Plant hormones pogil answer key

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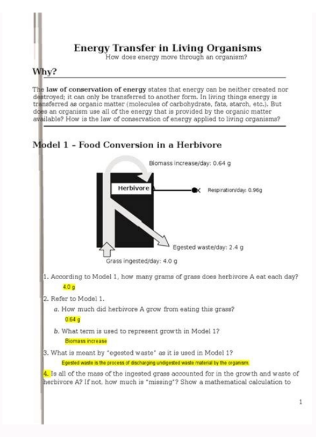
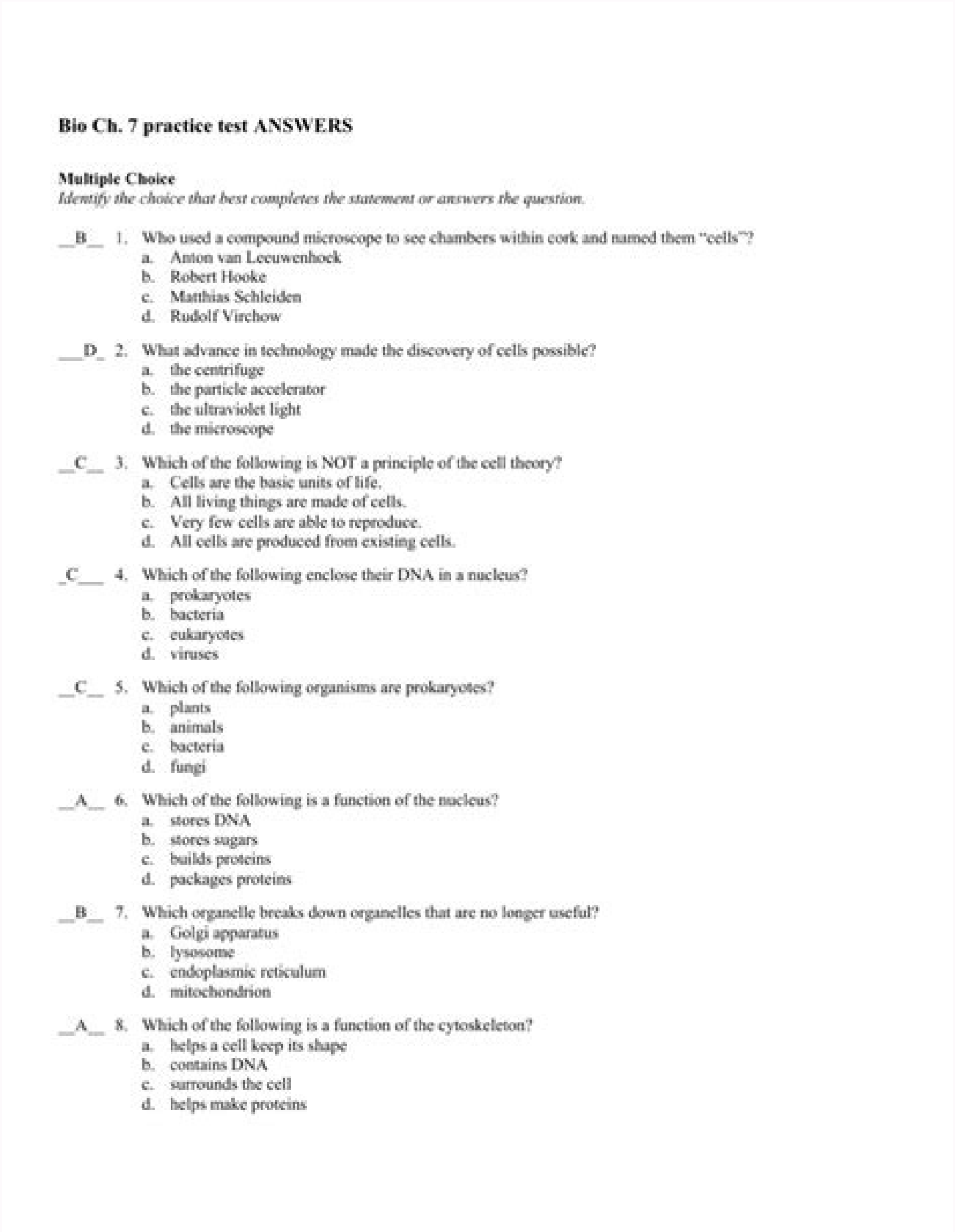




Bio Ch. 7 practice test ANSWERS

Multiple Choice
Identify the choice that best completes the statement or answers the question.

__B__ 1. Who used a compound microscope to see chambers within cork and named them "cells"?
- a. Anton van Leeuwenhoek
- b. Robert Hooke
- c. Matthias Schleiden
- d. Rudolf Virchow

__D__ 2. What advance in technology made the discovery of cells possible?
- a. the centrifuge
- b. the particle accelerator
- c. the ultraviolet light
- d. the microscope

__C__ 3. Which of the following is NOT a principle of the cell theory?
- a. Cells are the basic units of life.
- b. All living things are made of cells.
- c. Very few cells are able to reproduce.
- d. All cells are produced from existing cells.

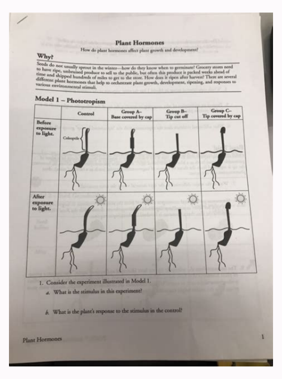
_C__ 4. Which of the following enclose their DNA in a nucleus?
- a. prokaryotes
- b. bacteria
- c. eukaryotes
- d. viruses

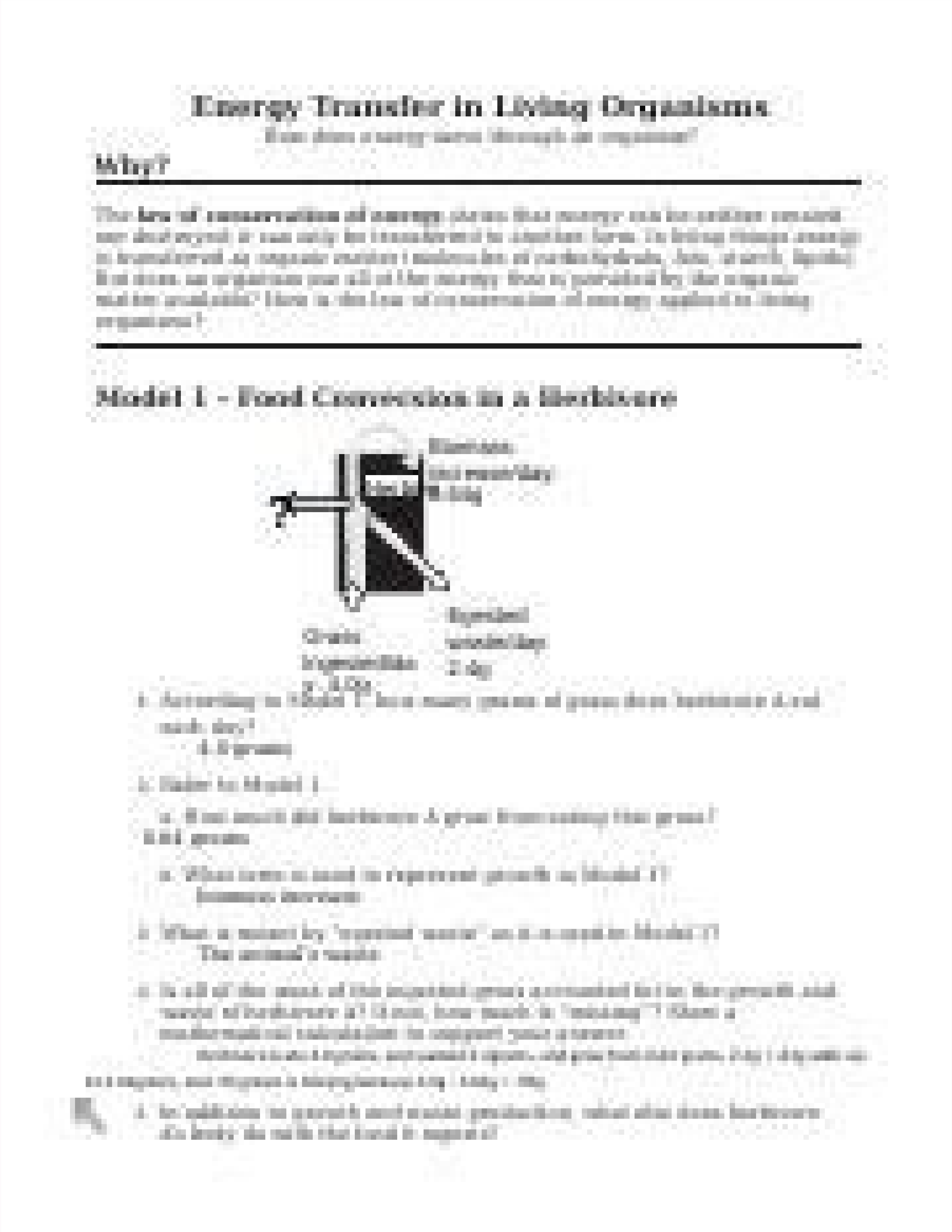
__C__ 5. Which of the following organisms are prokaryotes?
- a. plants
- b. animals
- c. bacteria
- d. fungi

__A__ 6. Which of the following is a function of the nucleus?
- a. stores DNA
- b. stores sugars
- c. builds proteins
- d. packages proteins

__B__ 7. Which organelle breaks down organelles that are no longer useful?
- a. Golgi apparatus
- b. lysosome
- c. endoplasmic reticulum
- d. mitochondrion

__A__ 8. Which of the following is a function of the cytoskeleton?
- a. helps a cell keep its shape
- b. contains DNA
- c. surrounds the cell
- d. helps make proteins

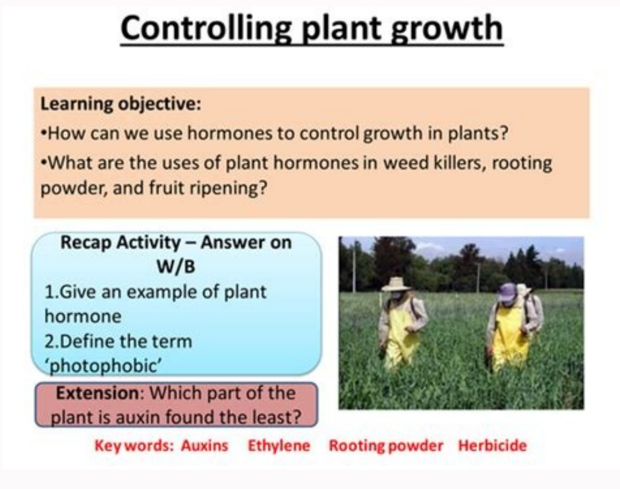




Energy Transfer in Living Organisms

Why?

Model 1 – Food Conversion in a Herbivore



Controlling plant growth

Learning objective:
•How can we use hormones to control growth in plants?
•What are the uses of plant hormones in weed killers, rooting powder, and fruit ripening?

Recap Activity – Answer on W/B
1.Give an example of plant hormone
2.Define the term 'photophobic'

Extension: Which part of the plant is auxin found the least?

Key words: Auxins Ethylene Rooting powder Herbicide

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Identify the hormones that regulate specific plant behaviors and describe their role in that behavior, including auxin, cytokinins, gibberellins, abscisic acid, ethylene, systemin, and methyl salicylate Recognize the stimulus that provokes a specific plant behavior, including phototropism, gravitropism, germination, thigmotropism, water/water stress and pathogen/herbivory defense Describe the pathways that regulates plant behaviors, including phototropism, gravitropism, germination, thigmotropism, water/water stress, and pathogen/herbivory defense Interpret and predict outcomes of experiments manipulating plant signaling pathways The information below was adapted from OpenStax Biology 30.6 A plant's sensory response to external stimuli relies on chemical messengers (hormones). Plant hormones affect all aspects of plant life, from flowering to fruit setting and maturation, and from phototropism to leaf fall. Just as in animals, hormones are signaling molecules which are present in very small amounts, transported throughout the plant body, and only elicit in responses in cells which have the appropriate hormone receptors. In plants, hormones travel large throughout the body via the vascular tissue (xylem and phloem) and cell-to-cell via plasmodesmata. Potentially every cell in a plant can produce plant hormones. In contrast, many animal hormones are produced only in specific glands. Plants do not have specialized hormone-producing glands. Hormones regulate a variety of plant behaviors in response to different stimuli or environmental conditions. This page is divided into two parts: Part 1 describes some of the hormones that initiate and regulate plant behaviors Part 2 describes the stimuli that provoke these responses and the pathways that regulate the responses. Throughout this reading, you should aim to recognize both the stimuli that provoke a specific behavior, as well as the hormones and (when described) the signaling pathway that mediates the response. In this section, we'll describe one plant hormone at a time and briefly describe all the plant behaviors associated with that hormone. In the section following, we'll then describe particular stimulus that initiates a plant behavior and the pathway that regulates that response. Auxins: the master growth regulator The term auxin is derived from the Greek word auxein, which means "to grow." Auxins are the main hormones responsible for cell elongation in phototropism (movement in response to light) and gravitropism (movement in response to gravity). Apical dominance (inhibition of lateral bud formation) is triggered by auxins produced in the apical meristem. Flowering, fruit ripening, and inhibition of abscission (leaf falling) are other plant responses under the direct or indirect control of auxins. Auxins also act as a relay for the effects of the blue light (via phot1 and phot2) and red/far-red responses (via phytochrome). Synthetic auxin is used as a rooting hormone to promote growth of roots on cuttings and detached leaves. Cytokinins: cell division Cytokinins promote cytokinesis (cell division). Cytokinins are most abundant in growing tissues, such as roots, embryos, and fruits, where cell division is occurring. Cytokinins also delay senescence (aging) in leaf tissues, promote mitosis (cell division), and stimulate differentiation of the meristem in shoots and roots. Many effects on plant development are under the influence of cytokinins, often in combination with auxin or another hormone. For example, apical dominance seems to result from a balance between auxins that inhibit lateral buds, and cytokinins that promote bushier growth. Gibberellins: stem, fruit, and seed growth Gibberellins (GAs) are a group of about 125 closely related plant hormones that stimulate shoot elongation, seed germination, and fruit and flower maturation. Maturing grapes are routinely treated with GA to promote larger fruit size. GAs are synthesized in the root and stem apical meristems, young leaves, and seed embryos. GAs also delay senescence (aging) in leaves and fruit and break dormancy (a state of inhibited growth and development) in the seeds of plants that require exposure to cold or light to germinate. Abscisic acid (described next) is a strong GA antagonist (works against it). Abscisic Acid (ABA): dormancy Abscisic acid (ABA) causes the abscission (dropping) leaves. ABA accumulates as a response to stressful environmental conditions, such as dehydration, cold temperatures, or shortened day lengths. Its activity counteracts many of the growth-promoting effects of GAs and auxins. ABA also inhibits stem elongation, induces dormancy in lateral buds and seeds, and closes stomata in drought conditions. ABA induces dormancy in seeds by blocking germination and promoting the synthesis of storage proteins. Many plants require a long period of cold temperature before seeds germinate, which protects young plants from sprouting too early during unseasonably warm weather in winter. As the hormone gradually breaks down over winter, the seed is released from dormancy and germinates when conditions are favorable in spring. ABA also regulates the short-term drought response: low soil moisture causes an increase in ABA, which causes stomata to close, reducing water loss. This video describes the activities of both gibberellins and abcisic acid (watch from 11:30 to 16:00): Ethylene: aging Ethylene promotes fruit ripening, flower wilting, and leaf fall. Ethylene is unusual as a hormone because it is a volatile gas (C_2H_4). Aging tissues (especially older leaves) and nodes of stems produce ethylene. The best-known effect of the hormone is the promotion of fruit ripening: ethylene stimulates the conversion of starch and acids into simple sugars. Ethylene also triggers leaf and fruit abscission, flower fading and dropping. Ethylene is widely used in agriculture. Commercial fruit growers control the timing of fruit ripening with application of the gas. Horticulturalists inhibit leaf dropping in ornamental plants by removing ethylene from greenhouses using fans and ventilation. This video provides a quick summary of the different roles of ethylene in plants: Systemin: anti-herbivory Systemin, named for the fact that it is distributed systemically (everywhere) in the plant body upon production, activates plant responses to wounds from herbivores. Systemin initiates production of compounds, like jasmonic acid, which taste bad and inhibit digestion by herbivores (causing a stomach ache!) to deter them from continuing to eat the plant. Methyl Salicylate (MeSa): immune response Methyl salicylate (MeSa) helps regulate responses to infection by parasites or pathogens. When a parasite or pathogen infects a cell, there is an specific, localized response called the hypersensitive response (HR). Following this very localized response, the plant initiates a systemic (whole body) response called the systemic acquired response (SAR). MeSA is responsible for inducing the SAR in response to the HR. In the section above, we've listed a set of plant hormones and briefly described the processes they regulate. In the section below, we'll describe the different stimuli that plants can respond to, the responses to these stimuli, and the hormones that play a role in the response pathway. In some cases, we will also go into some depth describing the pathways that regulate these responses. In other words, the section below explains how these hormones regulate the behaviors described in the previous section. Plant Responses to Light: Phototropism and Germination Plants are generally capable of detecting and responding to at least three wavelengths of light: blue light, red light, and far-red light. The different wavelengths are detected by different photoreceptors, which are comprised of a protein covalently bonded to a light-absorbing pigment called a chromophore. Together, the two are called a chromoprotein. The behaviors regulated by light stimuli include: phototrophism (movement toward light) stem elongation (growth) germination (seed sprouting) photoperiodism (flowering in response to length of day) We'll discuss these in turn below. Blue light: phototropism Plants are dependent on access to sunlight in order fix carbon dioxide into sugars; thus as stationary organisms they must grow toward sunlight in order to survive. Phototropism is movement toward or away from light. Tropism means movement, and photo means light, so "phototropism" is "movement in response to light." Phototropins are the chromoproteins responsible for mediating the phototropic response. Other responses under the control of phototropins are leaf opening and closing, chloroplast movement within cells, and the opening of stomata to permit gas exchange (and thus photosynthesis). Charles Darwin and his son Francis determined that light was perceived by the tip of the plant (the apical meristem), but that the response (bending) took place in a different part of the plant. They concluded that the signal had to travel from the apical meristem to the base of the plant to cause the bending. We now know that the detection of light in the apical meristem occurs via phototropins called phot1 and phot2, which specifically detect blue light. Blue light activates Phot1 and Phot2 (not shown); auxin accumulates on the shaded side of the stem in response to Phot1 and 2 activation; auxin promotes cell elongation, causing bending toward the light In 1913, Peter Boysen-Jensen cut off the tip of a seedling, covered the cut section with a layer of gelatin (essentially jello), and then replaced the tip. The cut seedling bent toward the light. However, when he inserted an impermeable barrier between the tip and the cut base, the seedling could no longer bend in response to light. Later experiments showed that the signal traveled on the shaded side of the seedling. When the barrier was inserted only on the illuminated side, the plant could still bend towards the light. Therefore, the chemical signal was a growth stimulant because the phototropic response involved faster cell elongation on the shaded side than on the illuminated side. We now know that the chemical signal is the plant hormone auxin, also called indole acetic acid or IAA. Experiments elucidating the phototropic response. Image credit: Modified from Koning, Ross E. 1994. Gibberellins. Plant Physiology Information Website. . (6-17-2017). Reprinted with permission. Auxin stimulates cell elongation on the shady side of the stem through a process called the acid growth hypothesis: Auxin causes cells to activate proton pumps, which then pump protons out of the cells and into the space between the plasma membrane and the cell wall. The movement of protons into the extracellular space does two things: The lower pH activates expansin, which breaks the links between the cellulose fibers in the cell walls, making them more flexible. The high concentration of protons causes sugars to move into the cell, which then creates an osmotic gradient where water moves into cell causing the cell to expand. To sum up, the phototropic response works like this: the phototropins phot1 and phot2 are present in the plant apical meristem. When activated by blue light, phot1 and phot2 cause accumulation of auxin on the shaded side of the plant. Auxin promotes cell elongation due to weakening of the cell wall combined with influx of water (which literally stretches the cells). Because the cell expansion occurs only on the shaded side of the stem, the plant bends away from the shade and toward the light. This video provides a concise summary of auxin's role in phototropism and the acid growth hypothesis (note that the video ends early to direct you to another study site, but the portion available here covers what you need to understand for this course): Red light: growth, germination, and photoperiodism Blue light promotes stem bending, but red light (as opposed to far-red light) promotes stem elongation, or growth. Why? Red light indicates full sun to a plant, while far-red light indicates that a plant is being shaded out by another plant. This is because unfiltered, full sunlight contains much more red light than far-red light. Chlorophyll absorbs strongly in the red region of the visible spectrum, but not in the far-red region, so any plant in the shade of another plant on the forest floor will be exposed to light that has been depleted of red light and but enriched for far-red-light. The non-shaded areas on the forest floor have more red light, and red light triggers plant growth. In other words, plants use the red vs far-red light detection to grow away from shade and towards light. The chromoproteins responsible for red/far-red light detection are called phytochromes. Phytochromes have two photo-interconvertible forms: Pr (phytochrome red) and Pfr (phytochrome far-red). The forms are named for what they are capable of absorbing next: the Pr form is capable of absorbing red light (~667 nm), and the Pfr form is capable of absorbing far-red light (~730 nm). When the Pr form absorbs red light, it is immediately converted to Pfr; and when Pfr absorbs far-red light, it is quickly converted back to Pr. Absorption of red or far-red light causes a massive change to the shape of the chromophore, altering the conformation and activity of the phytochrome protein to which it is bound. Pfr is the physiologically active form of the protein. Because phytochrome is in the Pfr state after exposure to red light, this means that exposure to red light turns the phytochrome “on.” Exposure to far-red light inhibits phytochrome activity. Together, the two forms represent the phytochrome system. The biologically inactive form of phytochrome (Pr) is converted to the biologically active form Pfr under illumination with red light. Far-red light and darkness convert the molecule back to the inactive form. Image credit: OpenStax Biology The phytochrome system acts as a biological light switch. It monitors the level, intensity, duration, and color of environmental light. The effect of red light is reversible by immediately shining far-red light on the sample, which converts the chromoprotein to the inactive Pr form. Additionally, Pfr can slowly revert to Pr in the dark, or break down over time. In all instances, the physiological response induced by red light is reversed. The active form of phytochrome (Pfr) can directly activate other molecules in the cytoplasm, or it can be trafficked to the nucleus, where it directly activates or represses specific gene expression. The behaviors that the phytochrome system regulates include plant growth, seed germination, and photoperiodism (behaviors regulated by day length): Phytochrome stimulates plant growth toward red light via the hormonecytokinin, which promotes cell division, and gibberellin, which promotes stem elongation. Cytokinin is activated by the Pfr form of phytochrome, thus causing cell division in the apical meristems that are in the presence of red light. Interestingly, cytokinin is only capable of promoting cell division when it is also in the presence of auxin, which is present at apical meristems but not other locations in the plant. Auxin also regulates levels of gibberellin. The phytochrome system also regulates seed germination in many plant species (illustrated below). As we’ve previously discussed, the seeds of many plants go into a dormant state after fertilization, in part to ensure that the seed germinates at a time and in a place that the seedling is more likely to successfully survive. There are many different signals that can trigger seed germination, depending on the plant species. For many plant species, this signal is red light, as red light provides a signal that the seed is in a good location for access to sunlight after germination. In contrast, a seed that germinates in shaded areas, or too deep under the soil to reach the sunlight, is likely to die soon after germination. In the dark, phytochrome is in the Pr (inactive form) and the seed will not germinate; it will only germinate if exposed to light at the surface of the soil. Upon exposure to light, Pr is converted to Pfr, Pfr signaling causes transcription of the gene that encodes amylase, an enzyme that breaks down starches stored in the seed into simple sugars, and then germination proceeds. (Note that some species of plants initiate germination through an light-independent process regulated by the hormone gibberellin, which is further described below.) Photoactivation of phytochrome to Pfr stimulates synthesis of Î±-amylase in the seed to promote germination. Image credit: Koning, Ross E. 1994. Gibberellins. Plant Physiology Information Website. . (6-17-2017). Reprinted with permission. Plant Responses to Gravity: Gravitropism Whether or not they germinate in the light or in total darkness, shoots usually sprout up from the ground, and roots grow downward into the ground. A plant laid on its side in the dark will send shoots upward when given enough time. Gravitropism ensures that roots grow into the soil and that shoots grow toward sunlight. Growth of the shoot apical tip upward is called negative gravitropism, whereas growth of the roots downward is called positive gravitropism. Amyloplasts (also known as statoliths) are specialized cellular compartments that contain starch granules that move in response to gravity. The starch granules are heavy, and literally fall to the bottom of the cellular compartment in response to gravity. Amyloplasts are found in shoots and in specialized cells of the root cap. When a plant is tilted, the statoliths drop to the new bottom cell wall, which causes auxin (produced by the root apical meristem just like at the shoot apical meristem) to redistribute to the new bottom of the root. In roots, a high concentration of auxin inhibits cell elongation, slowing growth on the lower side of the root, while cells develop normally on the upper side and causing the root to bend toward the high concentration of auxin and thus causing the root to grown down. Note that this is the exact opposite of auxin’s affect on shoots, where a higher concentration stimulates cell expansion, causing the shoot to bend away from the higher concentration of auxin. After root begins to grow vertically again, the amyloplasts return to their normal position and auxin is equally distributed on both sides of the root tip. Auxin and amyloplasts together mediate gravitropism. A, Cells in the root tips contain amyloplasts, which are heavy organelles that fall to the bottom of cells and activate pressure-sensitive receptors; activated receptors direct growth downward. B, Auxin distribution in the root tip changes as a result of gravity, with auxin accumulating in the direction of gravity; higher auxin distribution in roots inhibits cell elongation while lower auxin distribution promotes cell elongation. Image credit: A, modeled after Freeman Biological Sciences 5th edition Figure 40.12; B, modeled after Freeman Biological Sciences 5th edition Figure 40.13 Plant Growth Responses Other plant responses to different growth-related stimuli include: Apical dominance: many plants grow primarily at a single apical meristem and have limited lateral branches (which would result in multiple meristems). This phenomenon is called apical dominance, and is regulated by the presence of auxin at the apical meristem. Auxin is required for the function of other growth-regulating hormones such as cytokinins; cytokinins promote cell division, but only in the presence of auxin. Abscisic acid in the lateral buds inhibits production of auxin, and removal of the apical bud will release this inhibition of auxin, allowing the lateral buds to begin growing. Auxin and cytokinins together promote cell growth. Auxin is present only in the apical bud and not lateral buds; thus plant growth occurs only at the apical bud. Image credit: Doctor Smart – Own work, CC BY-SA 4.0, Leaf abscission: some plants drop leaves in response to changing seasons (based on temperatures, photoperiod, water, or other environmental conditions). This process is called leaf abscission, and is regulated by interactions between auxin and ethylene. During the growing season, the leaf produces high levels of auxin which blocks activity of ethylene; however, as the seasons change, the leaf produces lower levels of auxin. Lower levels of auxin permit ethylene to initiate senescence (aging) and ultimately programmed cell death at the site of leaf attachment to the stem, allowing the leaf to fall off in a controlled manner without harming the rest of the plant. Fruit growth: growth of fruits in size is promoted by gibberellins. Artificial addition of gibberellins to fruits while still on the plant will cause them to grow larger than they ordinarily would. Fruit ripening: once fruits have grown to the appropriate size, they begin ripening; this process is stimulated by ethylene. Fruit ripening is a form of senescence (aging), so the role that ethylene plays in fruit ripening is very similar to its role in leaf abscission. Plant Responses to Water or Water Stress (Drought) Germination : though we previously discussed germination controlled by the phytochrome system, the seeds of some plant species instead rely on the imbibition (intake) of water to initiate germination (shown below). Intake of water activates the hormone gibberellin, which then signals to transcribe the gene encoding amylase, an enzyme that breaks down starches stored in the seed into simple sugars, and then germination proceeds (note these final steps are identical to what occurs in phytochrome-regulated germination). When water is absent, germination in this pathway is blocked by a hormone called abscisic acid (also called ABA), which inhibits the activity of gibberellins. Thus gibberellins and abscisic acid act in opposition in regulating the the germination response. Following imbibition of water, gibberellins stimulate synthesis of Î±-amylase in the seed to promote germination. Image credit: Koning, Ross E. 1994. Gibberellins. Plant Physiology Information Website. . (6-17-2017). Reprinted with permission. Stomatal closing: as briefly noted above, activation of phot1 and phot2 by blue light cause stomata to open to permit gas exchange so that photosynthesis can occur. But in addition to sunlight and carbon dioxide, photosynthesis also requires water. When the plant is dehydrated due to drought, the hormone abscisic acid (ABA) causes stomata to close, preventing gas exchange and halting photosynthesis. This response to abscisic acid occurs even if blue light is present (Signaling from drought via ABA overrides the signaling from blue light via phot1). Guard cells regulate opening and closing of stomata in response to different signals. Image credit: June Kwak & Pascal MÃ¤ser, University of Maryland, Public Domain, Local cell death: in drought conditions, the immediate response is closing stomata, as noted above. However, because closed stomata prevent gas exchange, plants will die if the stomata remain closed for too long. Thus if a drought persists for too long, the plant will begin sacrificing certain areas by allowing the leaves or stems to die in localized regions. This process may be regulated by the hormone ethylene, which can induce localized cell death under certain conditions. Thigmotropism is movement in response to touch. Different plant species have different types of responses to touch, including slow thigmotropism and fast thigmotropism. Slow thigmotropism describes a plant response to a touch stimulus that affects direction of growth, such as vines that wrap around or grow along structures. Slow thigmotropsim is regulated by auxin, which redistributes in the elongating stem in response to the touch, ultimately resulting in differential cell elongation (much like the role auxin plays in phototropism). Fast thigmotropism only occurs in a few plant species, and describes a rapid plant response to touch such the way the venus flytrap snaps shut to trap an insect, or the way mimosa plants clamp their leaves closed in response to touch. This response occurs as a result of an electrical signal (much like in animal nervous systems!) which causes rapid changes in cell turgor pressure and thus rapid movement of structures associated wit those cells. This video shows an example of slow thigmotropism (mediated by auxin) in morning glory plants, which require a support structure of some type to grow optimally. The time lapse images were taken at 10 minute intervals (full information about this video can be found here): And this video shows an example of fast thigmotropism (mediated by membrane potential) in a venus flytrap: Plants face two types of enemies: herbivores and pathogens. Herbivores both large and small use plants as food, and actively chew them. Pathogens are agents of disease. These infectious microorganisms, such as fungi, bacteria, and nematodes, live off of the plant and damage its tissues. Plants have developed a variety of strategies to discourage or kill attackers. The first line of defense in plants is an intact and impenetrable barrier. Bark and the waxy cuticle can protect against predators. Other adaptations against herbivory include thorns, which are modified branches, and spines, which are modified leaves. They discourage animals by causing physical damage and inducing rashes and allergic reactions. A plant’s exterior protection can be compromised by mechanical damage, which may provide an entry point for pathogens. If the first line of defense is breached, the plant must resort to a different set of defense mechanisms, such as toxins and enzymes. Herbivory When herbivores breach a plant’s physical defenses, chemical responses are induced to deter further herbivory through a couple of different mechanisms, depending on the plant species: Systemin and jasmonic acid: In some plant species, damage to tissues from insects induces production of a hormone called systemin. Systemin is named for the fact that it travels throughout the plant (systemic) after it is produced locally (though this is true of all hormones, or course). Systemin activates production of jasmonic acid, which induces transcription of proteinase inhibitors. Proteinase inhibitors both taste bad and prevent breakdown of proteins in the herbivore’s gut, thus making the insect sick and deterring further herbifory. Volatile compounds: In some plant species, damage to tissues from insects induces production of volatile chemical attractants which are released into the air and attract certain parasites of the insects that are eating the plant. These parasites are often parasitoid wasps, that lay their eggs inside of the insect eating the plant; when the eggs hatch into larvae, the larvae eat the insect from the inside out and kill it. This video describes some of the chemical signaling that can occur between plants to communicate about herbivory and other threats: Pathogens and Parasites Plants demonstrate two sequential responses to parasites and pathogens, first the hypersensitive response, which then induces the systemic aquired response (SAR): The hypersensitive response occurs when a pathogen infects a plant cell. The response occurs via recognition of specific pathogen molecules, meaning the plant has specialized pathogen-specific receptors capable of detecting the pathogen molecules. Activation of these receptors induces a three-pronged, localized stress response: the plant produces phytoalexins, toxins that help kill the pathogen the cells infected by the pathogen are physically walled off to prevent pathogen escape the cells infected by the pathogen undergo programmed cell death, removing those cells as a food source for the pathogens In addition, activation of the hypersensitive response induces production of the hormone methyl salicylate (MeSA), which then induces activation of the systemic acquired response (SAR). The SAR is only induced in response to the hypersensitive response. The SAR activates transcription of general “pathogenesis-resistance” genes, which are not pathogen-specific (unlike in the hypersensitive response), but serve as general defense against pathogenic infection. The SAR is slower than the hypersensitive response, and also differs in that it is systemic instead of localized to the site of the infection. This video (beginning at 1:58) describes a general overview of the HR and SAR, though it does not mention the signaling molecules by name:

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