Chapter Twelve

Lab Exercise: Floral Morphology and Pollination Systems

The diversity of angiosperm flowers on earth is tremendous. There are over 300,000 different species, each with a unique flower. Yet, all flowers serve a similar function and evolved from the same common ancestor. Therefore, by understanding a few basic structures in a "general" flower, we can understand the structure and function of most flowers.

In this lab you will be responsible for learning the structure of a typical flower, studying some examples of "typical" and atypical flowers, and determining the identity of the most likely pollinators of some flowers on the basis of the color and morphology of the flower. Remember that the plants we see around us are the sporophytic generation, while the sexual generations (gametophytes) are relatively hidden. The flower is where gametophyte and sporophyte generations co-occur. As you look at flowers, try to understand the function as well as the name of each part of the flower by remembering how each part of the flower fits into the whole life cycle of the plant.

<u>Flower Morphology</u>

Your TA will provide you with what we will call a "typical" flower. Evolutionarily, floral parts are extraordinarily specialized leaves. These specialized leaves occur in groups or whorls, each with a different purpose.

Starting at the outside we find a roughly circular whorl of sepals (Figures 12.1 and 12.2), which are usually green and fairly small in relation to the size of the flower as a whole. Before the flower opens, it is the <u>sepals</u>, collectively called the <u>calyx</u>, that

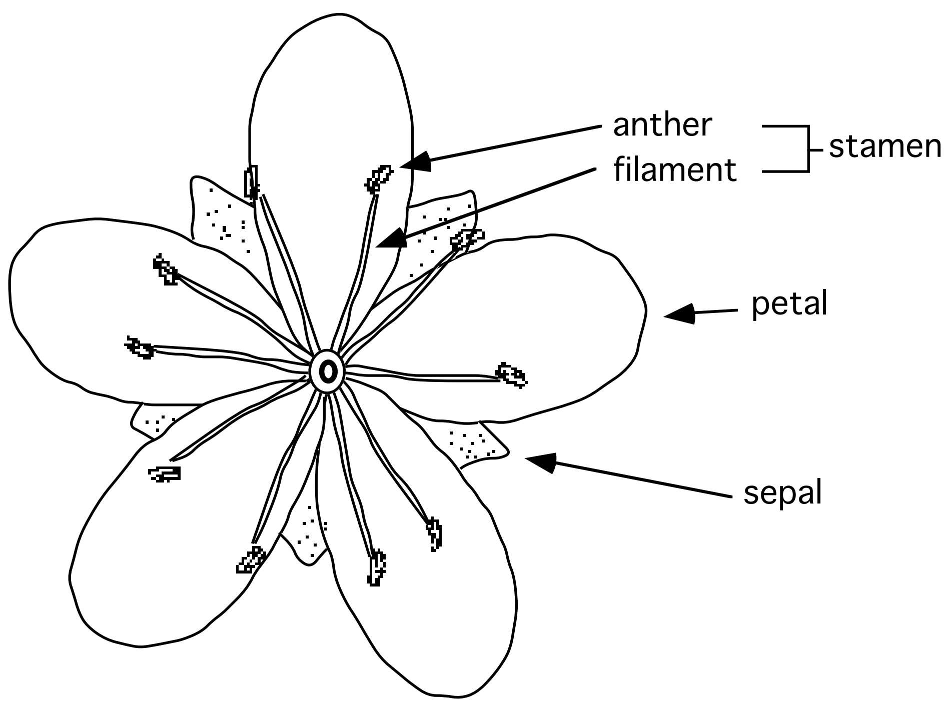

Figure 12.1. A typical angiosperm flower viewed from above.

enclose and protect the developing bud. Inside the sepals are petals, usually larger and more colorful. Note that in some species, for example in tulips, the sepals and petals look very much alike and act together to provide the color attracting pollinators. Together, the petals make up the corolla, and the calyx and corolla make up the perianth.

Continuing in towards the center of the flower, we encounter one or more whorls of stamens, which are the flower's male organs (Figure 12.1). Each stamen typically consists of a slender stalk or filament attached to the flower at its base and carrying on its free upper end a structure called an anther, which contains the pollen.

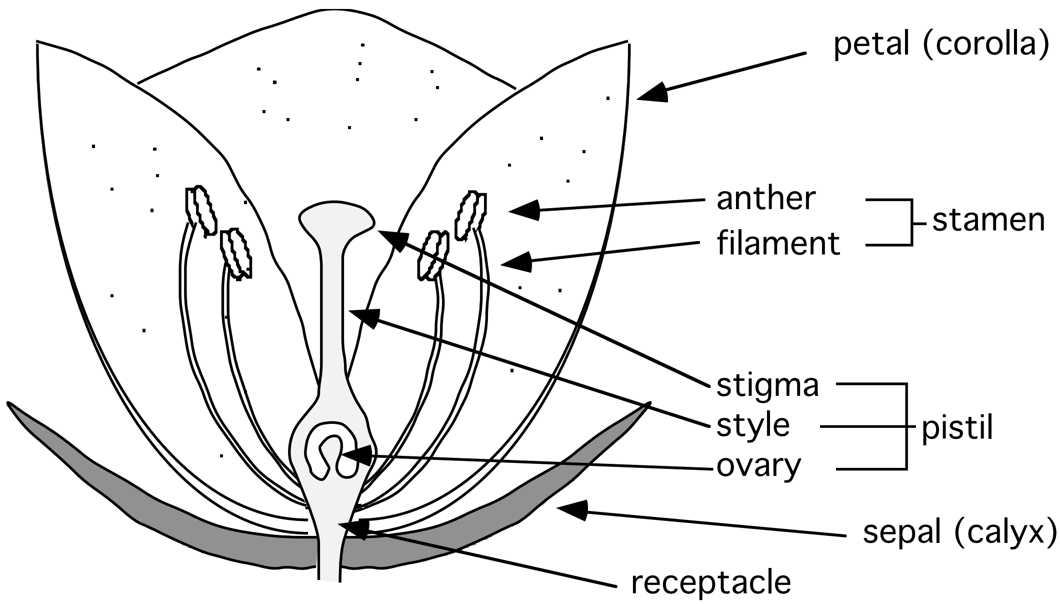

Figure 12.2. A cross section of a typical angiosperm flower, showing details of male and female portions of the flower.

Finally, in the center of the flower are the female organs, or carpels. Individual carpels, as well as fused carpels which make up a pistil, consist of a basal ovary containing the ovules, a slender column-shaped structure called a style, and on the end of the style the stigma, the function of which is to receive the pollen grains.

All of these parts of the flower are "sporophyte" structures. The pollen grain is the adult male gametophyte. When a grain finds itself in the comfortable environment of a stigma, it sprouts a long, slender, tubular outgrowth that pierces the tissue of the stigma, worms its way down the length of the style, and finally delivers one of its two sperm cells (gametes) to an egg cell within the ovule (the female gametophyte). The ovule is the structure that, after fertilization, gives rise to a seed.

All well and good, but in the real world this logical regular pattern of flower parts is not always so obvious. Three things can make flower structure a bit confusing: similarity of parts, absence of parts, and coalescence of parts or groups of flowers. You should try to look at examples of several different flowers in lab before you go on.

The most common instance of similarity of parts is resemblance between the sepals and the petals, which has already been mentioned as occurring in tulips. Similarly, brightly colored leaves and bracts surrounding the flower may also be confused with the petals. Other instances of "mimicry" exist, including situations in which the style and stigma resemble a stamen. The best way to sort out similar parts is to look at the organization of the whorls and to remember that it should go sepals, petals, stamens, pistil.

Many species have evolutionarily lost some parts of the flowers. The most obvious situation is that in which a plant or a species has male and female flowers. In this case, flowers have lost one sexual function, allowing them to specialize in the other. Many flowers have also lost petals or sepals.

Cohesion and fusion are common both within and among flowers. The petals may be fused to make a tube, as in a petunia flower. Or the filaments may be fused, as in the beautiful Hibiscus flowers. Fusion can also occur between different types of parts; for example, filaments can fuse with petals.

Flowers may combine to form what is called an inflorescence. In fact, one of the largest families of plants is the composites, which include sunflowers, dandelions, and a large number of what botanists call DYC's (damn yellow composites). Each "sunflower" is in actuality many flowers joined together. The inner flowers have lost their sepals and petals and are called disk florets. The outer flowers produce the petals along the edge of sunflowers and are called ray florets. Other examples of inflorescences abound.

When looking at each species, try to determine attractants and rewards offered by each flower. These may include, but not be limited to, color, nectar, odor, and pollen. Also, determine how the flower tries to "guide" the pollinators to specific locations in the flower in a particular order. In other words, try to think like a pollinator crawling around on the flower. Where would you go first?

Make sure that you are comfortable with the diversity of flowers we provide you with in the lab. Some are small and can be looked at under the scope. Don't worry about occasionally being fooled: we all are.

Pollination Vectors

Pollen is transferred from the anthers of one flower to the stigma of another (or the same flower) by a number of different agents. These include, but are not limited to, wind, beetles, flies, bees, butterflies, moths, birds, and bats. As might be expected, different species that require the same "type" of pollinator often share floral characteristics that act to attract that pollinator. For example, hummingbird pollinated flowers are usually tubular and red, because red is easily seen by birds and because tubular flowers are less accessible to bees and other insects that might take the rewards (usually nectar) without pollinating the flower.

Below we have provided you with a floral key to pollination systems. Using this key, you will be able to determine how a particular plant is pollinated, or at least narrow it down to a few likely possibilities. Keep in mind that some plants use a variety of pollinators and therefore may have characteristics that are intermediate between, or a combination of, more than one system.

The pollination systems addressed in this key are abbreviated as:
<u>Abiotic systems</u> (water pollination is not addressed in this key)

WI wind pollination

<u>Insects</u>

BT	beetles
F-M	flies (myophily)
F-S	flies (sapromyophily)
BE	bees
BU	butterflies
MO	moths

<u>Vertebrates</u>

BI	birds
BA	bats

This key is used to eliminate unlikely pollinators. Use this key to determine the most likely pollination system for at least two flowers provided for this purpose by the Teaching Assistant. For each flower, start with a list of all the options.:

WI BT F-M F-S BE BU MO BI BA

Then go through each of the floral characteristics below, crossing out systems that could not be involved (those listed in parentheses are unlikely, but possible candidates). For example, if the flower color is red, you would cross off your worksheet all the systems listed after red:

~~WI~~ ~~BT~~ ~~F-M~~ ~~F-S~~ BE BU MO BI ~~BA~~

The pollination system(s) that is (are) not crossed off your list is (are) the most likely candidate(s) for that particular species.

Complete the following exercises and hand in your work to your TA before you leave the lab:

1. Neatly diagram the structure of **two** flowers that appear different to you. On each one, label the following structures: anther, filament, stigma, style, ovary, petal, sepal (if present).

2. Sketch one entire inflorescence and label an individual flower.

3. For two different flowers, use the Key to Pollination Systems to identify the most likely pollinator of that flower. For each flower, describe what traits you used to eliminate **three** specific other possible pollinators (e.g. the presence of a fruity scent may lead you to eliminate birds as a possible pollinator).

KEY TO POLLINATION SYSTEMS

Flower feature	Description	Pollination Systems NOT Involved
SYMMETRY	radial	none
	bilateral	F-M, F-S
FLOWER SHAPE	tubular	WI, BT, F-M
	not tubular	MO, (BU), (BI), BA
FLOWER SIZE	small, inconspicuous	BT, BE, MO, BU, BI, BA
	showy, possibly large	WI
FLOWER COLOR	white	WI, F-S, (BE), (BI)
	yellow	WI, BT, F-M, F-S, MO, BA
	blue	WI, F-M, F-S, (MO), (BI), BA
	red	WI, BT, F-M, F-S, (BE), (MO), BA
	dull, inconspicuous	BE, BI
WHEN OPEN	day	MO, BA
	night	BE, BU, BI
ODOR	no odor	F-S, MO, BA
	putrid	WI, MO, BI, BA
	fragrant or fruity	WI, F-S, BI
POLLEN	few grains	WI, BA
	abundant	none
NECTAR	none	F-M, BE, MO, BU, BI, BA,
	accessible	(F-S), BE
	hidden	F-M, (F-S), MO, BU, BI, BA
NECTAR GUIDES	present	F-S
	absent	F-M, BE
NECTAR CONTENT	low sugar	BI, BE, BA
	low amino acids	BU, MO