MaLa Scientific

Lakshmi Atchison, Ph.D.

"Think Inside the Box" Human Skin Model and NGSS standards.

NGSS standards: the Mala Scientific Human Skin Model embraces student centered inquiry-based pedagogy. Our skin models are designed for student hands-on experiences for learning the integumentary system. Using a lesson plan and colorful guides students assemble and instantly learn the complexity of the 40 epidermal layers. This experience will leave students with lasting knowledge of the complexities and interconnected cells and tissues in the integumentary system.

- **High School Life Sciences**
- **HS Structure and Function: Anatomy, Physiology, Inheritance, Development and Differentiation**

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

How does this course HS-LS1-1 relate to the Human skin model? The cells of the skin are genetically programmed to divide in the innermost later (stratum Basale) of the skin where stem cells are located. DNA in the stem cells replicate and cells continuously divide in an orderly manner. DNA determines the structure of various skin proteins like collagen, elastin, keratin, melanin, and others. Our lessons enable students to construct a skin model, understand skin structure, and identify cell types that produce specific proteins encoded by DNA. The complexity of epidermal layers with specific cells and tissue types makes skin the first major system studied in natural science classrooms.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

The Mala Scientific Skin model is a perfect example to address this HS-LS1-2 unit. The complexity of the integumentary system illustrates the hierarchical organization of interacting systems. Using the "Think inside the Box" model and lesson plan, students immediately observe the hierarchical organization of interacting systems. They learn specific functions within cells and tissues of multicellular organisms. For example, the epidermis of the skin contains about 40 layers with specialized cells that perform specific functions. These cells produce proteins like keratin, collagen, melanin, and others. Within these multicellular epidermal, dermal, and hypodermal layers, there are 4 major tissues such as epithelial, connective, muscle, and nervous tissues. The precise organization of cells and tissues perform many major functions including protection, immunity, thermoregulation, and homeostasis making this a unique system within multicellular organisms.

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]

For HS-LS1-3, the Human Skin Model and Lesson Plan is an excellent approach to show feedback mechanisms. In hot temperatures, skin sweats through pores present in the outermost layer thus cooling the surface. Alternatively, in cold temperatures arrector pili muscles supporting each hair follicle strand straight (observed as 'goose bumps') thereby trapping heat. We experience this daily! This feedback mechanism maintains internal conditions within narrow limits. These are clearly illustrated and explained with critical thinking questions when students assemble the Think Inside the Box model.

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.

How do our models fit for HS-LS1-4 ? The Mala Scientific Skin model and lesson plan illustrates how cell division followed by differentiation of numerous specific cell types demonstrates the functional complexity of specific skin layers. This process results in 40 or more epidermal layers. Growth occurs due to cell division in the innermost layer (stratum Basale) of the skin where stem cells reside that maintain the integrity of the multicellular organ system.

HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

The Mala Scientific Skin Model and Lesson Plans present the orderly development and organization of skin structure. Construction of the skin model brings the precise organization of 40 layers of skin, cell types, and tissues into clarity. Environmental factors can cause mutations as can exposure to certain chemicals and tanning. Harmful UV rays from the sun can cause skin cancers such as basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and melanoma. There are about 1-2 million cases of BCC reported annually in the United States. Mutations in certain genes predispose some individuals to BCC. To date, two genes called CDKN2A and CDK4 have been primarily linked to familial melanoma. A mutation (alteration) in either of these genes gives a person an increased risk of melanoma.