**AP® Biology**

***QUICK REFERNCE***

**CLASS WEBSITE**

https://ftcsc.instructure.com

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**CONTACT INFORMATION**

* e-mail: paul.osterman@ftcsc.k12.in.us
* school 317-803-5674

**GRADE BREAKDOWN**

Tests 65%

Labs/Projects 25%

Quizzes/Homework 10%

**REQUIRED MATERIALS**

* Textbook: *Biology, AP® Edition*, Campbell, Neil A. and J. Reece, 8th Edition (2008)
* Pen and Pencil
* Calculator (simple, four-function with square root button)
* Colored pencils (small set)
* Three-ring binder to organize materials (optional)

**Advance Placement Biology**

Course Overview

This AP Biology course is designed to offer students a solid foundation to introductory college-level biology. By structuring the course around the four Big Ideas, Enduring Understandings, and Science Practices as outlined by the College Board, students will be assisted in developing an appreciation for the study of life and helped to identify and understand unifying principles within a diversified biological world.

Science is a way of knowing. Therefore, knowing about Biology requires that students learn the process of inquiry and develop critical thinking skills. The course will focus not only on knowing science content, but also learning skills to analyze and interpret data, and to communicate information in a meaningful way to others.

At the end of the course, students will have an awareness of the integration of other sciences into the study of Biology, understand how our own species is similar, yet different from other species, and become knowledgeable and responsible citizens by understanding biological issues that could potentially impact their lives.

Course Expectations

AP Biology is a challenging and fun course. It provides students with an opportunity to develop a conceptual framework for modern biology, emphasizing applications of biological knowledge and critical thinking to environmental and social concerns. This is a college-level course, and students will be held to high expectations and mature responsibilities just like a college freshman Biology major taking Introduction to Biology.

A good rule-of-thumb for time required outside of class is 1-2 hours per hour of class time. This means students should expect to spend 5-10 hours each week outside of class studying and completing various tasks. Some of the required AP labs require more time than our class periods allow. There will be occasions when students will need to spend lab time outside of regular school hours. Students may have to come in before and/or after school to complete certain labs.

The AP Biology Exam will be taken on Monday, May 14, 2018, at 8:00am. Everything students do in this class will prepare them to pass the AP exam. To prepare students for the AP exam, all unit tests will have an AP format, including multiple choice, free response, and grid-in questions.

Instructional Context

This course in AP biology will be taught to seniors. Students taking AP Biology do so as a capstone to their AP science studies. Many of the students who enroll in the course have previously taken AP courses like AP Chemistry. Classes meet daily for approximately fifty- minutes per class period. Students enrolling in the course typically have a significant interest in science and research and may major in some sort of science in college.

Late Work

If any work will be turned in late, the student must discuss the situation with the instructor prior to the due date. At the instructor’s discretion, additional time for the work *may* be granted. In such instances, penalties related to the score earned for the assigned may also be levied.

Assessment

Tests will be regularly administered throughout each semester. Tests cover material from multiple chapters. Additionally, tests will be cumulative. After the first test, subsequent tests will be constructed such that 90% of the test will evaluate current material and the remaining percentage of the test will be over any prior content. This is done because the AP exam in May will be a cumulative test.

Labs are a major component of the course. You will regularly perform laboratory investigations related to the content covered in the various instructional units. You are expected to be prepared for all labs by understanding content, reading laboratory instructions, and preparing for the instructor any questions that you may have.

Selected portions of the laboratory work may be completed outside of class time, either before or after school or on specified “lab nights,” to fulfill the laboratory experience requirement. Formal lab write-ups will be due approximately one week after labs are completed. Evaluative emphasis will be placed on methodology, representation of data, and analysis.

Quizzes will be given regularly as a means of checking to make sure students are mastering content as they progress through each unit. Individual quizzes will be short, usually 5-10 questions in length, and will always be announced in advance. Some quizzes will be taken using Clickers.

Bonus opportunities will be assigned at the instructor’s discretion.

Instructional Resources

1. Campbell, Reece et al., *Biology* 8th ed. 2008. Pearson Benjamin Cummings. ISBN – 978-0-13-135691-7

2. Science News – used for current updates and expansions of topics covered in class.

3. DVD’s – Human Genetics, BioSci II, Cells – used for additional images and movies on course related topics.

4. The Web – various web sites (The Biology Project, The Biology Place, NCIM etc.) are used to

 expand topics, provide reading documents or for searching out answers to

 questions raised in class.

5. Howard Hughes Medical Institute video series – used for several topics in the evolution unit.

6. Software – Logger Pro, Excel and Word (for processing data and writing lab reports).

7. *AP Biology Investigative Labs: an Inquiry Based Approach*

Advanced Placement Biology Content

This course in AP Biology is structured around the four Big Ideas; the Enduring Understandings within the big Ideas, and the Essential Knowledge within the Enduring Understandings.

**The Big Ideas:**

**Big Idea 1**: The process of evolution drives the diversity and unity of life.

**Big Idea 2**: Biological systems utilize fee energy and molecular building blocks to grow, to

 Reproduce, and to maintain dynamic homeostasis.

**Big Idea 3**: Living systems store, retrieve, transmit and respond to information essential to life processes.

**Big Idea 4**: Biological systems interact and these systems and their interactions possess complex properties.

The Investigative Laboratory Component

The course is structured around inquiry in the lab and the use of seven science practices throughout the course. Students will be given the opportunity to engage in student-directed laboratory investigations throughout the course using a minimum of 25% of instructional time. Students will conduct a minimum of eight inquiry-based investigations (two per big idea) throughout the course, as described in *AP Biology Investigative Labs: an Inquiry Based Approach.* The science practices covered by each lab are listed in this document. These practices are:

The Seven Science Practices

1. The student can use representations and models to communicate scientific phenomena and solve scientific

 problems.

2. The student can use mathematics appropriately.

3. The student can engage in scientific questioning to extend thinking or to guide investigations within the

 context of the AP course.

4. The student can plan and implement data collection strategies appropriate to a particular scientific question.

5. The student can perform data analysis and evaluation of evidence.

6. The student can work with scientific explanations and theories.

7. The student is able to connect and relate knowledge across various scales, concepts and representations in

 and across domains.

Units of Instruction

The course content has been divided into eight instructional units. Related chapters are organized into units. Four units will be presented each semester. The Four Big Ideas will be interwoven within the units.

A correlation of these units with the Essential Understandings is given in tables at the end of this document.

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| **Unit 1 – Introduction and Biochemistry** 1 – Introduction to AP Biology 2 – Chemistry of Life  3 – Water  4 – Carbon and Molecular Diversity 5 - Macromolecules | **Suggested Labs**Introduction to Inquiry Labs, GraphingArtificial Selection – predator/prey selection  simulationMacromolecules – testing and model makingEssay Writing, Rubric Setting, Practice Grading  |
| **Unit 2 – Cells and Cell Cycle** 7 – Membrane Structure and Function 6 – Tour of a Cell 12 – Cell Cycle 44 – Osmoregulation and Excretion  | **Suggested Labs**Cell observations with a MicroscopeOsmosis – dialysis tubing, potatoesMitosis |
| **Unit 3 – Cellular Energy** 8 – Introduction to Metabolism 9 – Cellular Respiration 10 – Photosynthesis | **Suggested Labs**Enzymes – computer probe labRespiration – pea respirationPhotosynthesis – computer probe lab |
| **Unit 4 – Organism Form and Function** 11 – Cell Communication 45 – Hormones, the Endocrine System 48 – Neurons, Synapses and Signaling 43 – Immune System 40 – Animal Form and Function | **Suggested Labs**Cell Communication – simulation or website  investigationHormones – project (Endocrine diseases)Nerve signaling – simulation or website investigation |
| **Unit 5 – Genetic Basis of Life** 13 – Meiosis and Sexual Life Cycles 14 – Mendel and the Gene Idea 15 – Chromosome Basis of Inheritance 21 – Genomes and their Evolution | **Suggested Labs**Meiosis simulationFast Plant – who’s the daddy?Fruit Fly Genetics simulation, Chi Square test Human Genetic Diseases – project |
| **Unit 6 – Gene Activity, Biotechnology** 16 – Molecular Basis of Heredity 17 – From Gene to Protein 18 – Regulation of Gene Expression 20 – Biotechnology 19 – Viruses (self-study) | **Suggested Labs**DNA IsolationTransformation using pGLORestriction Enzymes and Gel Electrophoresis |
| **Unit 7 – Evolution and Phylogeny** 22 – Descent with Modification: Darwin 23 – Evolution of Populations 24 – Origin of Species 25 – History of Life on Earth 26 – Phylogeny and the Tree of Life | **Suggested Labs**Population GeneticsEvo-Devo – videos from HHMIBlast Lab |
| **Unit 8 – Ecology** 52 – Introduction to Ecology 53 – Population Ecology 54 – Community Ecology 55 – Ecosystems 56 – Conservation Biology 51 – Animal Behavior (self-study) | **Suggested Labs**Animal Behavior – red worms or pillbugsTranspiration – whole plant methodAquatic Production – ecosystem simulation with probesConservation of a species - project |

Lab Schedule – by Big Idea and Content Unit

Below is a table that correlates the labs by each Big Idea and Content Unit. It is hoped that all labs listed per Big Idea can be covered, but at least a minimum of two will be covered in Inquiry format. The science practices covered in each lab are listed in *AP Biology Investigative Labs: an Inquiry Based Approach.*

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| **Big Idea 1: Evolution**Lab – Artificial Selection – predator/prey simulationLab – Population GeneticsLab – DNA Comparisons by BLAST | **Content Unit**Unit 1Unit 7Unit 7 |
| **Big Idea 2: Cellular Processes**Lab – Diffusion & OsmosisLab - Photosynthesis – computer probesLab – Cellular Respiration | **Content Unit**Unit 2Unit 3Unit 3 |
| **Big Idea 3: Genetics and Information Transfer**Lab – Cell Division: Mitosis and MeiosisLab - Bacterial TransformationLab – Restriction Enzyme Analysis of DNA | **Content Unit**Unit 2 and Unit 5Unit 6Unit 6 |
| **Big Idea 4: Interactions**Lab – Energy Dynamics – aquatic ecosystemsLab – Whole Plant TranspirationLab – Behavior – red worms or pillbugsLab – Enzymes – computer probes | **Content Unit**Unit 8Unit 8Unit 8Unit 3 |

Additional labs will be conducted to deepen students’ conceptual understanding and to reinforce the application of science practices within a hands-on, discoverer based environment. Directed Inquiry will be the most common method of lab instruction used. The course will provide opportunities for students to develop, record, and communicate the results of their laboratory investigations. Lab report formats will vary and may include the following: formal lab report, PowerPoint presentation, poster board presentation, oral presentation, response to directed questions on the lab or other format. Students will be required to maintain a portfolio of their lab activities on a flash drive or other storage device to take with them to college.

Instructor’s Conceptual Framework for Biology

The instructor’s conceptual framework for understanding Biology is well illustrated by a quote from Theodosius Dobzhansky (1973):

“**Nothing in Biology makes sense except in the light of Evolution”**

This conceptual framework will manifest itself in questions such as:

What is the adaptive value of \_\_\_\_\_\_\_\_\_?

Why has \_\_\_\_\_\_\_\_\_\_\_\_\_ persisted over time?

What is the role of the environment in \_\_\_\_\_\_\_\_\_\_\_\_\_? If the environment changes, what might happen over time?

Does \_\_\_\_\_\_\_\_ improve the ability of the organism to survive and reproduce? How?

The instructor will try to illuminate the “light of evolution” each and every class period.

Suggested Note-taking Methods

Cornell notes are suggested as a means of capturing and processing important ideas discussed in class. No specific note-taking method is required for the course, but by organizing information using the Cornell notes format, research has suggested students are better able to recall and retain information. Paper organized in the Cornell note format will always be available to students.

Homework

The bulk of the work done outside of class will take the form of reading, thinking, and writing. Students will be asked to read the chapters in each unit prior to their study in class. Additionally, labs or projects will likely be finished outside of class time. There may be reinforcement activities assigned for various chapters, and assigned daily work by need to be finished outside of class as well. Some lectures may be viewed online. In such instances students are required to take notes on the material covered in the online lectures.

Essential Knowledge Documents

Students will have the essential knowledge items and related learning objectives for each unit explicitly stated. The goal of this practice is to help students understand the expectations of student learning from the College Board. For each instructional unit, students will complete essential knowledge documents.

The essential knowledge documents describe the essential knowledge items for each instructional unit. Key learning objectives for each essential knowledge item are tied together. Students are then required to cite illustrative examples from reading, lectures, labs, or class activities that fulfill these objectives. At the bottom of each learning objective, students then draw or cite a figure in their textbook that can serve as a visual reminder of the concepts covered in the learning objective.

This practice will tie together chapters, instructional units, essential knowledge items, learning objectives, and the Big Ideas.

There are a number of goals for this particular practice. Students will see the connections between essential knowledge items and their associated learning objectives. Students will connect the concepts we are learning in class to the specific learning objectives. Students will identify or create visual cues that will help them later recall concepts related to the various learning objectives. It is hoped that these essential knowledge packets will serve as a powerful review tool prior to unit and semester tests in addition to AP exam.

Investigative Projects

Investigative projects may be used to create opportunities for students to extend the learning objectives from the Big Ideas outside of the laboratory investigations. The projects will be given to the students in the form of a choice board.

One of the options in the choice board will be the format of the project. Students may develop projects in the any of the following formats: written report, poster presentation, digital presentation, informational pamphlet, leading an online discussion group, or oral presentation. Other possibilities must be cleared with the instructor.

One of the options in the choice board will be for students to connect their biological and scientific knowledge to major social issues. The topics offered in the choice board are anticipated to change especially as new subjects or current events emerge in the field of Biology.

Students will be required to complete one investigative project per nine weeks for a total of four projects. At least one project over the year must be related to a major social issue.

The completion of these projects using the choice board will give students an opportunity, outside the laboratory investigations, to review the significant ideas of each instructional unit. Since the instructional units are designed to connect to the Big 4 ideas, these projects will tie these projects to the units and to the Big Ideas.

Choice Board by Unit, Big Idea, and Possible Topics

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| **Content Unit** | **Big Idea** | **Possible Topics – Students may suggest others** |
| Unit 1 – Introduction and Biochemistry | 2 and others | - Relationship of protein folding and structure to function- How organisms exploit the properties of water to survive- Adaptations of organisms to changing water levels- Acid precipitation- Symptoms of trace element deficiency- Adaptations of organisms to Se or other toxic elements |
| Unit 2 – Cells and Cell Cycle | 3 and others | - Factors that control or regulate cell cycle- Hayflick limit – what is it and what does it mean to cell cycle?- Aging diseases such as Progeria- Multi-cellularity - evolution of complexity- Cancer – when cell division control goes wrong |
| Unit 3 – Cellular Energy | 2 and others | - Global climate change and photosynthesis- Why do cells use ATP?- What’s new in brewing?- Diseases of the human respiration system- Why evolution needed aerobic respiration |
| Unit 4 – Organism Form and Function | 3 and others | - Human Endocrine diseases – causes and cure?- Linking cell communication, the endocrine system and the nervous system- When nerve signaling doesn’t work- Immune system disorders – causes and cure?- HIV – what is the latest? |
| Unit 5 – Genetic Basis of Life | 3 and others | - Human Genetic disease report – cause and cure?- RNA harnessed to control cells- RNAi – what is it and what does it do?- Epigenetics – how important is it?- Alphabet of Life – origin of the genetic code |
| Unit 6 – Gene Activity and Biotechnology | 3 and others | - Development of Glofish - Genetically modified pets – just because we can, should we?- HOX genes – why are they important?- What’s the latest in gene therapy?- What’s the latest technology break-through in biotechnology? |
| Unit 7 – Evolution and Phylogeny | 1 and others | - Deep sea events – the origin of life location?- Evolution of dogs – evolution in an eye-blink- Evo-Devo – what is it all about?- Gene duplication and human evolution- the RNA world’s role in the origin of life- Sponges or Comb jellies as the earliest animal?- How many kingdoms should we have? |
| Unit 8 – Ecology | 4 and others | - Acid precipitation – why should we worry?- Global warming – truth or fiction?- Humans: cause of latest mass extinction event?- Invasive species in our town, county and state- Supersites in our state – location and cleanup progress |

**Big Idea 1: The process of evolution drives the diversity and unity of Life**

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| **Essential Knowledge** | **Chapters/Sections** | **Illustrative Examples Covered** |
| 1.a.1 natural selection is a major mechanism of evolution. | 22.223.2 | - Graphical analysis of allele frequencies in a population- Application of the Hardy-Weinberg equilibrium equation |
| 1.a.2 Natural selection acts on phenotypic variations in populations. | 23.1, 23.4 | - Peppered moth- Sickle cell Anemia- Pesticide resistance in insects- Artificial selection- Antibiotic resistance- Loss of genetic diversity in monoculture |
| 1.a.3: Evolutionary change is also driven by random processes. | 23.3 | - Allele loss by genetic drift, Founders Effect and Bottlenecking |
| 1.a.4 Biological evolution is supported by scientific evidence from many disciplines including mathematics. | 22.325.2 | - Field observations- Fossil record- Homology and Analogy- Biogeography- Analysis of phylogenetic trees- Construction of phylogenetic trees based on sequence data |
| 1.b.1 Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today. | 25.1, 25.3 | - Cytoskeleton similarities- Membrane-bound organelles (mitochondria and/or chloroplasts)- Linear chromosomes- Universal genetic code |
| 1.b.2 Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. | 26.1 - 26.3 | - Number of heart chambers in animals- Opposable thumbs- Absence of legs in some sea mammals |
| 1.c.1 Speciation and extinction have occurred throughout the Earth’s history. | 24.3, 24.4, 25.4 | - Five major extinction events- Human impact on ecosystems and species extinction rates |
| 1.c.2 Speciation may occur when two populations become reproductively isolated from each other. | 24.1 | - Galapagos fauna examples- African violet examples- Salamander examples |
| 1.c.3 Populations of organisms continue to evolve. | 24.2, 44.1 | - Chemical resistance in many species- Observed directional phenotypic change in a population (Grants study)- A eukaryotic example that describes evolution of a structure or process. |
| 1.d.1 There are several hypothesis about the natural origin of life on Earth, each with supporting scientific evidence. | 4.1 25.1, 25.3 | - Abiogenesis of Life- Miller and Urey experiments- Volcanic vents- Comets and meteors |
| 1.d.2 Scientific evidences from many disciplines supports models of the origin of life.  | 25.126.6 | - Abiogenesis of Life- Miller and Urey experiments- Volcanic vents |

**Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.**

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| **Essential knowledge** | **Chapters/sections** | **Illustrative examples covered** |
| 2.a.1 All living systems require constant input of free energy. | 8.1 - 8.39.1 - 9.510.1, 10.2, 10.340.1 - 40.451.553.2, 53.455.2, 55.3 | - Krebs cycle- Glycolysis- Electron Transport Chain- Fermentation-Light Reaction- Calvin cycle- Endothermy and Ectothermy- Seasonal reproduction in animals and plants- Life history strategy- Change in the producer level can affect the number and size of other trophic levels- change in energy resource levels such as sunlight can affect the number and size of the trophic levels |
| 2.a.2 Organisms capture and store free energy for use in biological processes. | 8 .39.1 – 9.510.1 – 10.3 | - ATP- NADH in respiration- NADP in photosynthesis |
| 2.a.3 Organisms must exchange matter with the environment to grow, reproduce and maintain organization. | 3.1 – 3.34.1, 4.26.2 | - Cohesion and Adhesion- High specific heat capacity- Universal solvent supports reactions- Heat of vaporization and Heat of fusion- Water’s thermal conductivity |
| 2.b.1 Cell membranes are selectively permeable due to their structure. | 7.1, 7.2 | - Fluid mosaic model of membranes- Diffusion- Aquaporins- NA+/K+ pump |
| 2.b.2 Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes. | 7.3 – 7.5 | - Simple diffusion- Glucose transport- NA+/K+ pump- H+ pump |
| 2.b.3 Eukaryotic cells maintain internal membranes that partition the cell into specialized regions. | 6.2 – 6.5 | - Nuclear envelope- Endoplasmic reticulum- Mitochondria and Chloroplasts- Golgi bodies |
| 2.c.1 Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes. | 18.1, 18.240.244.445.2 | - Operons and Eukaryotic gene control mechanisms- Endothermy and Ectothermy- Kidney function- Glucose regulation- Calcium regulation |
| 2.c.2 Organisms respond to changes in their external environments. | 40.244.451.1 – 51.3 | - Endothermy and Ectothermy- Kidney function- Animal behavior examples |
| 2.d.1 All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions including exchange of matter and free energy. | 12.552.553.1 – 53.554.1 – 54.555.1 – 55.4 | - Cell density- Temperature and water availability- Sunlight- Symbiosis (mutualism, commensalism, parasitism)- Predator-prey relationships- Water and nutrient availability, temperature, salinity, and pH- Availability of nesting sites- Food chains and food webs- species diversity- Population density |
| 2.d.2 Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation to different environments. | 40.2, 40.344.2, 43.356.1 | - Gas exchange in aquatic and terrestrial plants- Digestive mechanisms in animals- Respiration systems of aquatic and terrestrial animals- Nitrogenous was production and elimination in aquatic and terrestrial animals- Excretory systems across the animal Kingdom- Thermoregulation in animals (countercurrent exchange mechanisms) |
| 2.d.3 Biological systems are affected by disruptions to their dynamic homeostasis. | 40.2, 40.343. 2- 44.456.1 | - Physiological responses to toxic substances- Dehydration- Immunological responses to pathogens, toxins and allergens- Invasive and/or eruptive species- Human impact- Natural disasters |
| 2.d.4 Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis. | 43.1 – 43.454.2 | - Invertebrate immune systems have nonspecific response mechanisms- Vertebrate immune systems have specific response mechanisms- Plants have a variety of defense mechanisms |
| 2.e.1 timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms. | 18.2 – 18.425.5 | - Morphogenesis of fingers and toes- Eukaryotic gene control mechanisms- HOX genes |
| 2.e.2 Timing and coordination of physiological events are regulated by multiple mechanisms. | 24.111.1 | - Release and reaction of pheromones- Visual displays in the reproductive cycle- Quorum sensing in bacteria |
| 2.e.3 Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. | 51.1, 51.2, 54.1 | - Hibernation, estivation, migration and courtship behaviors- Niche and resource portioning |

**Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.**

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| **Essential knowledge** | **Chapters/sections** | **Illustrative examples covered** |
| 3.a.1 DNA and in some cases RNA, is the primary source of heritable information. | 17.316.1, 16.217.1 – 17.419.220.1, 20.2 | - Addition of a poly-A tail- Addition of a GTP cap- Excision of introns- Enzymatic reactions- Transport by proteins- Synthesis and degradation- Electrophoresis- Plasmid-based transformations- Restriction enzyme analysis of DNA- PCR- Genetically modified foods- Transgenic animals, cloned animals- Pharmaceuticals such as Humulin |
| 3.a.2 In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis, or meiosis plus fertilization. | 12.1 – 12.313.1 – 13.3 | - Mitosis-promoting factor (MPF)- Platelet-derived growth factor (PDGF)- Cancer results from disruptions in cell cycle control- Meiosis and sexual life cycles |
| 3.a.3 The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring. | 14.1 – 14.415.1 – 15.420.4 | - Sickle cell anemia- Tay-Sachs disease- Huntington’s disease- X-linked traits- Klinefelter’s syndrome- Trisomy 21/Down syndrome- Civic issues such as ownership of genetic information, privacy, historical contexts etc. |
| 3.a.4 the inheritance pattern of many traits cannot be explained by simple Mendelian genetics. | 15.1 – 15.5 | - Sex-linked genes reside on the X chromosome in humans- The Y chromosome is small and carries few genes- In mammals and flies, females and XX and males and XY; X-linked recessive traits are usually expressed in males- Some traits are sex limited or sex influenced- Maternal inheritance of mitochondria and chloroplasts |
| 3.b.1 Gene regulation results in differential gene expression leading to cell specialization. | 18.1 – 18.3 | - Promoters- Terminators- Enhancers |
| 3.b.2 A variety of intercellular and intracellular signal transmissions mediate gene expression. | 11.1, 11.418.1 – 18.4 | - Cytokines regulate gene expression to allow for cell replication and division- Levels of cAMP regulate metabolic gene expression in bacteria- Expression of the SRY gene triggers the male sexual development pathway in animals- Morphogens stimulate cell differentiation and development- Changes in p53 activity can result in cancer- HOX genes and their role in development |
| 3.c.1 Changes in genotype can result in changes in phenotype. | 15.416.217.523.4 | - Antibiotic resistance mutations- Pesticide resistance mutations- Griffith’s experiments in transformation- Sickle cell disorder and heterozygote advantage |
| 3.c.2 Biological systems have multiple processes that increase genetic variation. | 13.4 | - Sexual reproduction and random assortment of chromosomes- Random fertilization- Crossing over of chromosomes |
| 3.c.3 Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts. | 19.1, 19.2 | - Transduction in bacteria- Transposons present in DNA |
| 3.d.1 Cell communication processes share common features that reflect a shared evolutionary history. | 11.1, 11.2 | - Use of pheromones to trigger reproduction and developmental pathways- Response to external signals by cells- Cell signaling mechanism comparison across bacteria to eukaryotes |
| 3.d.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. | 11.1, 11.243.248 1 – 48.345.1 – 45. 3 | - Plasmodesmata between plant cells allow material to be transported from cell to cell- Immune cells interact by cell-cell contact such as with T-cells and killer T-cells- Neuron transmission across synapsis- Neurotransmitters- Insulin and glucagon- Pituitary hormones |
| 3.d.3 Signal transduction pathways link signal reception with cellular response. | 11.3 | - G-protein linked receptors- Ligand-gated ion channels- Receptor tyrosine kinases- Secondary messengers such as cAMP, Calcium ions, and IP3. |
| 3.d.4 changes in signal transduction pathways can alter cellular response. | 11.4 | - Diabetes, heart disease, cancer- Effects of neurotoxins, poisons, and pesticides- Drug interactions |
| 3.e.1 Individuals can act on information and communicate it to others. | 51.1 | - Fight or flight response- Predator warnings- Avoidance responses- Territorial marking in mammals- Bee dances, bird songs- Courtship and mating behaviors |
| 3.e.2 Animals have nervous systems that detect external and internal signals, transmit and integrate information and produce responses. | 48.1 – 48.4 | - Acetylcholine- Epinephrine- Dopamine- GABA- Neuro-hormone production- Neurotransmission and responses |

**Big Idea 4: Biological systems interact, and these systems and their interactions posses complex properties.**

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| **Essential knowledge** | **Chapters/sections** | **Illustrative examples covered** |
| 4.a.1 The subcomponents of biological molecules and their sequence determine the properties of that molecule. | 5.1 – 5.5 | - Functions groups- Monomers and polymers- Levels of protein structure- Carbohydrates- Lipids |
| 4.a.2 The structure and function of subcellular components and their interactions, provide essential cellular processes. | 6.2 – 6.5 | - Organelle structure and function- Endomembrane system- Cytoskeleton (microtubules, microfilaments, and intermediate fibers) |
| 4.a.3 Interactions between external stimuli and regulated gene expression results in specialization of cells, tissues and organs. | 18.4 | - Promoters and gene expression- Enhancers and gene expression- Regulation of gene control mechanisms |
| 4.a.4 Organisms exhibit complex properties due to interactions between their constituent parts. | 44.1 – 44.348.451.1 – 55.4 | - Osmoregulation and Excretory system- Nerve signal transmission and response to external stimuli- Animal behavior examples |
| 4.a.5 Communities are composed of populations of organisms that interact in complex ways. | 53.1 – 53.654.1, 54.2 | - Predator/pre relationships- Symbiotic relationships- Niche resource partitioning |
| 4.a.6 Interactions among living systems and with their environment result in the movement of matter and energy. | 54.255.1 – 55.456.4 | - Food chains and food webs- Carbon cycle, nitrogen cycle- Biological magnification of DDT |
| 4.b.1 Interactions between molecules affect their structure and function. | 5.48.4, 8.5 | - Protein structure levels and folding- ATP cycling- Enzyme active sites and allosteric sites |
| 4.b.2 Cooperative interactions within organisms promote efficiency in the use of energy and matter. | 40.144.1 – 44.325.1 | - Exchange of gases- Circulation of fluids- Excretion of wastes as linked to environment- Bact. comm. in/around deep sea vents |
| 4.b.3 Interactions between and within populations influence patterns of species distribution and abundance. | 54.1 – 54.3 | - Examples of uniform, clumped and random distributions- Loss of keystone species; sea urchins, kelp and sea otters- Theoretical versus realized niches such as in barnacles, fence lizards |
| 4.b.4 Distribution of local and global ecosystems changes over time. | 25.455.556.1 | - Meteor impact on dinosaurs- Continental drift and mass extinctions- El Nino- Dutch elm disease or Emerald Ash borer |
| 4.c.1 Variation in molecular units provides cells with a wider range of functions. | 5.1 – 5.543.321.5 | - Different types of p’lipids in cell membr- Amino acid composition, protein fxn- Different types of hemoglobin- Different types of chlorophylls- Molecular diversity of antibodies in response to an antigen- Gene families and pseudogenes |
| 4.c.2 Environmental factors influence the expression of the genotype in an organism. | 14.3 | - Height and weight in humans- flower color based on soil pH- Sex determination in reptiles- Darker fur in cooler regions of the body in rabbits and cats |
| 4.c.3 The level of variation in a population affects population dynamics. | 23.1 – 23.3 | - Cheetahs, prairie chickens, condors - Bottle necking events |
| 4.c.4 the diversity of species within an ecosystem may influence the stability of the ecosystem. | 54.256.1 | - Keystone species, sea urchins, kelp and sea otters- Clear cutting forestry practices |