

wrong	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
right	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	
score	100	98.8	97.6	96.4	95.2	94.0	92.8	91.6	90.4	89.2	88.0	86.7	85.5	84.3	83.1	81.9	80.7	79.5	

Flower Morphology

Name _____

You are already familiar with a number of aspects of the vegetative structure of angiosperms from your previous laboratory work. Now you will concentrate on flower structure, since these are the parts of the plant that are most closely associated with sexual reproduction, and are widely used in the classification of the angiosperms. Over 250,000 species of angiosperms are recognized, and they include the principal plants covering the land surface and provide the great majority of the plants used for a variety of economic purposes.

Flower Structure

Although in gross appearance, the flowers of the angiosperms show a tremendous diversity, the parts which make up the flower are basically the same throughout. The most widely accepted interpretation of the nature of the flower is that it is a specialized branch; a stem with leaves. The flower has many parts.

The plant stem below the flower is called the **pedicel**. At the very tip of this is the **receptacle**. The receptacle is the stem portion of the flower. It is found at the base in the center of the flower. Its internodes are short and the number of leaves is usually small, so the receptacle is not usually a large or obvious part of the flower.

Sepals make up the lower (or outermost) whorl of floral leaves. They are frequently, but not always, green and rather leaf-like in appearance, although they usually are smaller than the foliage leaves of the plant. Collectively, all sepals of a flower constitute the **calyx**. The major function appears to be protection of the flower parts from herbivores during early development.

Petals are attached above (inside) the sepals on the receptacle. They are usually larger than the sepals, brightly colored, and rather leaf-like in that they are broad and rather thin organs. Collectively they constitute the **corolla**. They serve as additional protection against herbivores in the bud stage, and also attract insects and/or facilitate the pollination of the flower when the insect reaches it. The two leaflike appendages, the sepals and petals (calyx and corolla), together make up the **perianth** of a **complete** flower. They may be similar in appearance to one another, or one or the other or both may be missing from an **incomplete** flower.

Stamens, which are found above (inside) the corolla, are rarely leaflike in appearance. Each usually is composed of two distinct parts: an elongated narrow **filament** rising from the receptacle and a terminal enlarged **anther** which contains many **pollen grains**. All stamens of the flower, taken together, make up the **androecium**.

One or more **carpels**, are located in the center (top) of the flower. Collectively they constitute the **gynoecium**. Each carpel has three parts. Starting at the base these are: the **ovary**, an enlarged hollow region bearing one or more **ovules**; a narrower, short to long **style**; and a terminal **stigma** of various sizes and shapes. If more than one carpel occurs in a flower, all may be separate from one another, but more frequently they are joined to one another to form a compound structure. The term **pistil** is often used in conjunction with the gynoecium of a flower; this may or may not be synonymous with carpel. If carpels are not fused to one another in a flower, then each carpel can be called a pistil and the flower has one or more **simple** pistils. If, however, more than one carpel occurs in the flower and these are all joined to one another, the flower has a single **compound** pistil. The cavity in the ovary portion of carpel or pistil is called the **locule**. There is one locule in a simple pistil and one or more in a compound pistil. The portion of the ovary to which the ovule is attached is the **placenta**. The number of ovules varies from one to several hundred per locule, depending upon the species.

Carpels are not the only flower parts that may be joined to one another. Members of each whorl in the flower may be fused to other members of the same whorl. There may also be fusion between whorls; for example, the stamens of many flowers appear to diverge from the surface of the

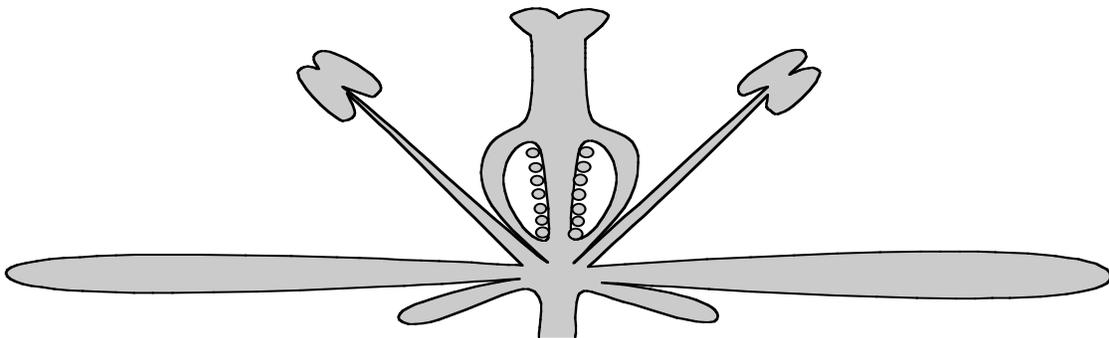
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Koning, Ross. E. 1994. Flower Morphology. *Plant Physiology Information Website*.
http://plantphys.info/plants_human/labpdf/flowermorph.pdf

corolla. In an extreme case, the perianth and stamens are fused to the ovary wall and become free from it only at the top of the ovary. In flowers where the floral whorls diverge below the gynoecium, the ovary is said to be **superior** and the flower **hypogynous**. In contrast, when the free floral whorls arise from the top of the ovary, the ovary is called **inferior** and the flower **epigynous**. An intermediate condition can be found in which the several floral whorls are attached around the middle of the ovary; such a flower is called **perigynous**.

Flowers are **perfect**, if both stamens and carpels are present but **imperfect** if one or the other is lacking. In the latter case, both staminate and carpellate flowers may occur on the same plant (**monoecious**) or may be on separate plants (**dioecious**). Flowers may be regular, exhibiting **radial** symmetry, or be irregular and show **bilateral** symmetry. Note, that in a longitudinal section such as the one below, it is not possible to be sure of the symmetry!

Use as many of the terms in **bold** type in the description above as possible to label the longitudinal section below (there should be at least 24 labels!):



Dissecting *Alstroemeria* or *Gladiolus* Flowers

Examine one of the flowers provided; draw and label the flower below to show all parts and their relation to one another. Then answer the following questions about your flower:

What is the symmetry of your flower? radial bilateral

Are both calyx and corolla present? yes no

The sepals are: free fused The petals are: free fused

How many sepals are there? _____ Petals? _____ Stamens? _____ Pistils? _____

Where are the stamens in relation to the sepals and petals? _____

If one, the pistil is simple compound

If compound, of how many carpels is it composed? _____

How did you determine this? _____

The ovary is: superior inferior

The flower is: hypogynous perigynous epigynous

How many ovules are there? one less than 20 many

Where is/are the placenta(e) to which they are attached? axile radial parietal

Give the complete flower formula for your flower (8 pts): _____

Diagram and label your flower in the space provided below. Use as many structure name labels as possible based upon the description on pages 1 and 2 (16 labels required).

Sex and Development in the Flower

THE POLLEN GRAIN. Look carefully at the stamen of the flower.

How many anther sacs do you find? _____

In most species there are four, one in each corner of the anther, but at maturity the two in each half fuse. Cells produced in the anther sacs divide by meiosis to produce four microspores each. These separate from one another and each divides once by mitosis to produce a **pollen grain** composed of a **tube cell** and a smaller **generative cell** within the **pollen wall**. It is at this stage that the anther sac opens, most often longitudinally, and the pollen is shed.

Observe the demonstration slide showing a cross section of a *Lilium* anther containing mature pollen grains.

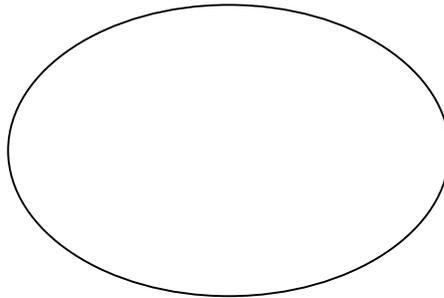
How can you distinguish the tube nucleus from the generative nucleus?

The tube nucleus is _____

The generative nucleus is _____

Examine fresh pollen from one of the flowers in the lab.

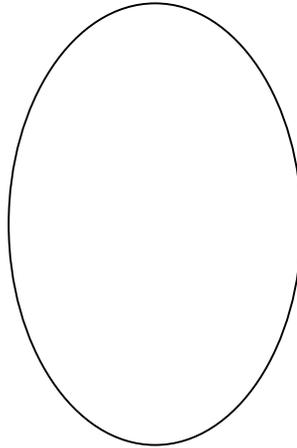
In the space below, sketch a diagram of the pollen grain (from a prepared slide) and label it completely.



THE EMBRYO SAC.

The carpel bears **ovules** which consist of one or two protective **integuments** which meet at the tip, leaving a narrow opening or **micropyle**. The ovule is connected to the ovary by means of a stalk, the **funiculus**. Inside the integument, meiosis has taken place and an haploid **embryo sac** develops within. This is organized into seven cells: three cells at the micropylar end (two **synergids** and one **egg**), three **antipodal** cells at the opposite end, and the one **central cell** containing two polar nuclei.

Observe the demonstration slide(s) of the ovule and embryo sac in *Rhododendron* and, in the space below, sketch a diagram of the ovule with embryo sac and label completely. Place your labels for the integument, micropyle, and funiculus on the left side of the diagram. Place your labels for the parts of the embryo sac on the right side.



POLLINATION AND SPERM PRODUCTION.

When the pollen grain is shed from the anther, it is carried (usually by insect, bird, or wind) to the stigma of a carpel. The pollen grain germinates there, sending out the tube cell, which grows through the tissues of the stigma and style to reach the ovary.

Keeping in mind the very small size of the pollen grain, and its non-green color, what is the source of nutrition of the pollen tube?

The nuclei remain near the tip of the pollen tube as it passes through the style, and the generative nucleus undergoes mitosis to form **two sperm nuclei**. On reaching the ovary, the pollen tube enters an ovule via the micropyle, penetrating a synergid and there bursting at the tip. The two sperm nuclei are discharged.

Observe the demonstration slides showing pollen tubes.

SYNGAMY.

One of the two sperm nuclei moves to the egg cell and fuses with its nucleus to form the **zygote**. The second sperm nucleus fuses with the two polar nuclei in the central cell to form a **primary endosperm cell**. This **double syngamy** is characteristic of all angiosperms.

If each nucleus in the syngamy has one set of chromosomes,
how many sets would be found in the zygote? _____

How many sets of chromosomes would be found in
the primary endosperm cell? _____

Observe the demonstration slide showing double syngamy in *Lilium*.

The primary endosperm cell, the zygote, and the rest of the ovule form the **seed**, a subject for future study.