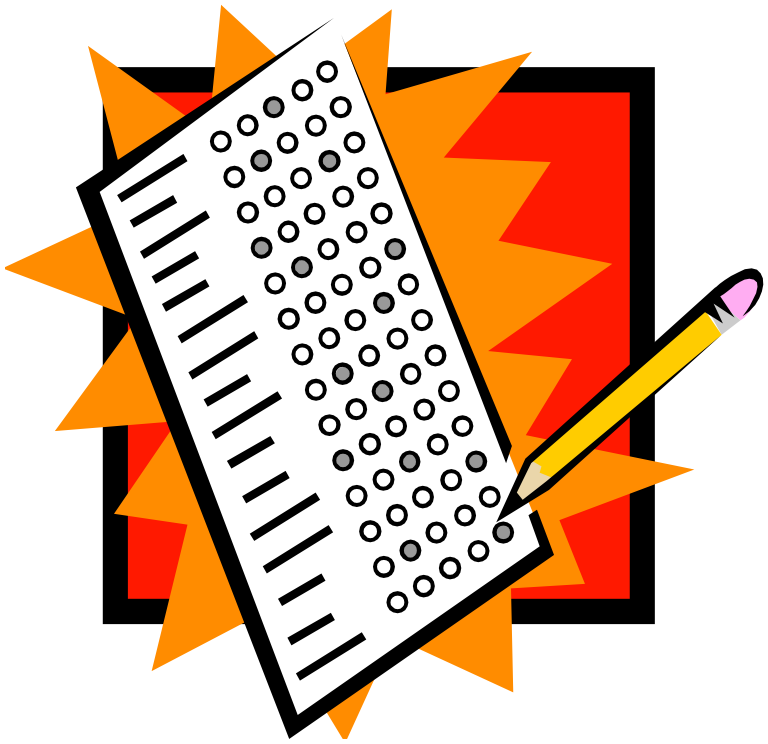
Stone Bridge High School
Science Department
Biology Class



Biology Essential SOL Knowledge

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Biology SOL Essential Knowledge

1. A **hypothesis** can be supported, modified, or rejected based on collected data. Hypotheses are tentative explanations that account for a set of facts and can be tested by further investigation.

2. A theory is an explanation of a large body of information, experimental and inferential, and serves as an overreaching framework for numerous concepts. It is subject to change as new evidence becomes available.

3. The development and refinement of magnifying lenses and light microscopes made the observation and description of microscopic organisms and living cells possible.

4. The development of the cell theory was accelerated by the ability to make observations on the microscopic level.

5. The cell theory states that all living things are composed of cells and cells come from other cells by cell reproduction.

6. Continued advances in microscopy allowed observation of cell organelles and ultra structure. Current technology allows the observation of cellular processes underlying both cell structure and function.

7. Scientists have developed hypotheses about conditions on early Earth that could have led to the formation of the first organic molecules, early self-replicating molecules, the source of free oxygen in Earth's atmosphere, and the appearance of prokaryotic and later eukaryotic cells.

8. Natural selection is a process by which organisms with traits well suited to an environment survive and reproduce at a greater rate than organisms less suited to the environment.

9. Throughout history people have created explanations for disease.

10. Pasteur and Koch's experimentation and hypotheses led to an understanding of the presence of microorganisms and their relationship to diseases.

11. The introduction of the germ theory led to the understanding that many diseases are caused by microorganisms.

12. Changes in health practices have resulted from the acceptance of the germ theory of disease.

13. The modern approach emphasizes sanitation, the safe handling of food and water, aseptic techniques to keep germs out of the body, and the development of vaccinations and other chemicals and processes to destroy microorganisms.

14. Once DNA was shown to be the genetic material, a race among scientists took place to work out its structure.

15. Studies of the amount of each DNA base in different organisms led to the concept of complementary base paring.

16. Interpretation of x-ray photographs of DNA were used to describe the shape and dimensions of the molecule. An analysis of this and other available data led to a structural model for the DNA double helix.

17. The double helix model explained how heredity information is passed on and provided the basis for an explosion of scientific research in molecular genetics.

18. Science depends on experimental and observational confirmation and is subject to change as new evidence becomes available.

19. Water is able to absorb large amounts of heat. As a result, lakes and oceans stabilize air and land temperatures.

20. Water absorbs heat when it evaporates, allowing organisms to release excess heat.

21. In the solid form, ice floats, preventing lakes and oceans from freezing solid.

22. (A) Water is able to dissolve many substances so the water inside and outside of cells is able to carry nutrients into and around cells, and wastes away from cells.

22. (B) Water molecules are both cohesive and adhesive due to the nature of bonding (polar covalent and hydrogen bonding).

23. The pH scale goes from 0 to 14. The pH of pure water is 7. Substances added to water can lower or raise the pH. A solution with a pH below 7 is acidic. A solution with a pH above 7 is basic.

24. Organisms can only tolerate small changes in pH because every cell has a particular pH at which it functions best. For example, changes in pH cause changes in enzyme conformation, resulting in a change in activity.

25. The main components of a living cell are carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur.

26. Carbon atoms can easily bond to several other carbon atoms in chains and rings to form large complex molecules.

27. Cells can make a variety of macromolecules from a relatively small set of monomers.

28. The primary functions of carbohydrate molecules are to provide and store energy. The primary functions of lipid macromolecules are to insulate, store energy, and make up cell membranes.

29. Nucleic acids (DNA and RNA) control cell activities by directing protein synthesis.

30. Some protein are structural (hair, nails). Others function in transport (hemoglobin), movement (muscle fibers and cytoskeleton elements), defense (antibiotics), and regulation of cell functions (hormones and enzymes).

31. Proteins are polymers made by linking together amino acid monomers.

32. A protein's structure depends on its specific conformation. The sequence of amino acids and the shape of the chain are a consequence of attractions between the chain's parts.

33. Each enzyme has a definite three-dimensional shape that allows it to recognize and bind with its substrate. In living cells, enzymes control the rate of metabolic reaction by acting as catalysts.

34. Most cells function best within a narrow range of temperature and pH. At low temperatures, reaction rates are too slow. High temperatures or extremes of pH can irreversibly change the structure of proteins and alter their function.

35. Photosynthesis and cell respiration are complimentary processes for cycling carbon dioxide and oxygen as well as transferring energy in ecosystems.

36. During photosynthesis, cells trap energy from sunlight with chlorophyll, and use the energy, carbon dioxide and water to produce energy-rich organic molecules (glucose) and oxygen.

37. During respiration, eukaryotic cells "burn" organic molecules with oxygen, which produce energy, carbon dioxide, and water.

38. Light is the initial source of energy for most communities.

39. Photosynthesis involves an energy conversion in which light is converted to chemical energy in specialized cells. These cells are found in autotrophs such as plants and some protists.

40. Cells release the chemical energy stored in the products of photosynthesis. This energy is transported within the cell in the form of ATP.

41. When cells need energy to do work, certain enzymes release the energy stored in the chemical bonds of ATP.

42. Earth's first cells were prokaryotes.

43. Prokaryotic cells exist in two major forms, eubacteria and archaebacteria.

44. Prokaryotes are the Earth's most abundant inhabitants. They can survive in a wide range of environments and obtain energy in a variety of ways.

45. Eukaryotes arose from prokaryotes and developed into larger more complex organisms from single-celled Protista to multicellular fungi, plants, and animals.

46. Several differences between eukaryotes and prokaryotes include size, genetic material surrounded by a nuclear membrane, and the addition of mitochondria and chloroplasts.

47. Cellular differences between plant and animal cells include the presence of a cell wall that give the plant cell a defined shape, chloroplasts, and number of vacuoles.

48. Essential cell structures and their functions include

- **the nucleus (contains DNA, site where RNA is made)**

- **ribosomes (site of protein synthesis)**

- **mitochondria (site of cell respiration)**

- **chloroplast (site of photosynthesis)**

- **endoplasmic reticulum (transports materials through the cell)**

- **Golgi bodies (cell products are packaged for export)**

- **lysosomes (contain digestive enzymes)**

- **cell membrane (controls what enters and leaves the cell)**

- **cell wall (provides support).**

49. Some organisms exist as a single cell while others are composed of many cells, each specialized to perform distinct metabolic functions.

50. The basic processes necessary for living things to survive are the same for a single cell as they are for a more complex organism.

51. A single-celled organism has to conduct all life processes by itself. A multicellular organism has groups of cells that specialize to perform specific functions.

52. Cell specialization occurs during the development of a multicellular organism. The genetic information necessary for all cellular functions remains in each cell but may not be used.

53. The fluid mosaic model of a membrane emphasizes the arrangement and function of a bilayer of phospholipids, transport proteins, and cholesterol.

54. Diffusion in cells occurs when substances (oxygen, carbon dioxide, salts, sugar, amino acids) which are dissolved in water move from an area of higher concentration to an area of lower concentration.

55. Osmosis refers to the movement of water molecules through a semi-permeable membrane from an area of greater water concentration or pressure to an area of lesser water concentration or pressure.

56. Active transport refers to the movement of solid and liquid particles into and out of a cell by endocytosis or exocytosis.

57. For the body to use food for energy, the food must first be digested into molecules that are absorbed and transported to cells, where the food is used for energy, and for repair and growth.

58. To burn food for the release of energy, oxygen must be supplied to cells and carbon dioxide removed. The respiratory system responds to changing demands by increasing or decreasing breathing rate in order to maintain homeostasis.

59. The circulatory system, which moves all of these substances to and from cells, responds to changing demands by increasing or decreasing heart rate and blood flow in order to maintain homeostasis.

60. The urinary system disposes of dissolved waste molecules, the intestinal tract removes solid wastes, and the skin and lungs rid the body of heat energy.

61. Specialized cells of the immune system and the molecules they produce are designed to protect against organisms and substances that enter from outside the body, and against some cancer cells that arise from within.

62. Communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells secrete substances that spread only to nearby cells.

63. Environmental factors that impact human health include: diet, exercise, sleep, stress, toxic substances that enter the body, viruses, and other living organisms that infect the body.

64. Genetic predisposition toward diseases impact human health. Awareness of genetic predisposition allows individuals to make lifestyle changes that can enhance quality of life.

65. Viruses are not cells. Basic viral structure consists of a nucleic acid core surrounded by a protein coat.

66. Viruses can only reproduce inside another living cell, the host cell.

67. The viral reproductive process is called the lytic cycle. It includes the following steps:

- A virus attaches to a host cell's membrane and injects its nucleic acid into the host cell.

- The viral nucleic acid takes over protein synthesis, creating new viruses.

- The host cell bursts (lyses) releasing the newly formed viruses.

68. Mitosis produces two genetically identical cells.

69. Meiosis occurs in sexual reproduction when a diploid germ cell produces four haploid daughter cells that can mature to become gametes (sperm or egg).

70. A typical cell goes through a process of growth, development, and reproduction called the cell cycle.

71. Mitosis and meiosis refer to division of the nuclear material. Cytokinesis is the division of the cytoplasm and organelles.

72. Mitosis is referred to in the following stages: prophase, metaphase, anaphase, and telophase.

73. Mendel's laws of heredity are based on his mathematical analysis and observations of patterns of inheritance of traits.

74. The laws of probability govern simple genetic recombinations.

75. Genotype describes the genetic make-up of an organism and phenotype describes the organism's appearance based on its genes.

76. Homozygous individuals have two identical alleles for a particular trait, while heterozygous individuals have contrasting alleles.

77. When one allele masks the effect of another, that allele is called dominant, and the other recessive. When an intermediate phenotype occurs and no allele dominates, incomplete dominance results.

78. The sorting and recombination of genes in sexual reproduction results in a great variety of gene combinations in the offspring of any two parents.

79. Inserting, deleting, or substituting DNA bases can alter genes. An altered gene may be passed on to every cell that develops from it, causing an altered phenotype.

80. An altered phenotype may be beneficial or detrimental.

81. Sometimes entire chromosomes can be added or deleted, resulting in a genetic disorder such as trisomy 21 (Down syndrome).

82. The genetic code is a sequence of DNA nucleotides in the nucleus of eukaryotic cells.

83. DNA is a polymer consisting of nucleotides. A DNA nucleotide is identified by the base it contains: adenine (A), guanine (G), cytosine (C), or thymine (T).

84. DNA is a double-stranded molecule. The strands are connected by complementary nucleotide pairs (A-T and C-G) like rungs on a ladder. The ladder twists to form a double helix.

85. In order for cells to make protein, the DNA code must be transcribed (copied) to messenger RNA (mRNA).

86. The mRNA carries the code from the nucleus to the ribosomes in the cytoplasm.

87. RNA is a single-stranded polymer for four nucleotide monomers. A RNA nucleotide is identified by the base it contains: adenine (A), guanine (G), cytosine (C), or uracil (U).

88. At the ribosome, amino acids are linked together to form specific proteins. The amino acid sequence is directed by the mRNA molecule.

89. Cells pass on their genetic code by replicating (copying) the DNA.

90. During DNA replication, enzymes unwind and unzip the double helix and each strand serves as a template for building a new DNA molecule. Free nucleotides bond to the template (A-T and C-G) forming a complementary strand. The final product of replication is two identical DNA molecules.

91. Forensic identification is an example of the application of DNA technology.

92. There is great potential for the development of useful products through genetic engineering (e.g., human growth hormone, insulin, and resistant fruits and vegetables).

93. Eugenics, a pseudo-science of selective procreation, was a movement throughout the twentieth century, worldwide as well as in Virginia, that demonstrated a misuse of the principles of heredity.

94. The Human Genome Project is a collaborative effort to map the entire gene sequence of organisms. This information will be useful in detection, prevention, and treatment of many genetic diseases.

95. The potential for identifying and altering genomes raises practical and ethical questions.

96. Cloning is the production of genetically identical cells and/or organisms.

97. Binomial nomenclature is a standard way of identifying a species with a scientific two-word name. The first word is the genus name and the second the species name.

98. A species is described as a group of organisms that has the ability to interbreed and produce fertile offspring.

99. A fossil is any evidence of an organism that lived long ago.

100. Scientists have used the fossil record to construct a history of life on Earth.

101. Populations are groups of interbreeding individuals that live in the same place at the same time, and compete with each other for food, water, shelter, and mates.

102. Populations produce more offspring than the environment can support.

103. Organisms with certain genetic variations will be favored to survive and pass their variations on to the next generation.

104. The unequal ability of individuals to survive and reproduce leads to the gradual change in a population, generation after generation.

105. Through his observations made in the Galapagos Islands, Charles Darwin formulated a theory of how species change over time called natural selection.

106. Natural selection is governed by the principles of genetics. The change in frequency of a gene in a given population leads to a change in a population and may result in the emergence of a new species.

107. Natural selection operates on populations over many generations.

108. Mutations are important in how populations change over time because they result in genetic changes to the gene pool.

109. Adaptations sometimes arise in response to environmental pressures, for example: the development of antibiotic resistance in bacterial populations, morphological changes in the peppered moth population, pesticide resistance.

110. Stephen Jay Gould's idea of punctuated equilibrium proposes that organisms may undergo rapid (in geologic time) bursts of speciation followed by long periods of time unchanged. This view is in contrast to the traditional evolutionary view of gradual and continuous change.

111. A community is a collection of interacting populations.

112. Population growth curves exhibit many characteristics such as: initial growth stage, exponential growth, steady state, decline, and extinction.

113. Limiting factors are the components of the environment that restrict the growth of populations.

114. Carrying capacity is the number of organisms that can be supported by the resources in an ecosystem.

115. Abiotic factors are the nonliving elements in an ecosystem such as temperature, moisture, air, salinity, and pH. Biotic factors are all of the living organisms that inhabit the environment including predators, food sources, and competitors.

116. Symbiosis is a close and permanent relationship between organisms of two different species. Examples include mutualism, commensalism, and parasitism.

117. An ecosystem consists of all the interacting species and the abiotic environment in a given geographic area.

118. Nutrients cycle through an ecosystem. The most common examples include carbon, oxygen, nitrogen, and water.

119. Flow of energy occurs between trophic levels in all ecosystems and can be depicted as follows:

- food chain

- food web

- pyramid of energy

- pyramid of biomass

- pyramid of numbers.

120. Ecological succession is a series of changes in a community in which new populations of organisms gradually replace existing ones.

121. A climax community occurs when succession slows down and a stable community is established. The climax community is made up of organisms that are successful in competing for resources in a given environment. The climax community in most of Virginia is a deciduous oak-hickory (hardwood) forest.

122. Human activities such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming have changed the Earth's land, oceans, and atmosphere.

123. Some of these changes have decreased the capacity of the environment to support some life forms.

Biology SOL Essential Skills

1. Collect preliminary observations, both qualitative and quantitative.

2. Make clear distinctions among observations, inferences, and predictions.

3. Formulate hypotheses based on cause and effect relationships.

4. Justify the hypotheses based both on preliminary observations and scientific literature.

5. Identify the independent variable (IV), and the values of the IV that will be used in the experiment.

6. Select dependent variables that allow collection of quantitative data.

7. Use appropriate technology for data collection, including: probeware interfaced to a graphing calculator and/or computer, microscope, video microscope, or digital camera with image processing software.

8. Identify variables that must be held constant.

9. Establish controls as appropriate.

10. Write clear, replicable procedures.

11. Record quantitative data in clearly labeled tables with units.

12. Include labeled diagrams in the data record.

13. Critically examine and discuss the validity of results reported in scientific literature and databases.

14. Explain how competing theories based on the same observations can be equally valid.

15. Recognize that in order to ensure the validity of scientific investigations, other members of the scientific community must evaluate the work.

16. Determine range, mean, and values for data, using a graphing calculator and/or computer spreadsheet software.

17. Plot data graphically, showing the independent and dependent variables.

18. Describe linear mathematical functions from the data, where appropriate, using a graphing calculator and/or computer spreadsheet.

19. Discuss accuracy, confidence, and sources of experimental error based on number of trials and variance in the data.

20. Recognize and discuss contradictory or unusual data.

21. Use evidence, apply logic, and construct an argument for conclusions based on reported data.

22. Determine the extent to which data supports/does not support the hypothesis, and propose further hypotheses and directions for continued research.

23. Recognize the equation for photosynthesis and respiration and identify the reactants and products.

24. Differentiate and give examples from local ecosystems:

- **Autotrophs and heterotrophs (producers, consumers, and decomposers)**

- **multicellular and unicellular organisms**

- **motile and non-motile organisms**

- **organisms with and without cell walls**

- **sexually and asexually reproducing organisms**

- **aquatic and terrestrial organisms**

- **behavioral responses to the environment.**

25. Predict possible gametes in a dihybrid cross, given parental genotypes.

26. Use a Punnett square to show all possible combinations of gametes and the likelihood that particular combinations will occur in monohybrid crosses.

27. Evaluate karyotype charts.

28. Given a DNA sequence, write a complementary mRNA **strand (A-U, T-A, C-G, and G-C).**

29. Construct and utilize dichotomous keys to classify groups of objects and organisms.

30. Describe relationships based on homologous structures.

31. Compare structural characteristics of an extinct organism, as evidenced by its fossil record, with present, familiar organisms.

32. Recognize similarities in embryonic stages in diverse organisms in the animal kingdom, from zygote through embryo.

33. Interpret a cladogram or phylogenic tree showing evolutionary relationships among organisms.

34. Describe relationships between organisms, given amino acid or nucleotide sequences.

35. Determine the relative age of a fossil given information about its position in the rock, and absolute dating by radioactive decay.

36. Differentiate between relative and absolute dating based on fossils in biological evolution.

37. Graph and interpret a population growth curve.

38. Given an illustration of a food chain and a food web, describe each organism as a producer (autotroph), consumer (primary/second order) or decomposer.

39. Observe and identify flora and fauna in a local community, using field guides and dichotomous keys for identifying and describing organisms that characterize the local ecosystem.

40. Identify and describe an ecosystem in terms of the following:

- **effects of biotic and abiotic components**

- **examples of interdependence**

- **evidence of human influences**

- **energy flow and nutrient cycling**

- **diversity analysis**

- **ecological succession.**