Planning Tool: Biology with Earth and Space Science – Fayette County Public Schools

Unit: 3B - Cell Division and Differentiation

Unit Question:  With environments changing constantly, how do organisms maintain a balance?

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| Unit lesson:  [Cell Division and Genetics Mitosis and the Cell Cycle - How a Single Cell Develops into the Trillions of Cell in a Human Body](https://serendipstudio.org/sci_edu/waldron/#mitosis)  |
| Date/Dates January 11-15, 2021 |
| Investigation Question: How do cells produce genetically identical daughter cells?Learning Intention: I am learning to explain the process DNA replication and and mitosis. |
| Success Criteria: I know I am successful when I can use a model to illustrate the role of cellular division (mitosis) in producing and maintaining complex organisms.  |
| Learning Goals Aligned to NGSS (KAS for Science)Crosscutting Concepts* Systems and System Models – … Models can be valuable in predicting a system’s behaviors…"
* Cause and Effect: Mechanism and Explanation – … A major activity of science is to uncover such causal connections, often with the hope that understanding the mechanisms will enable predictions… [Students] suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about small-scale mechanisms within the system

Scientific Practices:* Developing and Using Models – Develop, revise, and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
* Constructing Explanations – Apply scientific ideas, principles and/or evidence to provide an explanation of phenomena….

Disciplinary Core Ideas:* LS1.A: Structure and Function – "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."
* LS1.B: Growth and Development of Organisms – "In multicellular organisms individual cells grow and then divide by 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. 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."
* LS3.A: Inheritance of Traits – "Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content …"
 | Delivery Synchronous/ AsynchronousTeacher Determined | Key Learning Concepts:* Each cell contains chromosomes and each chromosome contains a long DNA molecule. Each DNA molecule has many genes. A gene provides the instructions for making a protein. Different versions of a gene are called alleles, and different alleles give the instructions for making different versions of a protein. These different versions of a protein can result in different phenotypic characteristics.
* Chromosomes come in pairs of homologous chromosomes. In each pair of homologous chromosomes, both chromosomes have the same genes at the same locations, but a gene may have different alleles in the two chromosomes of a homologous pair.
* The cell cycle includes two growth phases, DNA replication, mitosis and cytokinesis. DNA replication and mitosis ensure that each daughter cell receives a complete copy of the DNA in the parent cell. The cell cycle produces new cells for growth and repair.
* At the beginning of mitosis, the two copies of the DNA in each chromosome are condensed into compact sister chromatids which are attached at a centromere. During mitosis, spindle fibers line up the chromosomes in the middle of the cell and then separate the sister chromatids of each chromosome, resulting in two complete sets of chromosomes at opposite ends of the cell.
* At the end of mitosis, cytokinesis separates the two halves of the cell to form two genetically identical daughter cells.
* An exponential growth model illustrates how the number of cells can increase from a single-cell zygote to roughly a trillion cells in a newborn baby. If each cell divided each day, the number of cells would double each day; after 40 days, this would produce a trillion cells.

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| Instructional Suggestions and Background Knowledge:Scientists have estimated that a newborn baby has 1-4 trillion cells and an adult has 20-40 trillion cells (not counting bacteria;<http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002533>). You may want to show your students this one-minute time-lapse video of zygotes developing in vitro (<https://www.youtube.com/watch?v=4TGiIW7-9eQ>). Many students have difficulty distinguishing the concepts of DNA, genes and chromosomes, so you will probably want to reinforce student understanding that a gene is part of a DNA molecule contained in a chromosome.In the Student Handout a gene is defined as a segment of DNA that gives the instructions for making a protein. You should be aware that the definition of a gene has changed as scientific understanding has progressed. Initially, a gene was conceived as a unit of heredity that determines a phenotypic characteristic. A more sophisticated contemporary definition of a gene is a segment of DNA that codes for an RNA molecule, which may be pre-mRNA (which is modified to be messenger RNA that codes for the sequence of amino acids in one or more proteins), ribosomal RNA, transfer RNA or regulatory RNA. There is no single universally agreed-upon definition of a gene at this time. The changing definition of a gene illustrates the constantly evolving nature of science as scientists develop progressively more sophisticated understanding of concepts such as the gene. For additional information about the challenges and complexities of defining a gene, see<http://www.biologyreference.com/Fo-Gr/Gene.html>.The Student Handout includes the statement, "each cell needs to have a complete set of chromosomes". As you no doubt know, there are exceptions to this generalization, e.g. mammalian red blood cells (which do not have any chromosomes) and gametes (which have only one from each pair of homologous chromosomes).[1] To avoid undue complexities, we have omitted discussion of the special case of red blood cells and we have postponed discussion of gametes to “Meiosis and Fertilization – Understanding How Genes Are Inherited” (<http://serendipstudio.org/sci_edu/waldron/#meiosis>).For additional information on the cell cycle, see<https://courses.lumenlearning.com/biology1/chapter/the-cell-cycle/>. If you would like your students to know more about DNA replication, you can use pages 3-4 of the Student Handout for “DNA Structure, Function and Replication” (<https://serendipstudio.org/exchange/bioactivities/DNA>). |
| Differentiation strategies:ELL students – review the science specific use of the word gene, DNA, chromosome, Use visual aides and guides along with manipulativesFormative Assessments:Continuous monitoring of student responses looking for pre-conceptions and misunderstandings to guide instruction. |
| Technologies to implement? (Jamboard, PearDeck, Nearpod, Google Classroom, etc.) |
| Notes for alternate methods of delivery  |