**AP Biology Unit 8: Organismal Physiology**

**Big Idea II:** Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

**Enduring understanding 2.C:** Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.

<table>
<thead>
<tr>
<th>Essential knowledge 2.C.1:</th>
<th>Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.</th>
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</thead>
<tbody>
<tr>
<td>Essential knowledge 2.C.2:</td>
<td>Organisms respond to changes in their external environments.</td>
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<tr>
<td>Essential knowledge 2.D.2:</td>
<td>Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.</td>
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<tr>
<td>Essential knowledge 2.D.3:</td>
<td>Biological systems are affected by disruptions to their dynamic homeostasis</td>
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</tbody>
</table>

**My Look-Fors**

<table>
<thead>
<tr>
<th>Where can I find this in my journal?</th>
<th>How did I do on the assessment of this topic?</th>
<th>Do I need extra help with this topic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.</td>
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<tr>
<td>Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.</td>
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<tr>
<td>Operon regulation in genes, thermoregulation in animals, and plant responses to water limitations are all examples of negative feedback.</td>
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<tr>
<td>Choose one example above and describe the negative feedback mechanism it is a part of.</td>
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<tr>
<td>Positive feedback mechanisms amplify responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set-point. Amplification occurs when the stimulus is further activated which, in turn, initiates an additional response that produces system change.</td>
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<tr>
<td>Lactation in mammals, onset of labor in childbirth, and the ripening of fruit are all examples of positive feedback.</td>
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<tr>
<td>Choose one example above and describe the positive feedback mechanism it is a part of.</td>
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<td>Alteration in the mechanisms of feedback often results in deleterious consequences.</td>
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<tr>
<td>Diabetes mellitus, Grave’s disease, and some blood clotting diseases are examples of what can happen when factors are missing in the feedback loop.</td>
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</tbody>
</table>

**Organisms respond to changes in their environment through behavioral and physiological mechanisms. Apply this to the examples below**

<table>
<thead>
<tr>
<th>Photoperiodism and phototropism</th>
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<tbody>
<tr>
<td>Hibernation and Migration in Animals</td>
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<tr>
<td>Taxis and kinesis in animals</td>
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<tr>
<td>Chemotaxis in bacteria or sexual reproduction in fungi</td>
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<tr>
<td>Nocturnal and diurnal activity: circadian rhythms</td>
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<td>Shivering and sweating in humans</td>
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</tbody>
</table>

**Continuity of homeostatic mechanisms reflects common ancestry, while changes may occur in response to different environmental conditions.**

<table>
<thead>
<tr>
<th>What homeostatic mechanisms are found in all life?</th>
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<tbody>
<tr>
<td>Choose one homeostatic mechanism and examine how it is different in different types of organisms</td>
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<tr>
<td>Function of food vacuoles, gastrovascular cavities, and one-way digestive systems</td>
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<tr>
<td>Gas exchange between aquatic and terrestrial animals or aquatic and terrestrial plants</td>
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<tr>
<td>The production and elimination of nitrogenous waste in aquatic &amp; terrestrial animals</td>
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<tr>
<td>Osmoregulation in protists, fish, and bacteria or in aquatic and terrestrial plants</td>
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<tr>
<td>Homeostatic control systems in species of microbes, plants and animals support common ancestry. Choose one example to demonstrate this</td>
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<tr>
<td>Osmoregulation in protists, fish, and bacteria or in aquatic and terrestrial plants</td>
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<tr>
<td>Excretory systems in flatworms, earthworms, and vertebrates</td>
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**Disruptions at the molecular and cellular levels affect the health of the organism.**

<table>
<thead>
<tr>
<th>Physiological responses to toxic substances</th>
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<tbody>
<tr>
<td>Dehydration</td>
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</tbody>
</table>
**Immunological responses to pathogens, toxins, and allergens**

**Plants, invertebrates, and vertebrates have multiple, nonspecific immune responses**

Vertebrate immune systems lack pathogen-specific defense responses

*Plant defenses against pathogens include molecular recognition systems with systemic responses, infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects.*

*Vertebrate immune systems have non-specific AND non-heritable defense mechanisms against pathogens.*

**Mammals** use specific immune responses triggered by natural or artificial agents that disrupt dynamic homeostasis (below all applies to mammals)

- Describe a cell-mediated immune response and the type of white blood cell involved
- Describe a humoral immune response and the type of white blood cell involved
- What is the purpose of antigen? Where is it found?
- What is the purpose of an antibody? What type of cell makes these?
- Why does a second exposure to an antigen result in a more rapid and enhanced immune response?

**Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.**

- Induction of transcription factors during development results in sequential gene expression.
- What are homeotic genes?
  - Embryonic induction in development results in the correct timing of events
  - Temperature and the availability of water determine seed germination in most plants
  - Genetic mutations can result in abnormal developments
  - Genetic regulation of microRNAs plays an important role in the development of organisms and the control of cellular function
  - Apoptosis plays a role in normal development and differentiation, illustrative examples can include morphogenesis of fingers and toes, immune function, C. elegans development, or flower development

**In animals, internal and external signals regulate a variety of physiological responses that synchronize with environmental cycles and cues.**

Plants respond to environmental stimuli by sending internal signal molecules. Required examples are phototropism and photoperiodism

- In animals, internal and external signals regulate a variety of physiological responses that synchronize with environmental cycles and cues.
- Illustrative examples of animal responses to environment can include
  - Circadian rhythms (24 hour cycle) present in all eukaryotes even in the absence of external cues
  - Diurnal/nocturnal and sleep/awake/cycles
  - Jet lag in humans
  - Seasonal responses, such as hibernation, estivation and migration
  - Release and reaction to pheromones
  - Visual displays in the reproductive cycle

Fungi, bacteria, and protists respond to environmental stimuli

- Illustrative examples include: fruiting body formation in fungi, slime molds, and some bacteria, and quorum sensing in bacteria

Explain how these responses are vital to natural selection (what does the organism gain by these responses?)

Behaviors can be learned or innate

- Cooperative behavior within or between populations contributes to the survival of the populations. Illustrative examples can include
  - Availability of resources leading to fruiting body formation in fungi and certain types of bacteria
  - Niche and resource partitioning
  - Mutualistic relationships (lichens; bacteria in digestive tracts; mycorrhizae)
  - Biology of pollination

Signal transmission within and between cells mediate gene expression

Cytokines regulate gene expression allowing cell replication and division
Mating pheromones in yeast trigger mating gene expression

Levels of cAMP regulate metabolic gene expression in bacteria

Expression of the SRY gene triggers the male sexual development pathway in animals

Ethylene levels cause changes in the production of different enzymes, allowing fruit to ripen

Seed germination and gibberelin

Signal transmission within and between cells mediates cell functions

Mating pheromones in yeast trigger mating genes expression and sexual reproduction

Morphogens stimulate cell differentiation and development

Changes in p53 activity can result in cancer

HOX genes and their role in development

Communication involves transduction of stimulatory or inhibitory signals from other cells, organisms, or the environment

Correct and appropriate signal transduction processes are generally under strong selective pressure

In single celled organisms signal transduction pathways influence how a cell responds (quorum sensing, pheromones, and signals influencing movement)

In multicellular organisms, signal transduction pathways coordinate the activities between individual cells that support the function of the organism as a whole

Epinephrine stimulating glycogen breakdown in mammals

Temperature determination of sex in some vertebrates

DNA repair mechanisms

Cells can communicate over short and long distances and by coming in contact with another cell.

Describe how immune cells use antigen and antibodies to communicate through contact

Describe how plant cells transmit messages using plasmodesmata

Describe how bacteria use quorum sensing to communicate over a short distance

Describe how neurotransmitters communicate messages across the synaptic gap

Endocrine signals are produced by endocrine cells that release signaling molecules, which are specific and can travel long distances through the blood to reach all parts of the body. Examples include testosterone, estrogen, human growth hormone, thyroid hormones, insulin

Signal transduction pathways link signal reception with cellular response.

Signaling begins with the recognition of a chemical messenger, a ligand, by a receptor protein.

Different receptors recognize different chemical messengers, which can be peptides, small chemicals or proteins, in a specific one-to-one relationship.

A receptor protein recognizes signal molecules, causing the receptor protein’s shape to change, which initiates transduction of the signal.

G-protein linked receptors • Ligand-gated ion channels • Receptor tyrosine kinases are all examples of receptor proteins

Signal transduction is the process by which a signal is converted to a cellular response.

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, with the result of appropriate responses by the cell

Second messengers are often essential to the function of the cascade, examples can include cyclic GMP, cyclic AMP calcium ions (Ca2+), and inositol triphosphate (IP3)

Many signal transduction pathways include: protein modifications such as methylation, the addition of a methyl group, or phosphorylation cascades, in which a series of protein kinases add a phosphate group to the next protein in the cascade sequence, are essential in some signaling pathways.
### Conditions where signal transduction is blocked or defective can be deleterious, preventative or prophylactic.

Diseases who disrupt signal transduction pathways include: Diabetes, heart disease, neurological disease, autoimmune disease, cancer, cholera.

Substances who disrupt signal transduction pathways include: neurotoxins, poisons, pesticides, and drugs.

Some drugs are used for their ability to disrupt a signal transduction pathway, examples are hypertensives, anesthetics, birth control, and antihistamines.

- **Organisms exchange information with each other in response to internal changes and external cues, which can change behavior.**
  - Living systems have a variety of signal behaviors or cues that produce changes in the behavior of other organisms and can result in differential reproductive success.
  - List examples of signal behaviors used by populations.
  - Animals use visual, audible, tactile, electrical and chemical signals to indicate dominance, find food, establish territory and ensure reproductive success.
  - List examples of animal behaviors.
  - Natural selection favors innate and learned behaviors that increase survival and reproductive fitness.
  - Describe how these behaviors increase an organism’s fitness: • Parent and offspring interactions • Migration patterns • Courtship and mating behaviors • Foraging in bees and other animals • Avoidance behavior to electric fences, poisons, or traps.
  - Cooperative behavior tends to increase the fitness of the individual and the survival of the population.
  - Describe how these cooperative behaviors increase fitness: • Pack behavior in animals • Herd, flock and schooling behavior in animals • Predator warning • Colony and swarming behavior in insects.

### The neuron is the basic structure of the nervous system that reflects function.

- Describe a neuron’s structure (cell body, dendrites, axon, axon terminals, myelin sheath).
- The structure of the neuron allows for the detection, generation, transmission and integration of signal information.
- How are schwann cells related to neurons? Where are they found? What do they make?
- Transmission of information between neurons occurs across synapses.
- In most animals, transmission across synapses involves chemical messengers called neurotransmitters that results in a response that can be stimulatory or inhibitory.
- Describe the effects of Acetylcholine, Epinephrine, Norepinephrine, Dopamine, Serotonin, GABA.

### Different regions of the vertebrate brain have different functions.

- Describe which regions are responsible for Vision, Hearing, Muscle movement, Abstract thought and emotions, and Neuro-hormone production.
- Identify the hemispheres, the brainstem, cerebellum, and cerebrum in the brain.

### Organisms exhibit complex properties due to interactions between their constituent parts.

- How do interactions and coordination between organs provide essential biological activities? (stomach and small intestine; kidney and bladder; roots, stem, and leaves)
- How do interactions and coordination between organ systems provide biological activities? (circulatory system and respiratory system; nervous and muscular systems)