High School Science

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Biology Framework-September 2003 (.doc file)

Draft Biology Blueprints-July 2002

Draft High School Biology Framework

September 2003

Biology Curriculum Revision Team

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This draft Framework was created by teachers as a first step in the current revision of the course curriculum. Its purpose is to serve as a vehicle for review, discussion and critique by concerned stakeholders who are encouraged to provide written feedback to the Science Office for specific improvements and changes. Comments will be collected and reviewed and appropriate changes will be made. This will lead to the new course curriculum, which will align with and exceed the Maryland School Performance Program Core Learning Goals.

Frameworks are intended to provide the underlying structure of a course and contain two major components: 1) the Rationale and 2) the Scope and Sequence. The Rationale contains the goal, enduring understandings, content description, and instructional approach description of the course. The Scope and Sequence is a collection of the course indicators. This course Framework will lead to course Blueprints which will describe the “why, what and how” for each unit. Blueprints will lead to the Curriculum Guide which will contain concept maps, model lesson plans, model assessments, and other course resources.

Biology Rationale

Goal

The goal of Biology is for students to understand the complexity of the living world, including the functions and processes of organisms, their interactions with one another and the environment, and to respect the living world..

Enduring Understandings

1. Organisms are linked in a complex, balanced web of life.
2. The biological traits encoded in DNA explain both the diversity and the similarity of organisms.

3. The relationships between structure and function are important and can be found at all levels within an organism.
4. Biological processes occur in all organisms, from simple to complex.
5. Organisms can evolve over time due to the interactions of genetics and the environment.
6. Organisms maintain genetic continuity through sexual and asexual reproduction.

Content

Modern biology is experiencing a revolution. There are major advances in understanding life functions at the molecular level. Biotechnology has been a major element of this work providing advances in medicine and the human genome. This expanding knowledge has a significant influence on bioethics and other societal issues. The ecological side of biology remains significant as we have come to understand the role and influence of humans on the environment. Investigations in the laboratory and the field are important components of biology. Technology that extends the senses allows for observations at the molecular, cellular, organismic and environmental levels. Unifying principles in biology include ecology, patterns and relationships, cell structure and function, nucleic acids and protein synthesis, asexual and sexual reproduction, genetics, biological evolution, and diversity and taxonomy.

Instructional Approach

Instruction and learning are organized around the 5E's Inquiry Model. The teacher functions as facilitator or coach to nurture the students' growth to become independent learners. A variety of teaching strategies are used to promote inquiry, including laboratory experiments, demonstrations, direct instruction, current events, visual presentations and cooperative learning, as appropriate to the lesson and prior knowledge of the students. Time is provided to ensure that problem analysis, as well as solution strategies, are addressed. Students synthesize unifying principles from the course of study, make interdisciplinary connections, and apply these understandings to real world situations. The teacher provides opportunities for students to use technology and apply their knowledge and skills to projects and learning experiences. Teachers engage students in effective techniques of reading, writing and mathematics to extend their understandings of the content. Assessment is frequent, ongoing, and embedded in student learning experiences. Methods of evaluation incorporate rubrics and include pre-, formative, and summative assessment to evaluate teaching and learning. Teachers set high standards with challenging and rigorous expectations for all students and differentiate instruction and learning as appropriate.

Biology Scope and Sequence

The Scope and Sequence is identified by numbered goals, expectations, and indicators. The indicators from the Maryland State Performance Program Core Learning Goal 1 are shown here. These are used throughout the course. All concept indicators, Goal 3, are addressed by using Goal 1 indicators as the primary vehicles of instruction. Their placement at the beginning of this document does not imply that they are taught first or that they are taught only at the beginning of the course.

Skills and Process Indicators

Students will:

HS1.1 The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.

HS1.1.1 recognize that real problems have more than one solution and decisions to accept one over another are made on the basis of many issues.
HS1.1.2 modify or affirm scientific ideas according to accumulated evidence.

HS1.1.3 critique arguments that are based on faulty, misleading data or on the incomplete use of numbers.
HS1.1.4 recognize data that are biased.
HS1.1.5 explain factors that produce biased data (incomplete data, using data inappropriately, conflicts of interest, etc.).

HS1.2 The student will pose scientific questions and suggest investigative approaches to provide answers to questions.

HS1.2.1 identify meaningful, answerable scientific questions.
HS1.2.2 pose meaningful, answerable scientific questions.
HS1.2.3 formulate a working hypothesis.
HS1.2.4 test a working hypothesis.
HS1.2.5 select appropriate instruments and materials to conduct an investigation.
HS1.2.6 identify appropriate methods for conducting an investigation (independent and dependent variables, proper controls, repeat trials, appropriate sample size, etc.).
HS1.2.7 use relationships discovered in the lab to explain phenomena observed outside the laboratory.
HS1.2.8 defend the need for verifiable data.

HS1.3 The student will carry out scientific investigations effectively and employ the instruments, systems of measurement, and materials of science appropriately.

HS1.3.1 develop and demonstrate skills in using lab and field equipment to perform investigative techniques.
HS1.3.2 recognize safe laboratory procedures.
HS1.3.3 demonstrate safe handling of the chemicals and materials of science.
HS1.3.4 learn the use of new instruments and equipment by following instructions in a manual or from oral direction.
HS1.4 The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.

HS1.4.1 organize data appropriately using techniques such as tables, graphs, and webs (for graphs: axes labeled with appropriate intervals, independent and dependent variables on correct axes and appropriate title).
HS1.4.2 analyze data to make predictions, decisions, or draw conclusions.
HS1.4.3 use experimental data from various investigators to validate results.
HS1.4.4 determine the relationships between quantities and develop the mathematical model that describes these relationships.
HS1.4.5 check graphs to determine that they do not misrepresent results.
HS1.4.6 describe trends revealed by data.
HS1.4.7 determine the sources of error that limit the accuracy or precision of experimental results.
HS1.4.8 use models and computer simulations to extend his/her understanding of scientific concepts.
HS1.4.9 use analyzed data to confirm, modify, or reject an hypothesis.

HS1.5 The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.

HS1.5.1 demonstrate the ability to summarize data (measurements/observations).
HS1.5.2 explain scientific concepts and processes through drawing, writing, and/or oral communication.
HS1.5.3 use computers and/or graphing calculators to produce the visual materials (tables, graphs, and spreadsheets) that will be used for communicating results.
HS1.5.4 use tables, graphs, and displays to support arguments and claims in both written and oral

communication.
HS1.5.5 create and/or interpret graphics (scale drawings, photographs, digital images, field of view, etc.).
HS1.5.6 read a technical selection and interpret it appropriately.
HS1.5.7 use, explain, and/or construct various classification systems.
HS1.5.8 describe similarities and differences when explaining concepts and/or principles.
HS1.5.9 communicate conclusions derived through a synthesis of ideas.

HS1.6 The student will use mathematical processes.

HS1.6.1 use ratio and proportion in appropriate situations to solve problems.
HS1.6.2 use computers and/or graphing calculators to perform calculations for tables, graphs, or spreadsheets.
HS1.6.3 express and/or compare small and large quantities using scientific notation and relative order of magnitude.
HS1.6.4 manipulate quantities and/or numerical values in algebraic equations.
HS1.6.5 judge the reasonableness of an answer.

HS1.7 The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.

HS1.7.1 apply the skills, processes, and concepts of the course to societal issues.
HS1.7.2 identify and evaluate the impact of scientific ideas and/or advancements in technology on society.
HS1.7.3 describe the role of science in the development of literature, art, and music.
HS1.7.4 recognize mathematics as an integral part of the scientific process.
HS1.7.5 investigate career possibilities in the various areas of science.
HS1.7.6 explain how development of scientific knowledge leads to the creation of new technology and how technological advances allow for additional scientific accomplishments.

The following indicators come from MSPP Core Learning Goal 3 (Concepts of Biology) and are addressed by using Goal 1 (Skills and Processes) indicators as the primary vehicles of instruction.

Biology Concept Indicators
The student will:

HS3.1 The student will be able to explain the correlation between the structure and function of biologically important molecules and their relationship to cell processes.

HS3.1.1.A identify the monomers (building blocks) of lipids, proteins, carbohydrates, and nucleic acids. (H)
HS3.1.1.1 describe the properties of water (inorganic molecule, polarity, density, cohesion, adhesion, and universal solvent).
HS3.1.1.1.A analyze the relationship between the properties of water and living systems.
HS3.1.1.2 describe the characteristics of carbohydrates (organic molecule; monosaccharides are building blocks, supplier of energy and dietary fiber; structural component of cells; cell wall, cellulose).
HS3.1.1.2.A compare the use of carbohydrates and lipids as sources of energy.
HS3.1.1.3 describe lipids (organic molecule, component of cell membranes, stored energy supply).
HS3.1.1.3.A describe the importance of lipids as a component of the lipid bi-layer in cellular membranes. (H)
HS3.1.1.4 describe proteins (organic molecule, amino acids are building blocks, structural and

functional role, including enzymes).
HS3.1.1.4.A explain the role of proteins as a structural component of cells and their functions as catalysts in biochemical reactions (enzymes).
HS3.1.1.5a describe the structure of nucleic acids (organic molecule; nucleotides are building blocks – sugar, phosphate, & nitrogen bases; DNA is a double helix, RNA is a single strand).
HS3.1.1.5b describe functions of nucleic acids (DNA replication; DNA role in storage of genetic information).
HS3.1.1.6 identify the general role of minerals in living systems (inorganic substances essential for cellular processes).
HS3.1.1.7 describe the role of vitamins in maintaining good health in the human body (organic molecule; role in human body: C – wound healing, K – blood clotting, D – bone growth).
HS3.1.2.1 explain the concept of osmosis (predicting water flow across a membrane based on the cell's environment, explain role in living systems).
HS3.1.2.1.A identify the effects that changes in the solute concentration of the environment would have on a cell (chicken egg).
HS3.1.2.2a identify the effect of temperature on enzyme activity and metabolic rate.
HS3.1.2.2b identify the effect of temperature upon the rate of diffusion and states of matter.
HS3.1.2.3a read the pH scale and determine the relative values for acids and bases.
HS3.1.2.3b determine the effect of pH on living systems, both cellular and organismal.
HS3.1.2.3.A describe the action of buffers in the human blood in maintaining pH balance. (H)
HS3.1.2.4 explore enzyme regulation (effect of temperature, pH, and enzyme/substrate concentration on enzyme activity).
HS3.1.3.A identify the concept that matter is cycled through the ecosystem.
HS3.1.3.1 describe the movement of water between living systems and the environment (water cycle).
HS3.1.3.1.A analyze the components of the water cycle. (H)
HS3.1.3.2 analyze the cyclic relationship between photosynthesis and respiration during the carbon cycle.
HS3.1.3.2.A discuss human impact on the carbon cycle.
HS3.1.3.3a describe the role of bacteria in the nitrogen cycle.
HS3.1.3.3b identify ways that humans impact the nitrogen cycle.
HS3.1.3.3.A explain why the nitrogen cycle is important to living things.
HS3.1.3.4 describe how energy is transferred from the Sun (light) to organic molecules (chemical) through the process of photosynthesis (energy conversion: light, chemical; basic molecules involved).
HS3.1.3.4.A provide evidence that photosynthesis and respiration are opposite reactions.
HS3.1.3.5 distinguish between aerobic and anaerobic respiration (cellular respiration; energy released, use of oxygen; basic molecules involved in aerobic).
HS3.1.3.5.A explain how organisms, such as yeast and bacteria, respire without oxygen present.
HS3.1.3.6 identify the transfer of energy by chemosynthesis (from inorganic compounds).
HS3.1.3.6.A distinguish between photosynthesis and chemosynthesis as reactions that produce organic compounds. (H)
HS3.1.3.7 identify the role of ATP in the transfer and use of energy in photosynthetic and non-photosynthetic organisms (energy carrier molecule).

HS3.2 The student will demonstrate an understanding that all organisms are composed of cells which can function independently or as part of multicellular organisms.

HS3.2.1.A compare the structure of an animal cell and a plant cell (cell wall, chloroplast, centriole, size of vacuole).
HS3.2.1.B distinguish between prokaryotic and eukaryotic cells.
HS3.2.1.1a identify the role of the cell membrane in the transport of materials into and out of cells.
HS3.2.1.1b identify the role of plant vascular tissues in the transport of materials.
HS3.2.1.1c identify the role of animal vascular tissues in the transport of materials.
HS3.2.1.1d identify the role of the circulatory system in the transport of materials through an

organism.
HS3.2.1.1.A compare active transport and passive transport. (H)
HS3.2.1.1.B describe the role of the circulatory system in the transport of materials in the human body.
HS3.2.1.1.C compare the role of plant vascular tissues with animal vascular tissues in the transport of materials.
HS3.2.1.2 describe the process of waste disposal at both the cellular and organismal levels (roles of cell membrane, excretory and circulatory systems).
HS3.2.1.3a identify movements of cells (flagella, cilia, pseudopodia, gametes).
HS3.2.1.3b identify the interactions between skeletal and muscular systems in producing movement.
HS3.2.1.4 describe the relationship between feedback mechanisms and homeostasis (water balance, pH, temperature, role of endocrine system).
HS3.2.1.4a identify the roles of feedback and the endocrine system in maintaining organismal homeostasis.
HS3.2.1.4b identify the role of feedback in maintaining cellular and organismal homeostasis – water balance, pH, temperature.
HS3.2.1.5a describe sexual reproduction as it occurs in angiosperms and mammals.
HS3.2.1.5b describe the processes of asexual reproduction (binary fission, budding, vegetative, regeneration).
HS3.2.1.5c describe the role of reproductive organs of both plants (angiosperms) and animals (mammals) in the process of sexual reproduction.
HS3.2.1.5.A explain how sexual reproduction and asexual reproduction are dependent upon cell division.
HS3.2.1.5.B compare the processes of mitosis and meiosis.
HS3.2.1.5.C identify examples of reproduction (binary fission, conjugation, budding, mitosis).
HS3.2.1.6a describe the roles of sensory organs and the nervous system in the control of structures in human systems.
HS3.2.1.6b describe the role of the nucleus in mitosis.
HS3.2.1.6.A identify analogies of structure and function using organelles and organs or organ systems.
HS3.2.1.7 distinguish between the role of chloroplasts and mitochondria in energy capture and release.
HS3.2.1.8 identify the role of the ribosome in protein synthesis.
HS3.2.2.1-6 identify environmental factors that affect the metabolic activity of cells and organisms (pH, temperature, water, oxygen, carbon dioxide, light).
HS3.2.2.7 investigate the role of radiation in cancer and mutations.
HS3.2.2.8 describe the effects of toxins (natural or synthetic) on cells and organisms.

HS3.3 The student will analyze how traits are inherited and passed on from one generation to another.

HS3.3.1.1a recognize that meiosis involves two cell division processes to reduce the chromosome number by half.
HS3.3.1.1b analyze the effects of crossing-over on variation in offspring.
HS3.3.1.1c recognize that meiosis is a process that forms gametes
HS3.3.1.1.A understand the differences between egg and sperm production. (H)
HS3.3.1.2 define fertilization as the combination of haploid gametes to produce a diploid zygote.
HS3.3.2.1 identify phenotypes as the expression of inherited characteristics.
HS3.3.2.A interpret a karyotype. (H)
HS3.3.2.2 distinguish between dominant and recessive alleles for a given trait.
HS3.3.2.2.A predict if a trait is dominant or recessive using data from a given population.
HS3.3.2.2.B distinguish among modes of inheritance of traits (incomplete dominance, co-dominance, multiple alleles). (H)
HS3.3.2.3 demonstrate how sex linked traits are inherited (X-linked only; recessive phenotypes are more often expressed in males).
HS3.3.2.3.A distinguish between human autosomal diseases and human sex-linked diseases.
HS3.3.2.4 use heterozygous and homozygous pairs of alleles to represent genotypes.

HS3.3.2.5a predict using a Punnett Square the genotype and phenotype of offspring from given parents (monohybrid cross).
HS3.3.2.5b translate genotypes into phenotypes
HS3.3.2.5.A predict the genotype and phenotype of offspring for two traits from given parents (dihybrid cross) using a Punnett square. (H)
HS3.3.2.5.B predict the genotype and phenotype of an individual by performing a test cross (mate with homozygous recessive) using a Punnett square. (H)
HS3.3.2.6 use a pedigree to interpret patterns of inheritance within a family.
HS3.3.3.1 define a gene (a segment of DNA that codes for a protein).
HS3.3.3.2a describe the structure of DNA as a double helix.
HS3.3.3.2b analyze the parts of a nucleotide on a molecular basis – sugar, phosphate, and nitrogen bases.
HS3.3.3.3a show how the sequence of bases directs protein formation.
HS3.3.3.3b distinguish among the roles of DNA, mRNA, tRNA, and rRNA in protein synthesis.
HS3.3.3.4 explain how proteins control traits.
HS3.3.4.1 describe beneficial and harmful effects of mutations on individuals, society, and/or the environment.
HS3.3.4.1.A define mutations in terms of DNA structure.
HS3.3.4.2 identify the effects of abnormal chromosome number and form in organisms.
HS3.3.4.2.A explain how monoploidy and triploidy result in human diseases (Turner syndrome and Klinefelter syndrome).
HS3.3.4.3 identify the beneficial or harmful effects of DNA alteration (gene splicing, recombinant DNA, cloning) on an individual, society, and/or the environment.

HS3.4 The student will explain the mechanism of evolutionary change.

HS3.4.1.1a define natural selection.
HS3.4.1.1b describe the effects of environmental pressure on natural selection.
HS3.4.1.2a identify examples of adaptations.
HS3.4.1.2b identify the effects of adaptations on the survival of organisms.
HS3.4.1.3 state the effects of variation on survival.
HS3.4.2.1.A identify major distinguishing characteristics of the taxa Archaebacteria, Eubacteria, Protista, Fungi, Plantae, and Animalia (unicellular/multicellular; prokaryotic/eukaryotic; nutrition – absorption, ingestion, photosynthesis).
HS3.4.2.1a distinguish between prokaryotes and eukaryotes.
HS3.4.2.1b use relationships between organisms as a basis for classification.
HS3.4.2.2 describe the significance of anatomical similarities among organisms as evidence for evolutionary relationships, including homologous structures.
HS3.4.2.2.A use common classification schemes (dichotomous key, cladogram) as a basis for recognizing relationships between organisms and for grouping organisms by anatomical similarities or evolutionary trends. (H)
HS3.4.2.2.B describe evolutionary trends in major body systems.
HS3.4.2.3 estimate degrees of relatedness among organisms by comparing similarities of DNA base and/or amino acid sequences, including results from gel electrophoresis.

HS3.5 The student will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.

HS3.5.1.1a identify examples of abiotic and biotic factors (space, soil, water, air, temperature, food, light, organisms).
HS3.5.1.1b analyze the effects of abiotic factors (space, soil, water, air, temperature, light, and/or food) on organisms.
HS3.5.1.2a analyze the effects of predation, parasitism, mutualism, and commensalism on a

community.
HS3.5.1.2b identify the roles of organisms when given examples of predator-prey and/or parasite-host relationships.
HS3.5.2.A explain how the amount of energy decreases as it is transferred through an ecosystem.
HS3.5.2.1 describe the effect of diversity on the ecosystem.
HS3.5.2.2.1 describe the process of succession on land and in water.
HS3.5.2.2.2 state the effects of succession on the stability of the ecosystem.
HS3.5.2.2.A compare primary and secondary succession. (H)
HS3.5.2.3.1 define the term niche and state its importance to the stability of an ecosystem.
HS3.5.2.3.2 identify the trophic level of a given organism (producer, consumer, herbivore, carnivore, omnivore, scavenger, decomposer).
HS3.5.2.3.3 distinguish between producers and consumers.
HS3.5.2.3.4 distinguish among herbivore, carnivore, omnivore, and scavenger.
HS3.5.2.3.5 identify the importance of decomposers to an ecosystem.
HS3.5.2.5 analyze pyramids (energy, biomass).
HS3.5.3a identify effects of habitat destruction, pollution, and urbanization on populations.
HS3.5.3b describe the effects of natural disasters, disease, population increase, and depletion of food on populations.
HS3.5.3.A identify ways to minimize human impact on the environment.
HS3.5.4 illustrate how global food webs may be positively or negatively influenced by human activity and technology.
HS3.5.4.1 identify how organisms may be part of and dependent upon oceanic food webs.
HS3.5.4.2 identify how organisms may be part of and dependent upon terrestrial food webs.
HS3.5.4.A distinguish between oceanic and terrestrial food webs.
HS3.5.4.B identify the role or roles each organism plays in a food web.
HS3.5.4.C identify food chains from a given oceanic food web or terrestrial food web.

HS3.6 The student will investigate a biological issue and develop an action plan.

HS3.6.1 analyze the consequences and/or trade-offs between technological changes and their effect on the individual, society, and the environment. They may select topics such as bioethics, genetic engineering, endangered species, or food supply.
HS3.6.2 investigate a biological issue and be able to defend their position on topics such as animal rights, drug and alcohol abuse, viral diseases (e.g., AIDS), genetic engineering, bioethics, biodiversity, population growth, global sustainability, or origin of life.

Explanation of Codes Used in Indicators

HS# refers to MSPP Core Learning Goal #, 1= Process Skills, 2=Earth Science, 3= Biology, 4=Chemistry, 5=Physics, 6=Environmental Science

Second decimal place refers to MSPP expectation related to the goal.
Third decimal place refers to MSPP indicator related to the expectation.
Fourth decimal place refers to MSPP assessment limit or "at least item" related to the indicator.
Any additional decimal places refer to MCPS extensions added to MSPP "assessment limit" or "at least item."

Small letters such as "a," or "b" identify an MSPP indicator that is subdivided into separate MCPS indicators.

Italics identify the wording or intent of the MSPP Core Learning Goal.
Capital Letters identify a MCPS indicator that is not an MSPP indicator.
(H) identifies an indicator that will be assessed in MCPS Honors level courses.

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