uBEATS Teacher's Guide:

Cellular Adaptation & Death

(Grades 11-12)

This teacher guide is a supplementary text to support the use of the uBEATS Cellular Adaptation and Death module for grades 11-12.

To help students develop the knowledge necessary for an incredible future in health care, we created UNMC Building Excellence in Academics Through STEM (uBEATS), an online health science resource for Nebraska students.

UNMC uBEATS modules are short (15 minutes or less), interactive online health science modules to supplement curriculum taught in grades 6 – 12. These do not replace curriculum, but are a supplement for teachers and students incorporating evidence based information and UNMC expert guided material. Each module is chunked into sections with formative and summative assessments with immediate feedback provided.

Tips on how to utilize uBEATS modules:

- Internet access is required to view uBEATS modules.
- For those who have access to one-to-one technology, modules can be used in or outside of the classroom as a topic introduction, extension, or review.
- For classrooms without individual student devices modules can be used in whole group instruction. Formative assessment questions can use the teacher's preferred call and response method and summative assessment questions can be displayed on the board and answered individually by students or printed and distributed to students after viewing the module.

Objectives

- Define each type of cellular adaptation: atrophy, hypertrophy, dysplasia, hyperplasia, and metaplasia.
- Distinguish between necrosis and apoptosis.
- Discuss causes of necrosis and apoptosis.

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Introduction

As the cellular environment changes, the cells themselves can undergo changes in size, shape, number, or cell type. Such responses to the environment are called cellular adaptation. In addition to adaptive changes, there are times when the cell's functions totally cease. Cell death can be prompted in two different ways. One cause of cell death is apoptosis, a regulated process that occurs naturally in the cell cycle. Another cause is necrosis, which can be brought on by external injury or infection.

Prior Knowledge

Before beginning this module, the student should understand the Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning.

Core Idea LS1.A. Structure and Function

- ***By the end of grade 12***. Systems of specialized cells within organisms help them perform the essential functions of life, which involve chemical reactions that take place between different types of molecules, such as water, proteins, carbohydrates, lipids, and nucleic acids. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Outside that range (e.g., at a too high or too low external temperature, with too little food or water available), the organism cannot survive. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.

Core Idea LS1.B. Growth and Development of Organisms

- ***By the end of grade 12***. In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. As successive subdivisions of an embryo's cells occur, programmed genetic instructions and small differences in their immediate environments activate or inactivate different genes, which cause the cells to develop differently—a process called differentiation. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. In sexual reproduction, a specialized type of cell division called meiosis occurs that results in the production of sex cells, such as gametes in animals (sperm and eggs), which contain only one member from each chromosome pair in the parent cell. A Framework for K-12 Education.

Science and Engineering Practices **NGSS**

- Constructing explanations and designing solutions

Crosscutting Concepts NGSS

- Structure and function

Key Terms/Vocabulary

Cellular adaptation, apoptosis, necrosis, atrophy, hypertrophy, dysplasia, hyperplasia, metaplasia, plasticity, caspases, proteolytic enzymes, proapoptotic proteins, apoptotic bodies, lysosome, macrophage.

Science Standards

This module is related to the content of **UNMC High School Alliance: Introduction to Pathology and Microbiology**

Pathology is the study of disease processes. The field lays the foundation for all of clinical medicine and medical research. All diseases begin at the cellular level and changes in the structure and function of tissues ultimately lead to symptoms that health care providers see on a daily basis. This course will introduce students to medical terminology, normal histology and gross/microscopic pathology, allowing students to correlate the findings they see into basic clinical concepts.

Nebraska's College and Career Ready Standards for Science 2024 Nebraska Science Standards

Biology Structure and Function: SC.HSP.6.1.F

- Construct an explanation based on evidence that animals have structures that function to support survival, growth, behavior, and reproduction. Emphasis is on the basic principles of animal form and functions. Examples of basic principles could include animal nutrition, circulation, gas exchange, immunity, osmoregulation and excretion, hormonal and endocrine control, reproduction, development, neural control systems, and animal behavior.

Extensions of the lesson

- To help students become more familiar with the Key Terms of this module, the teacher can use the vocabulary list for a classroom Word Wall, or integrate the vocabulary into classroom word games during review sessions.
- To help the students see personal relevance, suggest that they have a private family conversation about their own experiences with bruises and/or skin scrapes to analyze what actually happens and what to do about such injuries.
- For active visuals that help students grasp the concepts, use an online search engine with the search term "video" followed by a vocabulary term.
- As student misconceptions become apparent, the teacher may need to reinforce these important concepts:
  - In biology, "-trophy" is a suffix referring to nutrition. When a cell suffers from atrophy, it shrinks. The opposite of atrophy is hypertrophy, in which the cell grows larger.
  - In biology, "-plasia" is a suffix referring to formation. In dysplasia, the cell shows abnormal formation. In hyperplasia, there is an increase in the number of cells. In metaplasia, the actual type of cell changes.
  - Metaplasia can be unhealthy (e.g. as a precursor to cancer), but metaplasia as it occurs in response to an irritant can be a healthy cellular adaptation.
  - Apoptosis is the process in which individual cells cause their own death. This is a normal, healthy function in the body to maintain the proper quality and quantity of cells.
  - Apoptosis is also a "clean" process that leaves behind no mess. The components of the dead cell are packaged and processed for recycled use in the body.
  - Necrosis, on the other hand, is unnatural. This kind of death is caused by external influences and it affects groups of cells, which die and spill their contents. This process in turn affects surrounding tissue.

Enrichment

- For information about Healthcare Career Opportunities, see the UNMC Health Career Book.
- To make connections in your community, contact local hospitals, healthcare clinics, nurses, doctors.
- To search online for lab activities, look for "lab activities cell death."