>Pimenta</td>
<td>Fruit</td>
<td>Pimenta officinalis</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrcia</td>
<td>Volatile oil and leaves</td>
<td>Myrcia acris</td>
</tr>
</tbody>
</table>

**Family 38. Polygalaceæ.**—A family of polypetalous herbs,
shrubs, or rarely small trees—the milkwort family—having alternate
simple entire leaves and irregular hypogynous flowers with four to eight
diadelphous or monadelphous stamens.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senega</td>
<td>Root</td>
<td>Polygala Senega</td>
</tr>
</tbody>
</table>

**Family 39. Rutaceæ or Rue Family.**—A family of pellucid,
punctate, polypetalous woody plants, rarely herbs having exstipulate
opposite, simple or compound leaves and variously shaped inflorescences
of perfect, five-parted flowers; fruit a capsule or berry. The plants contain ethereal oils in their intracellular cavities.

Official drug | Part used | Botanical name
---|---|---
Aurantii Dulcis Cortex | Outer rind of ripe fruit | Citrus Aurantium
Aurantii Amari Cortex | Kind of unripe fruit | Citrus vulgaris
Limonis Cortex | Outer rind of ripe fruit | Citrus Limonum
Limonis Succus | Fresh juice of ripe fruit | Citrus Limonum
Pilocarpus | Leaflets | } Pilocarpus Jaborandi
| | | Pilocarpus microphyllus
Buchu (short) | Leaves | Barosma betulina
Xanthoxylum | Bark | } Xanthoxylum americanum
| | | Fagara Clava-Herculis

Family 40. **Rhamnaceae** or Buckthorn Family.—Chloripetalous shrubs or small trees of warm temperate regions with spiny stems, simple leaves, small regular flowers, and fleshy winged drupaceous fruit.

Official drug | Part used | Botanical name
---|---|---
Rhamnus Purshiana | Bark | Rhamnus Purshiana
Frangula | Bark | Rhamnus Frangula

Unofficial
Rhamnus Cathartica | Fruit | Rhamnus cathartica

Family 41. **Turneraceae**.—An order of polypetalous herbs or shrubs—the turnerad family—mainly American, having alternate simple or pinnalified leaves, and axillary solitary or few-clustered perfect flowers with five stamens. There are six genera and 85 species. *Turnera*, the type genus, furnishes a number of ornamental greenhouse plants and the drug damiana.

Unofficial | Part used | Botanical name
---|---|---
Damiana | Leaves | Turnera diffusa variety aphrodisiaca

Family 42. **Simarubaceae**.—A family of very bitter polypetalous trees or shrubs—the quassia family—having alternate pinnate leaves and small dioecious flowers in axillary panicles or racemes. It embraces 33 genera and 110 species, all natives of warm countries.

Official drug | Part used | Botanical name
---|---|---
Quassia | Wood | Picrasma excelsa
| | Quassia amara

Family 43. **Zygophyllaceae**.—A family of polypetalous shrubs or herbs—the bean-caper family—having jointed branches, two-foliolate or pinnate stipulate leaves, and axillary peduncles bearing white, red,
or yellow flowers. It embraces 18 genera and 110 species, mainly tropical in distribution.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guiacum</td>
<td>Resin</td>
<td>{ Guiacum officinale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guiacum sanctum</td>
</tr>
</tbody>
</table>

**Family 44. Ternstroemiaceae.**—A family of polypetalous trees or shrubs—the tea or camellia family—having alternate simple leaves, and often large, showy, mostly five-parted flowers with numerous stamens. It embraces 41 genera and 310 species, nearly all natives of the tropics.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caffeina</td>
<td>Feebly basic principle</td>
<td>Thea chinensis</td>
</tr>
</tbody>
</table>

**Family 45. Sapindaceae.**—A family of polypetalous trees or shrubs—the soapberry family—having alternate, often evergreen, compound leaves, and small unsymmetrical odorless flowers with eight stamens. It embraces 122 genera, and 950 species, mainly tropical.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarana</td>
<td>Paste of crushed seeds</td>
<td>Paullinia Cupana</td>
</tr>
</tbody>
</table>

**Family 46. Sterculiaceae.**—A family of polypetalous shrubs, or trees—the cola-nut or sterculia family—having usually opposite, single, or three- to nine-foliate leaves and a variously shaped inflorescence of regular perfect flowers with frequently monadelphous stamens having two-celled anthers.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum theobromatis</td>
<td>Fixed oil</td>
<td>Theobroma Cacao</td>
</tr>
</tbody>
</table>

**Unofficial**

| Cola                    | Seed                    | Cola acuminata     |

**Family 47. Umbelliferae or Parsley Family.**—A family of polypetalous herbs or shrubs characterized as follows:

Inflorescence, an umbel (simple or compound) of small flowers, each, with five petals and five stamens and ovary two-celled, inferior, calyx adnate to ovary.

Fruit, a cremocarp, consisting of two seed-like dry carpels or mericarps which often separate when fruit is ripe. Entire plants possess aromatic volatile oils.
RUBIACEÆ

Official drug  Part used  Botanical name
Anisum  Ripe fruit  Pimpinella Anisum
Foeniculum  Nearly ripe fruit  Foeniculum vulgare
Sumbul  Rhizome and roots  Undetermined
Carum  Fruit  Carum Carvi
Conium  Unripe fruit  Conium maculatum
Asafoetida  Gum resin  Ferula foetida
Coriandrum  Ripe fruit  Coriandrum sativum

Unofficial  
Angelica  Root  Angelica archangelica
Apium  Root  Apium petroselinum
Celery (fruit)  Fruit  Apium graveolens
Ammoniacum  Gum resin  Dorema Ammoniacum

Family 48. Erythroxylaceæ.—Chloripetalous shrubs or trees with small zygomorphic flowers exhibiting a five-lobed calyx, five petals, 10 hypogynous stamens and a superior ovary; fruit a drupe. Indigenous to torrid and temperate zones.

Official drug  Part used  Botanical name
Coca  Leaves  / Erythroxylon Coca
        \ Erythroxylon Truxillense

Family 49. Vitaceæ or Grape Family.—Chloripetalous shrubs with abundant watery sap, whose stems climb by means of tendrils opposite the leaves; flowers hypogynous; fruit a berry.

Official drug  Part used  Botanical name
Vinum Album  Fermented juice of fruit  Vitis vinifera
Vinum Rubrum  Fermented juice of fruit in presence of their skins.  Vitis vinifera

Family 50. Puniceæ, or Pomegranate Family.—Chloripetalous trees of small size with opposite ovate-lanceolate, entire leaves, scarlet receptacle, calyx and corolla; fruit an edible berry with hard rind.

Official drug  Part used  Botanical name
Granatum  Bark of stem and root  Punica Granatum

Sub-class b. Sympetalæ Gamopetalæ

A division of dicotyledonous plants in which the flowers possess both calyx and corolla, the latter with petals more or less united into one piece.

Family 1. Rubiaceæ.—A large family of gamopetalous trees, shrubs, or herbs—the Madder family—with simple opposite or whorled
leaves, connected by interposed stipules, and perfect, often dimorphous, flowers. It embraces 25 tribes, 375 genera, and 4500 species in all parts of the world.

Usually contain valuable alkaloids.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinchona</td>
<td>Bark</td>
<td>Cinchona officinalis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cinchona Calisaya</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cinchona Ledgeriana, and hybrids</td>
</tr>
<tr>
<td>Cinchona Rubra</td>
<td>Bark</td>
<td>Cinchona succirubra</td>
</tr>
<tr>
<td>Ipecacuanha</td>
<td>Root</td>
<td>Cephalis Ipecacuanha</td>
</tr>
<tr>
<td>Gambir</td>
<td>Extract</td>
<td>Cephalis acuminata</td>
</tr>
<tr>
<td>Caffeina</td>
<td>Feebly basic substance</td>
<td>Ourouparia Gambir</td>
</tr>
</tbody>
</table>

**Family 2. Convolvulaceae.**—A large widely dispersed family of gamopetalous, chiefly climbing herbs, rarely shrubs or trees—the convolvulus or bindweed family—with alternate leaves, and showy pentamerous axillary flowers. It embraces about 36 genera and 870 species. Contains milky juices.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jalapa</td>
<td>Tuberous root</td>
<td>Exogonium Purga</td>
</tr>
<tr>
<td>Scammonium</td>
<td>Gum resin</td>
<td>Convolvulus Scammonia</td>
</tr>
</tbody>
</table>

**Family 3. Valerianaceae.**—A family of gamopetalous herbs—the valerian family—having opposite exstipulate leaves and cymes of small often irregular flowers with stamens fewer than the corolla lobe, and inserted on its tube. There are nine genera and 275 species. *Valeriana*, the type genus, distinguished by its triandrous flowers, includes the common or official valerian.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valeriana</td>
<td>Rhizome and roots</td>
<td>Valeriana officinalis</td>
</tr>
</tbody>
</table>

**Family 4. Sapotaceae.**—A family of gamopetalous plants—the star-apple or the sapodilla family—being mainly trees or shrubs with milky juice, alternate leathery leaves, and large flowers with perfect stamens. It embraces 38 genera, and 400 species, all natives of the warmer countries.

An important resin-producing family.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gutta-percha</td>
<td>Concrete exudation</td>
<td>Palaquium gutta</td>
</tr>
</tbody>
</table>
Family 5. **Gentianaceæ.**—A family of smooth annual or perennial gamopetalous herbs—the gentian family—with colorless bitter juice, opposite simple leaves, and showy, perfect, regular flowers. It is widely distributed over the world, especially in temperate regions, and embraces 49 genera, and about 575 species.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gentiana</td>
<td>Rhizome and roots</td>
<td>Gentiana lutea</td>
</tr>
<tr>
<td>Chirata</td>
<td>Entire plant</td>
<td>Swertia chirayita</td>
</tr>
</tbody>
</table>

Family 6. **Loganiaceæ, the Logania Family.**—Tropical herbs, shrubs, or trees containing bitter principles, often poisonous. Allied to the milkweed and gentian families. Leaves entire, stipulate, opposite, inflorescence cymose, flowers, regular and four- to five-parted, fruit a two-celled berry or capsule.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gelsemium</td>
<td>Rhizome and roots</td>
<td>Gelsemium sempervirens</td>
</tr>
<tr>
<td>Spigelia</td>
<td>Rhizome and roots</td>
<td>Spigelia marilandica</td>
</tr>
<tr>
<td>Nux vomica</td>
<td>Seed</td>
<td>Strychnos nux vomica</td>
</tr>
</tbody>
</table>

Unofficial

<table>
<thead>
<tr>
<th></th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuara</td>
<td>Extract</td>
<td>Strychnos toxifera</td>
</tr>
<tr>
<td>Ignatia</td>
<td>Seed</td>
<td>Strychnos Ignatii</td>
</tr>
</tbody>
</table>

Family 7. **Apocynaceæ.**—A family of gamopetalous herbaceous or woody plants—the dogbane family—mainly tropical or sub-tropical, with milky, mostly acrid juice, simple, entire, exstipulate leaves, and regular, five-parted flowers. It embraces 103 genera and 900 species.

Fruit, a pod containing many seeds which are often downy.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apocynum</td>
<td>Rhizome</td>
<td>Apocynum cannabinum and other species</td>
</tr>
<tr>
<td>Strophanthus</td>
<td>Seed</td>
<td>Strophanthus hispidus</td>
</tr>
</tbody>
</table>

Family 8. **Asclepiadaceæ.**—A large family of gamopetalous perennial herbs or shrubs—the milkweed family—erect or twining, having milky juice, leaves mostly opposite, five-parted umbellate flowers, stamens with the pollen cohering in waxy masses, and a fruit of two follicles. It embraces about 1300 species.

<table>
<thead>
<tr>
<th>Unofficial drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asclepias</td>
<td>Root</td>
<td>Asclepias tuberosa</td>
</tr>
<tr>
<td>Condurango</td>
<td>Bark</td>
<td>Gonolobus condurango</td>
</tr>
</tbody>
</table>

Family 9. **Caprifoliaceæ.**—A family of gamopetalous herbs shrubs, or rarely small trees—the honeysuckle family—mostly of the
northern hemisphere, having opposite lobed or odd-pinnate leaves, the inflorescence usually cymose with perfect regular or irregular flowers, and a baccate or drupaceous fruit. It includes 13 genera and about 200 species, the honeysuckle, viburnum, elder, etc.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viburnum Opulus</td>
<td>Bark</td>
<td>Viburnum opulus</td>
</tr>
<tr>
<td>Viburnum Prunifolium</td>
<td>Bark</td>
<td>Viburnum prunifolium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Viburnum lentago</td>
</tr>
<tr>
<td><strong>Unofficial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sambucus</td>
<td>Flowers</td>
<td>Sambucus canadensis</td>
</tr>
</tbody>
</table>

**Family 10. Solanaceae.**—A family of gamopetalous, frequently narcotic, poisonous plants—the nightshade family—having colorless juice, alternate simple leaves, regular pentameres and pentandrous flowers and many seeds. It embraces 72 genera, and 1750 species, found in all warm countries, particularly America. *Solanum*, the type genus, includes *S. tuberosum*, the cultivated potato; *S. Melongena*, the egg-plant; *S. nigrum*, the black nightshade; *S. Dulcamara*, the bittersweet; *S. Carolinense*, the Horse Nettle.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belladonnae Folia</td>
<td>Leaves</td>
<td>Atropa Belladonna</td>
</tr>
<tr>
<td>Belladonnae Radix</td>
<td>Root</td>
<td>Atropa Belladonna</td>
</tr>
<tr>
<td>Stramonium</td>
<td>Leaves</td>
<td>Datura Stramonium</td>
</tr>
<tr>
<td>Hyoscyamus</td>
<td>Leaves and flower</td>
<td>Hyoscyamus niger</td>
</tr>
<tr>
<td>Scopola</td>
<td>Rhizome</td>
<td>Scopola Carniolica</td>
</tr>
<tr>
<td>Capsicum</td>
<td>Fruit</td>
<td>Capsicum fastigiatum</td>
</tr>
<tr>
<td><strong>Unofficial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dulcamara</td>
<td>Twigs</td>
<td>Solanum dulcamara</td>
</tr>
<tr>
<td>Duboisia</td>
<td>Leaves</td>
<td>Duboisia myoporoides</td>
</tr>
<tr>
<td>Tabacum</td>
<td>Leaves</td>
<td>Nicotiana tabacum</td>
</tr>
</tbody>
</table>

**Family 11. Campanulaceae.**—A family of gamopetalous herbs—the bellwort family—of northern temperate regions, with alternate simple leaves and regular blue or white bell-shaped five-parted flowers, embracing 53 genera (including the Lobeliaceae) and a thousand species.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobelia</td>
<td>Leaves and flowering tops</td>
<td>Lobelia inflata</td>
</tr>
</tbody>
</table>

**Family 12. Ericaceae.**—A family of gamopetalous trees, shrubs, or perennial herbs—the heath family—with commonly alternate, undivided, often evergreen leaves, variously shaped clusters of symmet-
rical tetramerous or pentamerous flowers, and capsular, baccate or drupaceous fruit. They are natives of temperate or cold climates.

Leaves have a bitter astringent taste due to glucosides. Blossoms bell-shaped or wen-shaped.

**FAMILY 13. OLEACEÆ.**—A family of gamopetalous erect or climbing shrubs, trees, or rarely herbs—the olive family—with opposite, simple or pinnate leaves and perfect or unisexual flowers with four-lobed calyx, four-cleft corolla, and two or rarely four free stamens. It embraces 19 genera, and about 300 species, distributed over the warm or temperate regions of the world.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chimaphila</td>
<td>Leaves</td>
<td>Chimaphila umbellata</td>
</tr>
<tr>
<td>Uva Ursi</td>
<td>Leaves</td>
<td>Arctostaphylos Uva Ursi</td>
</tr>
<tr>
<td>Oleum Gaultheriae</td>
<td>Volatile oil</td>
<td>Gaultheria procumbens</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleum Olivæ</td>
<td>Fixed oil</td>
<td>Olea europaea</td>
</tr>
<tr>
<td>Manna</td>
<td>Saccharine exudate</td>
<td>Fraxinus ornus</td>
</tr>
</tbody>
</table>

**FAMILY 14. SCROPHULARIACEÆ.**—A family of gamopetalous plants—the figwort family—chiefly herbs with various forms of leaves and inflorescence, the flowers distinguished by having a persistent five-lobed calyx and a two-lipped corolla with four didynamous stamens, and often one staminode inserted on its tube, and the fruit a two-celled, usually many-seeded capsule with axile placentæ. It embraces 166 genera, and more than 2000 species. Contains bitter, acrid, poisonous principles.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digitalis¹</td>
<td>Leaves</td>
<td>Digitalis purpurea</td>
</tr>
<tr>
<td>Leptandra</td>
<td>Rhizome and roots</td>
<td>Veronica virginica</td>
</tr>
<tr>
<td>Unofficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbascum</td>
<td>Leaves</td>
<td>Verbascum thapsus</td>
</tr>
</tbody>
</table>

**FAMILY 15. LABIATÆ OR MINT FAMILY.**—A cosmopolitan family of sympetalous herbs, rarely shrubs, with quadrangular stems, opposite or whorled aromatic leaves, and usually thyrsoid or verticillate clusters of flowers, each with a two-lipped corolla, didynamous or diandrous stamens, and a four-lobed ovary. All of the members of this family are rich in volatile oils.
### Official drug  
<table>
<thead>
<tr>
<th>Plant</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salvia</td>
<td>Leaves</td>
<td>Salvia officinalis</td>
</tr>
<tr>
<td>Scutellaria</td>
<td>Dried plant</td>
<td>Scutellaria lateriflora</td>
</tr>
<tr>
<td>Marrubium</td>
<td>Leaves and flowering tops</td>
<td>Marrubium vulgare</td>
</tr>
<tr>
<td>Hedeoma</td>
<td>Leaves and flowering tops</td>
<td>Hedeoma pulegioides</td>
</tr>
<tr>
<td>Mentha Viridis</td>
<td>Leaves and flowering tops</td>
<td>Mentha spicata</td>
</tr>
<tr>
<td>Mentha Piperita</td>
<td>Leaves and flowering tops</td>
<td>Mentha piperita</td>
</tr>
<tr>
<td>Oleum Thymi</td>
<td>Volatile oil from leaves and flowering tops</td>
<td>Thymus vulgaris</td>
</tr>
<tr>
<td>Oleum Rosmarini</td>
<td>Volatile oil from fresh flowering tops</td>
<td>Rosmarinus officinalis</td>
</tr>
<tr>
<td>Oleum Lavendulae Florum</td>
<td>Volatile oil from fresh flowering tops</td>
<td>Lavandula officinalis</td>
</tr>
</tbody>
</table>

### Unofficial
<table>
<thead>
<tr>
<th>Plant</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melissa</td>
<td>Leaves and tops</td>
<td>Melissa officinalis</td>
</tr>
<tr>
<td>Origanum</td>
<td>Herb</td>
<td>Origanum majorana</td>
</tr>
</tbody>
</table>

**Family 16. Styraceae.**—A family of gamopetalous trees or shrubs—the storax family—having alternate simple leaves and usually white racemed flowers with a corolla of four to eight more or less united petals. It embraces seven genera and 235 species, natives of all parts of the world.

### Official drug  
<table>
<thead>
<tr>
<th>Plant</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzoinum</td>
<td>Balsamic resin</td>
<td>Styrax Benzoin</td>
</tr>
</tbody>
</table>

**Family 17. Composite.**—The largest family of plants embracing 835 genera, and over 10,000 species. A family of gamopetalous herbs, shrubs and rarely trees found in all parts of the world, having their flowers in a head or capitulum on a common receptacle, surmounted by an involucre, with five (rarely four) stamens inserted on the carolla, their anthers, syngenesious. Calyx tube crowned by a pappus in the form of bristles, teeth or scales, etc. Corolla either ligulate or tubular. In the perfect flowers a two-cleft style is present. Fruit, an akene. The plants of this family contain inulin, a substance isomeric with starch.

### Official drug  
<table>
<thead>
<tr>
<th>Plant</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthemis</td>
<td>Flower head</td>
<td>Anthemis nobilis</td>
</tr>
<tr>
<td>Arnica</td>
<td>Flower head</td>
<td>Arnica montana</td>
</tr>
<tr>
<td>Matricaria</td>
<td>Flower head</td>
<td>Matricaria Chamomilla</td>
</tr>
<tr>
<td>Calendula</td>
<td>Ligulate florets</td>
<td>Calendula officinalis</td>
</tr>
<tr>
<td>Lappa</td>
<td>Root</td>
<td>Arctium lappa</td>
</tr>
<tr>
<td>Pyrethrum</td>
<td>Root</td>
<td>Anacyclus Pyrethrum</td>
</tr>
<tr>
<td>Taraxacum</td>
<td>Root</td>
<td>Taraxacum officinale</td>
</tr>
</tbody>
</table>
Eupatorium
Grindelia
Lactuca
Santonica
Oleum Erigerontis

**Unofficial**
Pyrethri Flores
Carthamus
Cichorium
Inula
Absinthium
Achillea
Tanacetum

Leaves and flowering tops
Leaves and flowering tops
Concrete milk juice
Unexpanded flower heads
Volatile oil

FLOWER HEADS:
Eupatorium perfoliatum
Grindelia robusta
Grindelia squarrosa
Lactuca virosa
Artemisia pauciflora
Erigeron canadense
Chrysanthemum roseum
Chrysanthemum carneum
Carthamus tinctorius
Cichorium intybus
Inula Helenium
Artemisia Absinthium
Achillea millefolium
Tanacetum vulgare

**Family 18. Hydrophyllaceæ.**—Herbaceous, shrubby, or arborescent plants containing a watery, insipid juice and further characterized by having hairy and toothed pinnately compound leaves; scorpoid inflorescences, and two-valved fruits.

**Official drug**
Eriodictyon

**Part used**
Leaves

**Botanical name**
Eriodictyon californicum

**Family 19. Cucurbitaceæ.**—A natural family of usually succulent tendril-bearing dicotyledonous herbs—the gourd family—with climbing or prostate stems, simple pinnately veined alternate leaves, monoeocious or dioecious, rarely gamopetalous flowers, and a large, fleshy, usually three-celled fruit. It embraces 86 genera and about 630 species, mostly found in the tropics.

**Official drug**
Pepo
Colocynthis
Elaterinum

**Part used**
Seed
Peeled dried fruit
Neutral principle

**Botanical name**
Cucurbita Pepo
Citrus Colocynthis
Ecballium Elaterium

**SUBDIVISION II.—THE GYMNOSPERMS**

The Gymnosperms comprise an ancient and historic group of plants which were more numerous in the Paleozoic and Carboniferous periods than now. They differ from the Angiosperms mainly in their seeds being exposed. Most of their number are evergreens, retaining their leaves throughout the year, important exceptions being the Larches which drop their foliage upon the advent of winter.

The groups still extant are the Cycads or Fern Palms, the Gnetums, the Ginkgos, and the Conifers. Of these the Conifers are of most
pharmaceutic importance. This, the largest group of Gymnosperms, includes the pines, firs, spruces, hemlocks, junipers, balsams, cedars, and arbor vitae. The following Gymnospermous plants yield products of pharmaceutic and medicinal value:

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinus strobus</td>
<td>White pine bark</td>
</tr>
<tr>
<td>Pinus palustris</td>
<td>Turpentine, rosin and tar</td>
</tr>
<tr>
<td>Pinus glabra</td>
<td></td>
</tr>
<tr>
<td>Pinus echinata</td>
<td></td>
</tr>
<tr>
<td>Pinus taeda and other species of Pinus</td>
<td></td>
</tr>
<tr>
<td>Abies balsamea</td>
<td>Balsam of fir</td>
</tr>
<tr>
<td>Larix decidua</td>
<td>Venice turpentine</td>
</tr>
<tr>
<td>Picea excelsa (Abies excelsa)</td>
<td>Burgundy pitch</td>
</tr>
<tr>
<td>Tsuga occidentalis</td>
<td>Volatile oil</td>
</tr>
<tr>
<td>Juniperus Oxycedrus</td>
<td>Oil of cade</td>
</tr>
<tr>
<td>Juniperus communis</td>
<td>Juniper berries and volatile oil</td>
</tr>
<tr>
<td>Juniperus Sabina</td>
<td>Tops and volatile oil of savin</td>
</tr>
<tr>
<td>Callitris quadrivalvis</td>
<td>Sandarac</td>
</tr>
<tr>
<td>Pinus sylvestris</td>
<td>Volatile oil</td>
</tr>
</tbody>
</table>

Fig. 38.—Inflorescences of the pine. 1. Terminal twig; 2. ovulate cone; 3. staminate cone; 4. two-year-old cone. (From Hamaker.)
**PINACEÆ**

**Family i. PINACEÆ.—** Old name Coniferae. The pine family. (Cone-bearing family.) Trees or shrubs, with resinous juice, mostly awl-shaped or needle-shaped leaves, and monoecious or rarely dioecious flowers in catkins, destitute of calyx or carolla. Three sub-families, Abietineæ, or proper pine family; Cupressineæ, or cypress family; and Taxineæ, or yew family. All are evergreen excepting the Larches.

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terebinthina</td>
<td>Concrete oleoresin</td>
<td>Pinus palustris and</td>
</tr>
<tr>
<td>Resina</td>
<td>Resin</td>
<td>other species</td>
</tr>
<tr>
<td>Pix Liquida</td>
<td>Destructive distillate product</td>
<td>Other species</td>
</tr>
<tr>
<td>Terebinthina Canadensis</td>
<td>Liquid oleoresin</td>
<td>Abies balsamea</td>
</tr>
<tr>
<td>Sabina</td>
<td>Tops</td>
<td>Juniperus Sabina</td>
</tr>
<tr>
<td>Oleum Cadinum</td>
<td>Oily product</td>
<td>Juniperus Oxycedrus</td>
</tr>
<tr>
<td>Oleum Juniperi</td>
<td>Volatile oil</td>
<td>Juniperus communis</td>
</tr>
</tbody>
</table>

**Unofficial**

<table>
<thead>
<tr>
<th>Official drug</th>
<th>Part used</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pix Burgundica</td>
<td>Resinous exudate</td>
<td>Abies excelsa</td>
</tr>
<tr>
<td>Sandaraca</td>
<td>Resinous exudate</td>
<td>Callitris quadralvis</td>
</tr>
<tr>
<td>Dammar</td>
<td>Resinous exudate</td>
<td>Agathis loranthifolia</td>
</tr>
<tr>
<td>Pix Canadensis</td>
<td>Resinous exudate</td>
<td>Tsuga canadensis</td>
</tr>
<tr>
<td>Succinum (amber)</td>
<td>Fossil resin</td>
<td>Pinites succinifer</td>
</tr>
<tr>
<td>Terebinthina Veneta</td>
<td>Oleoresin</td>
<td>Larix succinifer</td>
</tr>
<tr>
<td>Juniperus</td>
<td>Fruit</td>
<td>Juniperus communis</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY

Le Maout and Decaisne’s “Descriptive and Analytical Botany.”
Bastin’s “College Botany.”
Macfarlane’s “Lectures on the Comparative Morphology and Taxonomy of the Angiospermia”.
Kramer’s “Botany and Pharmacognosy.”
Steven’s “Plant Anatomy.”
Hamaker’s “Outlines of Biology.”
“Elements of Botany and Pharmacognosy,” by Mary L. Creighton.
Warming’s “Systematic Botany,” translated by Potter.
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