# Plant Life Cycle: Flowers

The Flower – unique to angiosperms, composed of sepals, petals, stamens, and carpels (see fig. 1.1 and 5.1) inserted into the receptacle (the expanded top of the flower stalk – the pedicel or peduncle)

Floral organs

Perianth – collective term for the calyx (sepals) and corolla (petals) of a flower

Calyx – collective term for the outermost whorl of leafy structures – the sepals – which cover and protect the flower bud

Corolla – collective term for the inner whorl of often brightly colored and conspicuous structures – the petals – which function as animal pollinator attractors

Androecium – collective term for the male structures, the stamens

Stamen – the pollen-producing (sperm-producing) organ of the flower

Filament – the stalk of the stamen

Anther – the chambered structure in which pollen is produced

Gynoecium – collective term for the female structures, the pistils (carpels)

Carpel – the basic unit of the gynoecium

Simple pistil – a pistil composed of one carpel

Compound pistil – a pistil composed of two or more fused carpels

A flower may have

One simple pistil (see fig. 5.1 and 5.2a)

Multiple simple pistils

One compound pistil (see fig. 5.2b)

Pistil – the egg-producing organ of the flower (fig. 5.1)

Stigma – the tip of the pistil on which pollen is deposited

Style – the part of the pistil connecting the stigma to the ovary

Ovary – the ovule-containing (egg-containing) base of the pistil

Complete flowers – have all four floral appendages, sepals, petals, stamens, and carpels

Perfect flowers – have both functional stamens and functional carpels; i.e., bisexual

Modified flowers

Incomplete flowers – lack one or more of the four floral appendages

Incomplete perfect flowers – lack sepals and(or) petals (see fig. 5.4a)

Incomplete imperfect (unisexual) flowers – lack either stamens or carpels and may or may not lack sepals or petals

Staminate flowers – unisexual flowers with stamens and no carpels

Pistilate flowers – unisexual flowers with carpels and no stamens

Tepals – a collective term sometimes used for sepals and petals of the same flower when they look alike

Ovary position (see fig. 5.4b)

Superior ovary – the ovary is above the sepals, petals and stamens (= hypogynous flower – one in which the sepals, petals, and stamens are inserted below the ovary); perigynous flowers in which sepals, petals, and stamens are inserted around the middle of the ovary – often on the rim of a structure called a floral cup – are usually considered to have superior ovaries

Inferior ovary – the ovary is below the sepals, petals and stamens (= epigynous flower – one in which the sepals, petals, and stamens are inserted above the ovary)

Symmetry (see fig. 5.4c)

Regular (actinomorphic) flowers have radial symmetry – they can be cut into mirror image halves along many lines of symmetry

Irregular (zygomorphic) flowers have bilateral symmetry – they can be cut into mirror image halves along only one line of symmetry

Inflorescences – clustered groupings of flowers on the same plant; e.g., spike, raceme, panicle, umbel, catkin, head (see fig. 5.5)

Meiosis

Diploid cells (2*n*) contain pairs of homologous chromosomes (one chromosome of each homologous pair comes from one parent and the other chromosome of each homologous pair comes from the other parent)

Homologous chromosomes have pairs of genes, one on each chromosome (one from each parent), that are involved in control of the same character (e.g., pea plants have a pair of genes that controls flower color)

Haploid cells (*n*) contain half the chromosome complement of diploid cells; i.e., one chromosome from each pair

Sex cells or gametes are haploid cells produced as part of the reproductive process

Meiosis is the process by which haploid cells are produced from diploid cells – some people call it reduction division

Fertilization is the process by which gametes unite

A zygote is the first cell after fertilization and, therefore, is always diploid

Typical animal life-cycle

- Gametes (*n*) fuse in fertilization to form a zygote (2*n*)
- The zygote (2*n*) divides by mitosis to produce a diploid (2*n*) multicellular organism
- Diploid (2*n*) cells of the mature organism divide by meiosis to produce haploid (*n*) gametes

Typical plants life-cycle (see fig. 5.6)

- Gametes (*n*) fuse in fertilization to form a zygote (2*n*)
- The zygote (2*n*) divides by mitosis to produce a diploid (2*n*) multicellular plant
- Diploid (2*n*) cells of the mature plant divide by meiosis to produce haploid (*n*) cells
- Haploid (*n*) cells develop into haploid (*n*) structures that produce haploid (*n*) gametes

Setting the stage for meiosis

Interphase – chromosomes replicate and each chromosome is composed of two chromatids

Meiosis I (see fig. 5.7)

Prophase I – the nuclear envelope fragments, the chromosomes (each composed of two sister chromatids) begin to condense, homologous chromosomes pair with one another, and spindle fibers attach to the centromeres of the chromosomes

Metaphase I – chromosomes have fully condensed and homologous pairs of chromosomes are lined up at the center of the cell at the equatorial plane (= on the metaphase plate)

Anaphase I – the chromosomes of each homologous pair (with sister chromatids still attached at their centromeres) separate toward opposite poles of the cell

Telophase I and cytokinesis – the chromosomes become uncondensed, new nuclear envelopes form around each set of chromosomes, and the cell divides such that one nucleus is in each of the two daughter cells

The bottom line for meiosis I – One cell with pairs of homologous chromosomes divides to produce two cells each of which has one chromosome from each of the homologous pairs (e.g., a plant cell with 18 pairs of chromosomes – 36 total – divides to produce two cells each of which contains 18 chromosomes, one from each pair)

Meiosis II (see fig. 5.7)

Prophase II – the nuclear envelope fragments, the chromosomes (each composed of two chromatids) begin to condense, and spindle fibers attach to the centromeres of the chromosomes

Metaphase II – the chromosomes have fully condensed and are lined up on the metaphase (equatorial) plate

Anaphase II – the centromere of each chromosome divides and the sister chromatids separate toward opposite poles of the cell

Telophase II and Cytokinesis – the chromosomes become uncondensed, new nuclear envelopes form around each set of chromosomes, and the cell divides such that one nucleus is in each of the two daughter cells

The bottom line for meiosis II – One cell with a certain number of chromosomes, each composed of two chromatids, divides to produce two cells each of which contains the same number of chromosomes as the parent cell, but each chromosome is composed of only one chromatid (e.g., a plant cell produced during meiosis I containing 18 chromosomes, each composed of two chromatids, divides to produce two cells each of which contains 18 chromosomes, each composed of one chromatid)

In meiosis overall, one diploid cell with a certain number of chromosome pairs (e.g., a plant cell with 18 pairs of chromosomes – 36 total – each chromosome composed of two chromatids) undergoes two division events to produce a total of four cells each of which contains half the original number of chromosomes (e.g., cells of the above plant with 18 chromosomes, each composed of one chromatid)

Meiosis in flowering plants (see fig. 5.8)

A mature plant, which is diploid (2*n*), produces flowers with stamens (male) and(or) pistils (female)

Inside of anther chambers located on the filament of the stamen, diploid (2*n*) cells divide by meiosis to produce cells that develop into pollen grains, each containing two haploid (*n*) sperm

Inside of ovules located inside the ovary of the pistil, a diploid (2*n*) cell divides by meiosis to produce four haploid (*n*) cells, one of which develops into a structure that contains a haploid (*n*) egg and several other haploid cells

Pollination and Fertilization (see fig. 5.8)

A pollen grain is transferred by various means (e.g., wind, water, insects, birds) from an anther to the sigma of a pistil (pollination)

The pollen grain germinates and a pollen tube grows through the tissues of the stigma and style to the interior of the ovary to an ovule

Both of the haploid (*n*) sperm cells migrate through the pollen tube; one sperm cell fuses with the haploid (*n*) egg cell (fertilization) to produce a diploid (2*n*) zygote, and the other sperm cell fuses with two of the other cells (a second fertilization) to produce a triploid (3*n*) endosperm cell (this process is known as double fertilization and is unique to angiosperms)

The diploid (2*n*) zygote divides by mitosis to produce a diploid (2*n*) multicellular embryo; the triploid (3*n*) endosperm cell divides by mitosis to produce triploid (3*n*) endosperm tissue, which serves as a food reserve for the embryo

The ovule (still inside the ovary of the pistil) matures into a seed, which contains an embryo surrounded by endosperm; the ovary matures into a fruit

Eventually, the seed is released from the fruit and falls to the ground where it germinates and the diploid (2*n*) embryo develops into a diploid (2*n*) seedling, which develops into a mature diploid (2*n*) plant

Animal pollination (see fig. 5.9)

Color and scent attract animals to flowers

Bee-pollinated flowers are often yellow, blue, or purple

Many bird-pollinated flowers are red

Flowers pollinated by night visitors such as moths and bats are usually white or light colored

Some flowers have contrasting color patterns called nectar guides that direct insects toward the nectar

Essential oils, volatile oils that impart fragrance, attract pollinators by scent; essential oils of flowers have been used in perfumes for hundreds of years

The reward for the animal is nectar, pollen, or both, and the movement of pollen from one flower to another by the pollinator is simply incidental

Flowering plants and their animal pollinators have adapted to one another over very long times in a process called coevolution

Wind pollination

Wind-pollinated flowers are usually small and inconspicuous, but they usually occur in large numbers and produce large amounts of dry, lightweight pollen

Main Points of A Closer Look 5.1 – Mad About Tulips

The tulip story is an example of human attraction to flowers because of their beauty of color, form, and fragrance

On occasion, certain ornamental plants have become extremely important economically

Main Points of A Closer Look 5.2 – Pollen is More Than Something to Sneeze At

Palynology, the study of pollen, has many diverse field including petroleum geology, archeology, criminology, anthropology, aerobiology, and the study of allergy

This lecture outline was prepared mainly from *Plants and Society*, by Levetin and McMahon, 2003 (3rd edition), and may contain phrases or entire sentences taken verbatim from that source.