

SUGGESTED SKILL

 *Concept Explanation*

1.B

Explain biological concepts and/or processes.



AVAILABLE RESOURCES

- Classroom Resource > [Cell-to-Cell Communication—Cell Signaling](#)

ILLUSTRATIVE EXAMPLES

Cell-to-Cell Contact

IST.3.A.1

- Immune cells interact by cell-to-cell contact, antigen-presenting cells (APCs), helper T-cells, and killer T-cells.
- Plasmodesmata between plant cells allow material to be transported from cell to cell.

Cell Communication Using Local Regulators IST-3.B.1

- Neurotransmitters
- Plant immune response
- Quorum sensing in bacteria
- Morphogens in embryonic development

IST-3.B.1.a

- Insulin
- Human growth hormone
- Thyroid hormones
- Testosterone
- Estrogen

TOPIC 4.1

Cell Communication

Required Course Content

ENDURING UNDERSTANDING

IST-3

Cells communicate by generating, transmitting, receiving, and responding to chemical signals.

LEARNING OBJECTIVE

IST-3.A

Describe the ways that cells can communicate with one another.

IST-3.B

Explain how cells communicate with one another over short and long distances.

ESSENTIAL KNOWLEDGE

IST-3.A.1

Cells communicate with one another through direct contact with other cells or from a distance via chemical signaling—
a. Cells communicate by cell-to-cell contact.

IST-3.B.1

Cells communicate over short distances by using local regulators that target cells in the vicinity of the signal-emitting cell—
a. Signals released by one cell type can travel long distances to target cells of another cell type.

TOPIC 4.2

Introduction to
Signal Transduction

SUGGESTED SKILL

 *Concept Application***1.A**

Describe biological concepts and/or processes.



Required Course Content

AVAILABLE RESOURCES

- Classroom Resource > [Cell-to-Cell Communication—Cell Signaling](#)

ENDURING UNDERSTANDING

IST-3

Cells communicate by generating, transmitting, receiving, and responding to chemical signals.

LEARNING OBJECTIVE

IST-3.C

Describe the components of a signal transduction pathway.

IST-3.D

Describe the role of components of a signal transduction pathway in producing a cellular response.

ESSENTIAL KNOWLEDGE

IST-3.C.1

Signal transduction pathways link signal reception with cellular responses.

IST-3.C.2

Many signal transduction pathways include protein modification and phosphorylation cascades.

IST-3.D.1

Signaling begins with the recognition of a chemical messenger—a ligand—by a receptor protein in a target cell—

- The ligand-binding domain of a receptor recognizes a specific chemical messenger, which can be a peptide, a small chemical, or protein, in a specific one-to-one relationship.
- G protein-coupled receptors are an example of a receptor protein in eukaryotes.

IST-3.D.2

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, resulting in the appropriate responses by the cell, which could include cell growth, secretion of molecules, or gene expression—

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LEARNING OBJECTIVE**IST-3.D**

Describe the role of components of a signal transduction pathway in producing a cellular response.


ESSENTIAL KNOWLEDGE

- a. After the ligand binds, the intracellular domain of a receptor protein changes shape, initiating transduction of the signal.
- b. Second messengers (such as cyclic AMP) are molecules that relay and amplify the intracellular signal.
- c. Binding of ligand-to-ligand-gated channels can cause the channel to open or close.

TOPIC 4.3

Signal Transduction

SUGGESTED SKILL

 *Argumentation*

6.C

Provide reasoning to justify a claim by connecting evidence to biological theories.



Required Course Content

ENDURING UNDERSTANDING

IST-3

Cells communicate by generating, transmitting, receiving, and responding to chemical signals.

LEARNING OBJECTIVE

IST-3.E

Describe the role of the environment in eliciting a cellular response.

IST-3.F

Describe the different types of cellular responses elicited by a signal transduction pathway.

ESSENTIAL KNOWLEDGE

IST-3.E.1

Signal transduction pathways influence how the cell responds to its environment.

IST-3.F.1

Signal transduction may result in changes in gene expression and cell function, which may alter phenotype or result in programmed cell death (apoptosis).

AVAILABLE RESOURCES

- Classroom Resource > [Cell-to-Cell Communication—Cell Signaling](#)

ILLUSTRATIVE EXAMPLES


Using Signal Transduction to Respond to the Environment

- Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing)
- Epinephrine stimulation of glycogen breakdown in mammals

IST-3.F.1

- Cytokines regulate gene expression to allow for cell replication and division.
- Mating pheromones in yeast trigger mating gene expression.
- Expression of the *SRY* gene triggers the male sexual development pathway in animals.
- Ethylene levels cause changes in the production, of different enzymes allowing fruits to ripen.
- HOX genes and their role in development.

SUGGESTED SKILL

 Argumentation

6.E.b

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.



AVAILABLE RESOURCES

- Classroom Resource > [Cell-to-Cell Communication—Cell Signaling](#)

TOPIC 4.4

Changes in Signal Transduction Pathways

Required Course Content

ENDURING UNDERSTANDING

IST-3

Cells communicate by generating, transmitting, receiving, and responding to chemical signals.

LEARNING OBJECTIVE

IST-3.G

Explain how a change in the structure of any signaling molecule affects the activity of the signaling pathway.

ESSENTIAL KNOWLEDGE

IST-3.G.1

Changes in signal transduction pathways can alter cellular response—

- Mutations in any domain of the receptor protein or in any component of the signaling pathway may affect the downstream components by altering the subsequent transduction of the signal.


IST-3.G.2

Chemicals that interfere with any component of the signaling pathway may activate or inhibit the pathway.

TOPIC 4.5

Feedback

SUGGESTED SKILL

 Argumentation

6.E.b

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.



Required Course Content

ENDURING UNDERSTANDING

ENE-3

Timing and coordination of biological mechanisms involved in growth, reproduction, and homeostasis depend on organisms responding to environmental cues.

LEARNING OBJECTIVE

ENE-3.A

Describe positive and/or negative feedback mechanisms.

ENE-3.B

Explain how negative feedback helps to maintain homeostasis.

ENE-3.C

Explain how positive feedback affects homeostasis.

ESSENTIAL KNOWLEDGE

ENE-3.A.1

Organisms use feedback mechanisms to maintain their internal environments and respond to internal and external environmental changes.

ENE-3.B.1

Negative feedback mechanisms maintain homeostasis for a particular condition by regulating physiological processes. If a system is perturbed, negative feedback mechanisms return the system back to its target set point. These processes operate at the molecular and cellular levels.

ENE-3.C.1

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.

AVAILABLE RESOURCES

- Classroom Resource > [Cell-to-Cell Communication—Cell Signaling](#)

ILLUSTRATIVE EXAMPLE


ENE-3.B.1

- Blood sugar regulation by insulin/glucagon

ENE-3.C.1


- Lactation in mammals
- Onset of labor in childbirth
- Ripening of fruit

SUGGESTED SKILLS

 *Representing and Describing Data*

4.B.b

Describe data from a table or graph, including describing trends and/or patterns in the data.

 *Statistical Tests and Data Analysis*

5.A.e

Perform mathematical calculations, including percentages.



AVAILABLE RESOURCES

- AP Biology Lab Manual > [Mitosis Lab](#)

TOPIC 4.6

Cell Cycle

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.B

Describe the events that occur in the cell cycle.

IST-1.C

Explain how mitosis results in the transmission of chromosomes from one generation to the next.

ESSENTIAL KNOWLEDGE

IST-1.B.1

In eukaryotes, cells divide and transmit genetic information via two highly regulated processes.

IST-1.B.2

The cell cycle is a highly regulated series of events for the growth and reproduction of cells—

- The cell cycle consists of sequential stages of interphase (G₁, S, G₂), mitosis, and cytokinesis.
- A cell can enter a stage (G₀) where it no longer divides, but it can reenter the cell cycle in response to appropriate cues. Nondividing cells may exit the cell cycle or be held at a particular stage in the cell cycle.

IST-1.C.1


Mitosis is a process that ensures the transfer of a complete genome from a parent cell to two genetically identical daughter cells—

- Mitosis plays a role in growth, tissue repair, and asexual reproduction.
- Mitosis alternates with interphase in the cell cycle.
- Mitosis occurs in a sequential series of steps (prophase, metaphase, anaphase, telophase).

TOPIC 4.7

Regulation of
Cell Cycle

SUGGESTED SKILL

 Argumentation

6.E.a

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on biological concepts or processes.

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.D

Describe the role of checkpoints in regulating the cell cycle.

IST-1.E

Describe the effects of disruptions to the cell cycle on the cell or organism.

ESSENTIAL KNOWLEDGE

IST-1.D.1

A number of internal controls or checkpoints regulate progression through the cycle.

IST-1.D.2

Interactions between cyclins and cyclin-dependent kinases control the cell cycle.

EXCLUSION STATEMENT—*Knowledge of specific cyclin-Cdk pairs or growth factors is beyond the scope of the course and the AP Exam.*

IST-1.E.1

Disruptions to the cell cycle may result in cancer and/or programmed cell death (apoptosis).