Ohio Science

Biology Content Statements: Grades 9-12

Adopted 2018

Biology

1. **Cellular genetics** B.H.1
   - a. Discuss ways that human genetic information can be used (e.g., ancestry, health) and the ethical implications of using this information. B.H.1.DTES.A
   - a. Using information from the Human Genome Project, show how DNA testing companies have developed and what information is used to show how people are related. B.H.1.ICSC.A
   - b. Compare the DNA sequences of different cells from the same organism. B.H.1.ICSC.B
   - c. Explain how all cells, except gametes, in a specific organism have identical genetic information (DNA) but have different functions. B.H.1.ICSC.C
   - d. Compare the information that is provided by various commercial genetic testing companies and determine how it can be used. B.H.1.ICSC.D
   - a. Describe the central dogma (DNA to RNA to protein) and its relationship to heredity. B.H.1.RAS.A

2. **Structure and function of DNA in cells** B.H.2
   - a. Discuss and provide evidence that phenotypic variations may result from genetic recombination through meiosis (e.g., sorting, recombination, crossing over) and sexual reproduction. B.H.2.ICSC.A
   - a. Given one strand of DNA, construct the complementary strand and/or the mRNA molecule transcribed from it. B.H.2.RAS.A
   - b. Describe the process of meiosis in relation to the function of DNA and chromosomes in coding the instructions for traits passed from parents to offspring. B.H.2.RAS.B

3. **Genetic mechanisms and inheritance** B.H.3

   a. Propose hypotheses, design experiments and analyze a population (e.g., dog breeds, fruit flies, Fast Plants, virtual simulations) to identify the genotypes of one or more individuals with unknown genotypes. Use Punnett Squares and pedigrees based on their phenotypes and the phenotypes of their offspring. Use the principles of statistics to compare real-world data to predicted outcomes. B.H.3.DSK.A

   a. Explain the outcomes of a series of genetic crosses from a population (e.g., fruit flies, virtual simulation, Fast Plants) using Mendelian and non-Mendelian genetics (e.g., incomplete dominance, sex-linked traits, dihybrid crosses). Include a discussion of gene interactions, gene linkage and the source of phenotypic variation. B.H.3.ICSC.A

   a. Use a model of meiosis to demonstrate crossing over and independent assortment during gamete formation. Explain how this contributes to variation within a population. B.H.3.RAS.A

4. **Mutations** B.H.4

   a. Given examples of original and mutated DNA segments, analyze the mutation and identify the impact on phenotype. Make a connection to how natural selection might favor, select against or be neutral on the resulting changes in the protein (phenotype). B.H.4.ICSC.A

   a. Recall types of mutations and describe the effects they might have on a protein. B.H.4.RAS.A

   b. Classify mutations as gene mutations (e.g., insertion, deletion, substitution) or chromosomal mutations (e.g., trisomy, monosomy). B.H.4.RAS.B

   c. Evaluate chromosome maps to identify linkage groups. B.H.4.RAS.C

5. **Modern genetics** B.H.5

   a. Research current genetic engineering practices (e.g., Clustered Regularly Interspaced Short Palindromic Repeats [CRISPR], GMO, specially modified bacteria, cloning, epigenetic technology). Evaluate the implications of implementing genetic engineering practices. B.H.5.DTES.A

   b. Using knowledge of genetic technology, create a proposal for the design of a product to solve a current world problem (e.g., golden rice, oil-eating bacteria, insulin-producing bacteria, pigs for producing human organs). B.H.5.DTES.B

   a. Given a problem (e.g., diseases, hunger, pests, water concerns), propose a solution that uses genetic technology (e.g., specially modified bacteria, GMO, CRISPR, epigenetic technology) and defend your reasoning. B.H.5.DSK.A

   b. Use electrophoresis (actual or virtual) technology to evaluate DNA results (e.g., crime scene analysis, paternity, phylogenetic relationships). B.H.5.DSK.B

   a. Explain how electrophoresis is used to evaluate DNA results (e.g., crime scene analysis, paternity, phylogenetic relationships). B.H.5.ICSC.A

   a. Create a timeline of the significant discoveries in genetics. B.H.5.RAS.A

1. **Mechanisms** B.E.1

   a. Consider an organic farming operation growing a heritage variety of sweet corn. The operation borders a large, industrial farm producing genetically modified corn. The organic farm's success is threatened by both gene flow from the corporate GMO (genetically modified organism) farm and genetic drift. Propose a solution to minimize the effect of these factors on the organic farm. B.E.1.DTES.A

   b. Design a solution to lessen the impact of genetic drift (e.g., increasing genetic variation in populations of cheetahs or lowland gorillas housed in zoos around the world). B.E.1.DTES.B

   c. Critique a real-world solution to the arrival of an invasive species and how it changed native populations and/or the invasive population with respect to Hardy-Weinberg assumptions (e.g., Ohio examples: Japanese honeysuckle, zebra and quagga mussels, Emerald Ash Borers, purple loosestrife, white-nose syndrome in bats). B.E.1.DTES.C

   d. Design an engineering or technical solution to keep out or remove an invasive species from a local habitat (e.g., invasive fish out of Lake Michigan, garlic mustard, Zebras mussels, invasive lampreys from Great Lakes tributaries). B.E.1.DTES.D

   e. Construct a program to remove all descendants of invasive species in a habitat (e.g. rats on small Pacific island). Design an engineering/technical solution to help return native species following the intentional removal of all invasive species (e.g. rats on small Pacific islands). B.E.1.DTES.E

   f. Design and construct a habitat that maintains the gene pool of a transplanted population at equilibrium. B.E.1.DTES.F

   a. Generate hypotheses to explain real-world examples of apparent genetic drift (e.g., maintaining heritage breeds of crop plants and livestock, hemophilia in Queen Victoria's descendants, polydactylism in the Amish population, inbreeding in isolates, island populations, loss of diversity in artificially fertilized livestock or zoo populations). B.E.1.DSK.A

   b. Generate hypotheses to predict the ecological changes following the appearance of an invasive species into a new habitat (e.g., fire ants invading Ohio) based on reports of the impact of that species in other habitats in the recent past. B.E.1.DSK.B

   a. Identify and explain a real-world example of genetic drift. B.E.1.ICSC.A

   b. Using a model of Hardy Weinberg, explain the results of a change generated in the model population. Prepare a visual representation to present information. B.E.1.ICSC.B

   c. Identify the likely stakeholders (e.g., commercial or sporting groups) affected by the arrival of an invasive species. Prepare a presentation for those stakeholders about predicted changes and the basis for making these predictions. B.E.1.ICSC.C

   a. Differentiate between gene flow (e.g., pollen from GM crops blowing to an organic farmer's crop) and genetic drift (e.g., limited variation within corn crops). B.E.1.RAS.A

b. Use Hardy-Weinberg principles to explain the concept of an individual acting as a "carrier" of a rare genetic disorder. B.E.1.RAS.B

c. Provide an example of an invasive species and describe the nature of the biological relationship with each native species that is impacted. B.E.1.RAS.C

2. **Speciation** B.E.2

   a. Design a medical protocol to discourage the persistence (spread) of antibiotic resistance through natural selection in populations of bacteria. B.E.2.DTES.A

   b. Design an agricultural solution/procedure to discourage the persistence (spread) of herbicide resistance in crop plants or pesticide resistance in insects through natural selection. B.E.2.DTES.B

   c. Observe and measure traits within several groups of local species. Propose an engineering solution to block or allow interbreeding between neighboring populations (e.g., tassel-eared squirrels). B.E.2.DTES.C

   d. Design a technological solution to determine identification in species where visual cues alone cannot determine the identity (e.g., bird species that can only be identified by their song or mating behaviors). B.E.2.DTES.D

   a. For two closely related species such as sibling species, (e.g., tassel-eared squirrels, yellow-rumped and Audubon's warbler, plant examples) propose hypotheses to explain their current distributions. B.E.2.DSK.A

   b. Examine neighboring populations of similar species. Propose one or more analyses to determine if they are distinct species. B.E.2.DSK.B

   c. Select a group of organisms and generate an evolutionary hypothesis with a cladogram using researched data (e.g., molecular, anatomical, binomial nomenclature). Evaluate cladograms produced by classmates. Support proposed evolutionary relationships with evidence. B.E.2.DSK.C

   a. Given information about the current range and population size of a species, predict the effect of a change in environmental factors (e.g., retreat of the last glaciers, rapid increase in water temperatures in the Gulf of Maine) on the species. B.E.2.ICSC.A

   b. Design a public exhibit that attracts tourists by demonstrating convergent evolution of plants on different continents. B.E.2.ICSC.B

   c. Compare the work of Lamarck, Darwin and Wallace. B.E.2.ICSC.C

   d. Present graphically the distribution of a specific trait within and between species in a group (e.g., needle length or number of needles in multiple pine species). Interpret your data through natural selection. B.E.2.ICSC.D

   e. Explore modern and historical evidence from various disciplines (e.g., molecular, anatomical, paleontological) that support the theory of evolution through natural selection. B.E.2.ICSC.E

   f. Interpret the degree of evolutionary relatedness (phylogenetic closeness) based on information found in a cladogram. B.E.2.ICSC.F

   g. Evaluate two or more cladograms representing different hypotheses of the evolution of a given clade. B.E.2.ICSC.G

   a. Explain how natural selection has affected a species (e.g., Darwin's finches, peppered moths, Hawaiian honeycreepers, Galapagos tortoises). B.E.2.RAS.A

   b. Identify a geographical barrier likely responsible for distinct, yet similar populations in an area (e.g., Lake Erie Water Snakes (LEWS), tassel-eared squirrels)

and explain how it might account for the close similarity of multiple forms. B.E.2.RAS.B

c. Use molecular, anatomical, and/or paleontological data to explain classic examples of convergent evolution. B.E.2.RAS.C

d. Given data in a table (e.g., molecular, anatomical, binomial nomenclature) illustrate evolutionary relatedness (phylogenetic closeness) using a cladogram. B.E.2.RAS.D

1. **Biodiversity** B.DI.1

   a. Investigate a species of extremely low abundance (e.g., Vaquita porpoise, Sumatran/Javan rhinos or native bees) and propose monitoring or management methods to increase the genetic diversity. B.DI.1.DTES.A

   b. Propose and justify suggestions to increase diversity and stability of an ecosystem. B.DI.1.DTES.B

   c. Design, evaluate, and refine a solution to reduce the impacts of human activities on the environment and biodiversity. B.DI.1.DTES.C

   d. Investigate the practice of stocking fish in Ohio to identify potential problems and benefits of this practice. Examine how this practice impacts the environment. Develop a public service announcement (PSA) to inform the community about a specific fish that will be stocked in the community's local waterway. B.DI.1.DTES.D

   e. Explore a species that has been removed from the endangered species list (e.g., Lake Erie Water Snakes (LEWS), river otters, bobcats). Evaluate how this action can impact the species and the environment. B.DI.1.DTES.E

   a. Investigate various agricultural/crop production practices, then propose a hypothesis to explain how these practices might impact a species' genetic diversity. B.DI.1.DSK.A

   b. Review data (e.g., recorded by National Center for Biotechnology Information, National Institutes of Health, Centers for Disease Control and Prevention) to examine genetic diversity within populations. Evaluate populations with specific genetic traits and how these are related to the survival abilities of the population (e.g., Irish potato famine, northern white rhino, hemophilia, sickle cell anemia, malaria). B.DI.1.DSK.B

   c. Compare and contrast the factors that influence growing/propagating different varieties (e.g., heirloom and genetically modified organisms) of plants of the same species. This could include growing each variety if resources permit. Using this information, advise the stakeholders of a country/community about the trade-offs of growing each type of plant. B.DI.1.DSK.C

   d. Investigate species diversity for local populations, which could include school grounds and/or local wildlife areas, by comparing the number of different species to the abundance of each species. Consider a stream survey or investigate the influence of introducing wolves back into an ecosystem (e.g., Isle Royale, Yellowstone). B.DI.1.DSK.D

   a. Use a model or simulation to analyze the impact of an environmental stressor on the genetic diversity and long-term survival of a population. B.DI.1.ICSC.A

   b. Using data on a variety of Ohio species, create a chart comparing the species diversity across the state's ecosystems. B.DI.1.ICSC.B

   c. Use historical and real-time data (e.g., Ohio Department of Natural Resources (ODNR) historical and current data) to monitor changes in populations of Ohio species and correlate population size to wildlife management policies (e.g., river otters, deer, Canada geese, sturgeons). B.DI.1.ICSC.C

d. Examine current lake or stream fish populations in local bodies of water to make predictions of future population numbers. Compare this to past years data from ODNR and project future population numbers. B.DI.1.ICSC.D

e. Investigate the species diversity within a biome. Analyze the number of different types of vertebrates, invertebrates and plant species in a biome. Identify patterns in distribution between different biomes and consider the influence latitude and/or altitude plays on species diversity. Correlate the patterns of diversity with energy flow, cycles of matter, and persistence within biological communities. B.DI.1.ICSC.E

a. Identify organisms with high (e.g., tomatoes, beans) and low (e.g., cheetahs) genetic diversity. Recognize that species with low genetic diversity are more likely to become extinct. B.DI.1.RAS.A

2. **Ecosystems** B.DI.2

   a. Devise a plan to address the ecological and economic impacts of an invasive species. The plan should address lessening the species' impacts. B.DI.2.DTES.A

   b. Design, evaluate, and communicate to stakeholders the strategies to restore equilibrium to an ecosystem previously altered by human impact (e.g., dams, channelization, urbanization, nutrient overload/algal blooms in lakes). B.DI.2.DTES.B

   c. Select a species that has recently been removed from the endangered species list. Evaluate the current management plan and how this action will impact the species and the environment. B.DI.2.DTES.C

   d. Design a tracking method to estimate population size and carrying capacity for an organism. B.DI.2.DTES.D

   a. Devise a study to investigate an ecosystem in equilibrium and an ecosystem in disequilibrium (e.g., changing populations of algae species in an aquarium as a function of phosphorus concentration over time). Gather data and analyze the results. B.DI.2.DSK.A

   b. Investigate how urban sprawl affects carrying capacity for a native population (e.g., loss of native populations from the introduction of kudzu for groundcover, the use of Japanese honeysuckle for ornamentation). B.DI.2.DSK.B

   c. Use real-time data (e.g., from student designed tracking methods or Movebank data) to track and monitor populations. Analyze data to determine population cycles and carrying capacity. B.DI.2.DSK.C

   a. Predict how predator/prey population cycles (e.g., moose/wolf, hare/lynx) will change if there are changes in the numbers of either species. B.DI.2.ICSC.A

   b. Explain how humans can impact predator/prey relationships (e.g., hunting large predators such as wolves, hunting large herbivores such as bison, Nile Perch). B.DI.2.ICSC.B

   c. Compare equilibrium and disequilibrium. Give examples of each in real populations. Relate this to Ohio animals and plants. Consider the impact of stocking fish on a native population of the same or similar (able to interbreed) fish (e.g., rainbow trout). B.DI.2.ICSC.C

   d. Investigate an invasive species in Ohio (e.g., zebra mussels, purple loosestrife, emerald ash borer, sea lamprey, honeysuckle, gobies, Asian carp), analyze its impacts and predict the ecological and economic impacts on communities. Research should include analyzing the factors that contribute to the organism's success as well as various ideas to provide a solution for managing the species. B.DI.2.ICSC.D

   e. Analyze population data for patterns in population cycles and determine carrying capacities. Identify and explain correlations between variables in population data. B.DI.2.ICSC.E

   f. Track the effect of varying levels of disturbance (e.g., regulated hunting, poaching, seasonal flooding, volcanic eruption, sea level rise) on ecosystems and create data sets to communicate findings. B.DI.2.ICSC.F

a. Identify and label various features of population growth curves (e.g., fast or slow growth rates, carrying capacity, equilibrium, population boom and bust). B.DI.2.RAS.A

b. Describe the characteristics of exponential and logistical growth. B.DI.2.RAS.B

3. **Loss of diversity** B.DI.3

   a. Heat retention due to increasing levels of atmospheric greenhouse gases poses challenges for species. Use data-driven models to predict how current rates of change could reshape the range and distribution of species. B.DI.3.DTES.A

   b. Design, evaluate, or refine a solution for reducing the impacts of human activities (e.g., urbanization, building dams, introduction of invasive species, sinking ships to rebuild coral reefs, creating manmade lakes) on the environment and biodiversity. B.DI.3.DTES.B

   c. Research how domestication and selective breeding have impacted animal and plant genetic biodiversity (e.g., apples, dogs). Analyze the impacts of the changes. Predict how biodiversity will be impacted in the future. B.DI.3.DTES.C

   d. Research the role zoos are playing in the conservation of endangered or threatened species. Analyze the impact of these efforts to address the potential loss of diversity within the species or within the ecosystem. Identify the limitations of zoo-based captive breeding programs (e.g., inbreeding) and propose solutions to minimize such problems. B.DI.3.DTES.D

   e. Investigate a species of extremely low abundance (e.g., Vaquita porpoise, Sumatran/Javan rhinos) and propose monitoring or management methods to improve the genetic diversity. B.DI.3.DTES.E

   f. Research the possibility of bringing back extinct species. Examine species restoration methods and techniques. Explore the possibility of de-extinction of a species, its ecological impacts, moral implications and economic values. B.DI.3.DTES.F

   g. Research an invasive species in Ohio, analyze its ecological and economic impacts on biological and human communities. Identify factors that contribute to the species' success and propose solutions to reduce the ecological and economic impacts of the species. B.DI.3.DTES.G

   a. Use satellite or buoy temperature data to analyze ocean temperature and evaluate temperature effects on marine life. B.DI.3.DSK.A

   b. Investigate a local species (e.g., tree, insect, amphibian, reptile). Use historical and current data to create a profile of the species showing the impact of climate over the past century. B.DI.3.DSK.B

   c. Conduct an experiment to measure changes in temperature of an enclosed environment (e.g., terrarium, 2L bottle) by altering variables such as light intensity, CO2 and humidity. Compare the effect of different factors on the enclosed ecosystem. B.DI.3.DSK.C

   d. Plan a project utilizing real-time/authentic data (e.g., community planners, ODNR, interviews with local farmers) to explain strategies (e.g., pest control, water supply, crop rotations, stormwater management) used to adapt to changes in climate. B.DI.3.DSK.D

   e. Design a study to examine how Earth system interactions are modified by human activities (e.g., an increase in atmospheric carbon dioxide results in an increase in ocean acidification that impacts marine populations). B.DI.3.DSK.E

f. Given a factor that may impact the ecosystem (e.g., weather event, pesticide, climate change) predict the influence of the impact on the ecosystem. Predict which species would be most vulnerable to extinction and which species would be most resilient. Defend your reasoning. B.DI.3.DSK.F

g. Examine the established programs to repopulate endangered animal species. Pick a species involved in the restoration and describe current methodology and costs of these programs. Project the benefits to society and why these species are critical to their ecosystem. Examine the role of social media, national economy, politics, energy use, commercial interests, and local traditions in the decision-making process. B.DI.3.DSK.G

h. Investigate the prevalence of invasive species in the local area and the impact these species have on native species. B.DI.3.DSK.H

a. Given real-world data charts from NASA or NOAA construct graphs to examine how factors involved in climate change impact global biological diversity (e.g., coral reefs, desertification, ocean acidification). B.DI.3.ICSC.A

b. Compare historical levels of atmospheric greenhouse gases with levels over the last century. Relate this to climate change and its impact on biodiversity. B.DI.3.ICSC.B

c. Identify patterns in local weather conditions (e.g., temperature, precipitation) and changes in the severity or frequency of extreme weather events. Make inferences on how these changes may impact Ohio climate zones in the future. B.DI.3.ICSC.C

d. Provide examples of GMOs and examine their possible impact on the environment. B.DI.3.ICSC.D

e. Use principles of evolution through natural selection to explain the rise in the occurrence of herbicide-resistant weeds in areas using herbicide-resistant GMO corn and soy seeds. Compare this process with the rise of antibiotic-resistant microbes. B.DI.3.ICSC.E

f. Explore a region of the world that is experiencing high rates of extinction and examine the cause. Analyze the impact of extinction on keystone species, food webs, niches and cycling of matter. B.DI.3.ICSC.F

g. Discuss the limitations of zoos, arboretums and botanical gardens as defenses against global biodiversity loss. B.DI.3.ICSC.G

h. Explain the impact of various invasive species control methods on invasive and native species populations (e.g., LEWS). B.DI.3.ICSC.H

i. Investigate the increase of human disease due to invasion and range expansion of disease vectors (e.g., mosquitoes, ticks). Examine both human and natural means for vector movement (e.g., severe acute respiratory syndrome [SARS], West Nile, Bird Flu, Tsetse fly, nematodes). B.DI.3.ICSC.I

a. Describe feedback loops that exist between sunlight, the ocean, the atmosphere and the biosphere. B.DI.3.RAS.A

b. List examples of local environmental impacts caused by climate change (e.g., increased flooding, shoreline erosion, shifting planting zones, drought). B.DI.3.RAS.B

c. Draw and label a biogeochemical cycle (e.g., carbon cycle, water cycle, nitrogen cycle). Identify the factors within this cycle that are influenced by climate change. B.DI.3.RAS.C

d. Identify and describe anthropogenic factors (e.g., acid rain, ozone depletion, landfill leaching, thermal pollution, light pollution) and correlate these influences with their impacts on the environment. B.DI.3.RAS.D

e. Graph the global growth of the human population over the last 10,000 years B.DI.3.RAS.E

f. List historical events that have that resulted in species extinction. B.DI.3.RAS.F

g. Categorize recent causes of extinction of species (e.g., overharvesting, habitat loss). B.DI.3.RAS.G

h. Identify possible impacts species extinction has on biological communities. B.DI.3.RAS.H

i. Describe common ways invasive species are introduced to a new habitat. B.DI.3.RAS.I

j. Describe the characteristics of successful invasive species. B.DI.3.RAS.J

k. Create a list of invasive species for your local area and identify the native species with which they compete. Relate this to the ecological controls of native species in the area and how the invasive species escapes those (e.g., invasive starlings are more aggressive at defending nest sites than native bluebirds). B.DI.3.RAS.K

1. **Cell structure and function** B.C.1

   a. Research the cause and effect of various homeostatic diseases (e.g., Type 2 diabetes, high blood pressure, gout) and develop solutions to achieve homeostatic balance for patients that suffer from this disease. Suggest an explanation for the increased incidence of diabetes worldwide. B.C.1.DTES.A

   a. Develop an investigation to observe how materials transport across a selectively permeable membrane and how various cells respond to different environmental conditions to maintain a dynamic equilibrium. Construct a model of the phospholipid bilayer and predict the movement of various materials across the membrane. B.C.1.DSK.A

   b. Collect and analyze microscopic organisms from a local pond or stream. Infer evolutionary relationships between organisms according to ancestral traits and derived characteristics like cell parts and multicellularity. B.C.1.DSK.B

   c. Plan and conduct an investigation that identifies or manipulates feedback mechanisms to maintain homeostasis. Investigations could include heart rate response to exercise, stomate response to moisture and temperature and root development in response to water levels. B.C.1.DSK.C

   a. Use a model of the phospholipid bilayer and demonstrate transport of various materials across a semipermeable membrane that maintains homeostasis. Provide a survival advantage explanation for why some organelles have double membranes. B.C.1.ICSC.A

   b. Within a cell, model the synthesis of a hormone such as insulin, including modifications, from start to finish. B.C.1.ICSC.B

   c. Create a graphic organizer consisting of various cells and cell structures. Organize them according to size. Investigate how each would appear under different types of microscopes. B.C.1.ICSC.C

   d. Illustrate a model of negative or positive feedback including a sensor, a control center, effectors and variables being regulated. B.C.1.ICSC.D

   a. Identify different types of transport. Determine how materials move across a selectively permeable membrane. B.C.1.RAS.A

   b. Identify the interactivity of organelles resulting in cellular processes such as protein synthesis and metabolism. B.C.1.RAS.B

   c. Compare negative and positive feedback mechanisms. B.C.1.RAS.C

2. **Cellular Processes** B.C.2

   a. Refine a product such as yogurt so that it better addresses dietary concerns, restraints and restrictions (e.g. diabetics, infants, bodybuilders). B.C.2.DTES.A

   b. Plan and design an investigation using algae, fungi or other microorganisms to biosynthesize a natural product that has commercial applications. B.C.2.DTES.B

   c. Promote awareness of photosynthetic processes as a component of the Earth's CO2 recycling system. Design a "green" environment (e.g., school, house, microenvironment) that demonstrates sustainable environmental practices, such as vegetated green roof systems to improve air quality. The design should encompass the efficient use of fuel resources and building materials to lower carbon footprint and reduce greenhouse gas emissions. Generate an argument and present data justifying how the design improves sustainability. B.C.2.DTES.C

   a. Design a lab studying yeast and adjust variables such as temperature, pH and food sources. Use probes or other methods to measure gas exchange. B.C.2.DSK.A

   b. Research various biomolecules found in food. Investigate a food source and identify its biomolecule components. Evaluate and critique popular food options on the market and determine if the nutritional analysis is factual. Using nutritional data create a new marketing promotion for healthier food choices and present findings. B.C.2.DSK.B

   c. Plan and design an investigation to determine the factors (e.g., temperature, pH, substrate concentration) that affect the activity of enzymes on their substrates (e.g., peroxidase). Research diseases caused by enzymatic deficiencies and propose possible solutions or evaluate how medical breakthroughs have solved the problem (e.g., lactase persistence, adrenoleukodystrophy, mitochondrial disorders). B.C.2.DSK.C

   d. Design experiments to study gas exchange in photosynthetic organisms. Analyze the data generated to justify which environmental conditions are the most efficient for the photosynthetic organisms. Probes could be used to measure gas exchange. B.C.2.DSK.D

   a. Provide data from fermentation activities (e.g., Kombucha, sauerkraut) and evaluate variables and outcomes. B.C.2.ICSC.A

   b. Research various techniques to extract oil or hormones from algae. Infer the structural changes (e.g., cellular inclusions, smooth endoplasmic reticulum proliferation) to the algal cells that these techniques may cause. Which strains of algae utilize the most cost-efficient metabolic pathways for oil or hormone production? B.C.2.ICSC.B

   c. Using a simulation or data predict the effects of different variables (e.g., temperature, pH, salinity) on enzyme structure and function. Given a graph, interpret and analyze activation energy with optimal pH and temperature. B.C.2.ICSC.C

   d. Generate a model to depict the role of photosynthesis and cellular respiration in the cycling of matter and energy through biogeochemical cycles B.C.2.ICSC.D

a. Identify the cellular organelles involved in fermentation. Include inputs and outputs required for the process. B.C.2.RAS.A

b. Construct models of various biomolecules. Identify basic building blocks, functions, and location of biomolecules in food and/or the environment. B.C.2.RAS.B

c. Identify the structure and function of enzymes and substrates applying models such as lock and key or induced fit. B.C.2.RAS.C

d. Identify key organelles, as well as the inputs and outputs of matter and energy, utilized by photosynthesis and cellular respiration. B.C.2.RAS.D