uBEATS Teacher's Guide:

Bone Growth and Clinical Application to Dentistry

This teacher guide is a supplementary text to support the use of the uBEATS "Bone Growth and Clinical Application to Dentistry" 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 they 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

- Describe and differentiate bone cell types and their functions.
- Describe types of bones and identify the locations of each in the human body.
- Describe the function of collagen and how collagen associates with bone and cartilage.
- Explain the process of bone formation and ossification.
- Compare and contrast endochondral and intramembranous ossification and provide examples of each.
- Identify histological zones at growth plates of long bones.
- Apply the foundational knowledge to clinical applications in dentistry, including clinical presentations of Cleidocranial Dysplasia and osseointegration as it relates to dental implantation.

Introduction

Bones play a vital role in the everyday functioning of your body. Bones support the tissues of the body and protect vital structures like the heart and lungs. They provide the mechanical basis for movement, regulate calcium levels, provide a continuous supply of new blood cells.

Prior Knowledge

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

Core Idea LS1.A: Structure and Function. A Framework for K-12 Science Education

How individual organisms are configured and how these structures function to support life, growth, behavior, and reproduction. The first core idea hinges on the unifying principle that cells are the basic unit of life.

Science and Engineering Practices NGSS

Asking questions and defining problems

Crosscutting Concepts NGSS

Patterns; Structure and Function

Key Terms/Vocabulary

Bone, collagen, cartilage, ossification, endochondral ossification, intramembranous ossification, histological zones, growth plate, axial skeleton, appendicular skeleton, osteoblast, osteocyte, extracellular matrix, osteoid, bone matrix, bone spicules, spongy bone, compact bone, osteoclast, bone resorbing, bone deposition, periosteum, trabeculae, bone marrow, long bones, short bones, flat bones, irregular bones, sesamoid bones, cuboidal bone, tubular bone, tendon, cartilage precursor, mesenchyme, connective tissue, ossification center, osteoprogenitor cells, cartilaginous bone formation, chondroblast, chondrocyte, hyaline cartilage, zone of reserve cartilage, zone of proliferation, zone of hypertrophy, zone of calcified cartilage, zone of resorption, bone modeling, remodeling, woven bone, lamellar bone, appositional growth, interstitial growth, epiphyses, articular cartilage, epiphyseal plate, cranial synchondroses, orthodontics, dental implants, cleidocranial dysplasia, primary teeth, permanent teeth, supernumerary teeth, osseointegration, bisphosphonates, osteogenesis, osteonecrosis.

Science Standards

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

  SC.HSP.6.3. Gather, analyze, and communicate evidence of the relationship between structures and physiological processes of the skeletal system.

- National Consortium for Health Science Education **NCHSE**

  1.1.2.a. Identify basic structures and describe functions of the human skeletal system.

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 review sessions.

The strenuous vocabulary of this module can be intimidating. As student misconceptions become apparent, the teacher may need to reinforce these important concepts:

- Basic root words appear within longer words:
  - "-cyte" means cell.
  - "osteo-", "osseo-", "ossi-" all mean bone.
  - "chondro-" means cartilage.
  - "-blast" means germinate or form.
  - "-clast" means break down.
- There are two different processes that develop bones in a fetus. One involves cartilage templates, while the other does not.
  - **Intramembranous ossification** involves these steps: mesenchymal cells to osteoprogenitor cells to osteoblasts to osteoid (bone matrix) to osteocytes.
  - **Endochondral ossification** involves these steps: mesenchymal cells secrete type II collagen to chondroblasts to cartilage model to osteoprogenitor cells to osteoblasts to osteocytes.
- Once bones have formed, they continue to actively change.
  - During bone modeling, bone size and shape can change.
  - During bone remodeling, bone size and shape remain the same. This process involves selective bone resorption by osteoclasts, followed by replacement deposits from osteoblasts.

Enrichment

Use a browser to search the Internet for information about "Embryonic and Fetal Bone Formation" at sites such as med.libretexts.org

Search for information about "Dental Implants."

Explore the differences between bone modeling and bone remodeling.