Chapter 15 – Development in Plants

1. General Information

Different plants grow at different rates, under different conditions, at different times (duh)
Growth is thought as an increase in size, due to an increase in the number of cells present
Development is the specialization of cells to perform different function

2. Seed and Embryo Development

Review pollination and fertilization from Chapter 11
Remember that during fertilization, a zygote and a polar nuclei is created, known as double fertilization
Embryo – develops from the zygote (2n)
Endosperm – protects and nourishes the embryo (3n)
Cotyledons – bumps on the seed, seed leaves – carry on photosynthesis in new plant till leaves develop
Made of endosperm tissue, Marks the start of differentiation
Sometimes the cotyledons carry food for the young plant
Cells between the cotyledons form the embryonic shoot, which will develop into the stem/leaves
Plants are categorized according to the number of cotyledons
Monocots – 1 cotyledon. All the veins in the plant are parallel, rings in the stem are scattered, and pistils and stamens are in multiples of 3
Dicots – 2 cotyledons, branched veins, rings in the stem are organized, pistils and stamens are in multiples of 4 or 5
The embryonic shoot and roots develop at opposite ends of the seed
Meristems – tissue that is capable of rapid cell divisions to stimulate growth
Apex – the tip of booth the shoot and the root, contains a mass of undifferentiated cells
Apical Meristems – tissue at the apex that supplies the cells for growth in length
Lateral Meristems – found on the perimeter of the stem, allows the stem to increase in diameter
After fertilization, the polar nuclei divides rapidly, forming the endosperm, a storehouse for nutrients
The wall of the ovule forms a tough **seed coat** to protect the embryo and endosperm
The seed then remains dormant until it sprouts. Ovary then ripens into a fruit, seeds are dispersed

3. Seed Germination

Germination – the sprouting of the seed. Occurs if temperatures are suitable and water/O_2 is available
Water and O_2 pass through the seed coat, triggering the embryo to resume growth
O2 is needed in order to start cellular respiration to release the stored food in the endosperm
Enzymes digest the food in the endosperm, the seed coat fractures, and the embryonic root emerges
The shoot pushes out of the soil, and the sun triggers the shoot to straighten up
The cotyledon emerges with the shoot, providing early photosynthesis for the plant
Plants only germinate when chances of survival are rather high

4. **Primary and Secondary Growth**

Primary Growth – an increase in the length of the roots and stems
Secondary Growth – an increase in the diameter of the stems
After germination, the seed starts growing, leaves grow from the apical meristems
Roots penetrate the soil, anchoring the plant, providing it with water
Root Cap – unorganized mass of cells that protects the apical meristems as the root grows
Cambium – another type of meristem, differentiates into two types of the transport tissue in the stem
Xylem – transports water and minerals from the roots throughout the plant
Phloem - transports containing dissolved sugars and amino acids out of the plant
Cork cambium – some plants have this secondary layer of cambium, develops into bark
Meristems in the buds produce cells that differentiate into leaves, branches, and flowers
Xylem cells at the center of a large tree contain no cytoplasm and are dead, but the cell walls remain
These make up for most of the wood in a tree. The tree can survive w/o these dead cells
Chimney Tree – a redwood whose interior was burned out, but it's still alive
Pericycle – a cylinder of meristem tissue that surrounds the xylem and phloem in the root

5. Factors affecting Plant Growth

Genes, DNA – controls RNA synthesis – controls protein synthesis – controls cell processes
Environmental factors, such as temperature, light, gases, water, minerals, affect growth
Hormones, vitamins, food, etc also affect growth
Many times growth is triggered by the cell's location in the plant or by certain nutrients
There are 5 groups of plant hormones that regulate growth, controlled by DNA and the environment
Hormones produced by tissues that have other functions, and are effective in small concentrations

Auxins – 1st plant hormone identified. **Produced in the apical meristems**
Causes cells in the growing regions of the plant to elongate, but concentrations play a large role
Auxins in the apical bud may prevent branches from growing
Causes the plant to grow in height
Auxins are used to grow plants from cuttings, promote fruit growth w/o fertilization (seedless fruit)
2,3-D – a herbicide used to kill weeds
2, 4, 5-T – **Agent Orange** - Used in Vietnam to defoliate trees and create **dioxin**, a deadly poison

Gibberellins – discovered by Kurosawa in fungal infected rice plants
Gibberellin is the chemical that caused the abnormal growth, and now over 60 types discovered
Synthesized in apical parts of stems and roots. Influence stem elongation and growth
Many plants grow faster than treated with gibberellins, especially when used together with auxins
Also can be used to produce seedless fruit

Cytokinins – promotes cell division and organ development, such as the growth of branches
Work in combination with auxins to regulate the total growth pattern of the plant
Found in the tips of the roots, germinating seeds, and fruits
Produced in the roots and transported throughout the plant
Also responsible for chloroplast development and chlorophyll synthesis
Promotes the growth of branches and inhibit the formation of roots
In contrast auxins promote the growth of roots and inhibit the growth of branches

Abscisic Acid – synthesized in green leaves, root caps, fruits.
Helps dormant seeds survive harsh conditions
Called the **stress hormone** because it may help protect the plant against water loss
Controls the opening and closing of the stomates under certain weather conditions

Ethylene – a simple gas that occurs as a natural metabolic product in plants
Promotes fruit ripening and the again of tissues. Causes leaves, flowers, and fruits to fall
Counteracts the effect of auxins. Auxins produce ethylene to stop branch formation
The Chinese used ethylene to ripen fruit in ripening rooms

6. Plant Movements

Plant growth and development depends on movement that occur due to environmental conditions
Some plant movements are due to stimulating, or touching, a part of the plant
Tropisms – movements either toward or away from the stimulating force (doesn't have to be physical)
Phototropism – plants tend to grow toward light. Tested by Charles Darwin
Caused by a shoot tip that produces a chemical. If the tip is covered, the stem doesn't bend
Gravitropism – growth toward or away from the Earth's gravitational pull
Stems and flower stalks grow away from gravity. Roots grow towards gravity
Auxins and other hormones are mainly responsible for this behavior
Hydrotropism – growth toward or away from water
Chemotropism – growth toward or away from certain chemical agents

7. **Photoperiodism** – mechanisms that are sensitive to the relatively amount of light and dark in a 24 hour period
Some plants only bloom when a day is longer or shorter than a certain number of hours
Some florists can use this knowledge to "force" plants to bloom year round
It is actually the length of the night rather than the length of the day that controls photoperiodic responses
Long day plants – flower when the night is shorter than a critical length
Short day plants – flower when the night is longer than a critical length
Phytochrome – a pigment that can alternate between two slightly different chemical structures
Detects light and darkness by absorbing different wavelengths of red light

8. Differences Between Plant and Animal Development

Plants continue to grow throughout their life, when animals reach a peak and stop
The oldest, tallest, and largest living organisms in the world are all plants in Northern California
In general, Plants grow faster than animals. Kelp and bamboo can grow 1 meter/day
Plants need both pollination and fertilization to produce seeds, while animals need only fertilization
Plants use double fertilization (zygote and endosperm) while animals produce just an zygote
Animal development includes rearranging of cells for differentiation. Plant cells don't
The position of the embryonic cell in a plant determines it's future role
Plants have a period of dormancy, while animals development is continuous
Locations of unevenly distributed organelles can give signals for a cell's future purpose