

# Manitoba

Education, Citizenship and Youth

## SENIOR 4 BIOLOGY 40S

Student Specific Learning Outcomes

DRAFT / Unedited Version

April 2005

## Cluster 0: Biology Skills and Attitudes

### **Demonstrating Understanding**

S4B-0-U1 Use appropriate strategies and skills to develop an understanding of biological concepts.

*Examples: using concept maps, sort-and predict frames, concept frames...*

S4B-0-U2 Demonstrate an in-depth understanding of biological concepts.

*Examples: use accurate scientific vocabulary, explain concept to someone else, make generalizations, compare/contrast, identify patterns, apply knowledge to new situations/contexts, draw inferences, create analogies, creative presentations...*

### **Personal Perspectives/Reflection**

S4B-0-P1 Demonstrate confidence in their ability to carry out investigations.

S4B-0-P2 Demonstrate a continuing, more informed interest in biology and biology-related careers and issues.

S4B-0-P3 Recognize the importance of maintaining biodiversity and the role that individuals can play in this endeavor.

S4B-0-P4 Recognize that humans have impacted and continue to impact the environment.

S4B-0-P5 Appreciate that technological developments can create ethical dilemmas related to their use that challenge personal and societal decision-making.

### **Scientific Inquiry/Problem-Solving**

S4B-0-S1 Use appropriate scientific problem-solving or inquiry strategies when answering a question or solving a problem.

S4B-0-S2 Demonstrate work habits that ensure personal safety, the safety of others, and consideration of the environment.

S4B-0-S3 Record, organize and display data and observations using an appropriate format.

S4B-0-S4 Evaluate the relevance, reliability, and adequacy of data and data collection methods.

Include: discrepancies in data, sources of error.

S4B-0-S8 Analyze data or observations in order to explain the results of an investigation and identify implications of these findings.

### **Decision-Making**

S4B-0-D1 Identify and explore a current issue.

*Examples: clarify the issue, identify different viewpoints and/or stakeholders, research existing data/information.*

S4B-0-D2 Evaluate implications of possible alternatives or positions related to an issue.

*Examples: positive and negative consequences of a decision, strengths and weaknesses of a position, ethical dilemmas...*

S4B-0-D3 Recognize that decisions reflect values and consider their own values and those of others when making a decision.

S4B-0-D4 Recommend an alternative or identify a position and provide justification.

S4B-0-D5 Propose a course of action related to an issue.

S4B-0-D6 Evaluate the process used by themselves or others to arrive at a decision.

### **Information Management and Communication**

S4B-0-I1 Synthesize information obtained from a variety of sources.

Include: print and electronic sources, resource people, different types of writing.

S4B-0-I2 Evaluate information obtained to determine its usefulness for information needs.

*Examples: scientific accuracy, reliability, currency, relevance, balance of perspectives, bias...*

S4B-0-I3 Quote from or refer to sources as required and reference sources according to accepted practice.

S4B-0-I4 Communicate information in a variety of forms appropriate to the audience, purpose and context.

## **Group Work**

S4B-0-G1 Collaborate with others to achieve group goals and responsibilities.

S4B-0-G2 Elicit, clarify and respond to questions, ideas, and diverse points of view in discussions.

S4B-0-G3 Evaluate individual and group processes used.

## **Nature of Science**

S4B-0-N1 Describe the role of evidence in developing scientific understanding and how this understanding changes when new evidence is introduced.

S4B-0-N2 Understand that development and acceptance of scientific evidence, theories, or technologies are affected by many factors.

*Examples: cultural and historical context, politics, economics, personalities...*

S4B-0-N3 Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena.

## **Part 1 - Genetics**

### **Unit 1 - Understanding Biological Inheritance**

1. Outline Mendel's principles of inheritance, stating their importance to the understanding of heredity.  
Include: principles of segregation, dominance, independent assortment.
2. Explain what is meant by the terms heterozygous and homozygous.
3. Distinguish between genotype and phenotype and use these terms appropriately when discussing the outcomes of genetic crosses.
4. Use Punnett squares to solve a variety of autosomal inheritance problems and justify the results by using appropriate terminology.  
Include: monohybrid cross, dihybrid cross, testcross, P generation, F<sub>1</sub> generation, F<sub>2</sub> generation, phenotypic ratio, genotypic ratio, dominant alleles, recessive alleles, purebred, hybrid, carrier.
5. Describe examples and solve problems involving the inheritance of phenotypic traits that do not follow a dominant-recessive pattern.  
*Examples: co-dominance, incomplete dominance, multiple alleles, lethal genes...*
6. Explain the basis for sex determination in humans.  
Include: XX and XY
7. Describe examples and solve problems involving sex-linked genes.  
*Examples: red-green colour-blindness, hemophilia, Duchenne muscular dystrophy...*
8. Use pedigree charts to illustrate the inheritance of genetically determined traits in a family tree and to determine the probability of certain offspring having particular traits.  
Include: symbols and notation used.
9. Discuss ethical issues that may arise as a result of genetic testing for inherited conditions or disorders.
10. Discuss the role of meiosis and sexual reproduction in producing genetic variability in offspring.  
Include: crossing-over, randomness

11. Explain how chromosome mutations may arise during meiosis.  
Include: non-disjunction
12. Identify monosomy and trisomy chromosome mutations from karyotypes.  
*Examples: Down syndrome, Turner syndrome, Klinefelter syndrome...*

## **Unit 2 – Mechanisms of Inheritance**

1. Outline significant scientific contributions/discoveries that lead to our understanding of the structure and function of the DNA molecule.  
Include: timeline, individual contributions, multidisciplinary collaboration, competitive environment...
2. Describe the structure of a DNA nucleotide.  
Include: deoxyribose sugar, phosphate group, nitrogenous bases
3. Describe the structure of a DNA molecule.  
Include: double helix, nucleotides, base-pairing, gene
4. Describe the process of DNA replication.  
Include: template, semi-conservative replication, role of enzymes
5. Compare DNA and RNA in terms of their structure, use and location in the cell.
6. Outline the steps involved in protein synthesis.  
Include: mRNA, codon, amino acid, transcription, tRNA, anticodon, ribosome, translation
7. Relate the consequences of gene mutation to the final protein product.  
*Examples: point mutation in sickle cell anemia, frameshift mutation in B-thalassemia...*
8. Discuss implications of gene mutation to genetic variation.  
Include: source of new alleles.
9. Investigate an issue related to the application of gene technology in bioresources.  
Include: understanding the technology/processes involved, economic implications, a variety of perspectives, personal/societal/global implications.

10. Investigate an issue related to the application of gene technology in humans.  
Include: understanding the technology/processes involved, ethical and legal implications, a variety of perspectives, personal, societal/global implications.

## **Part 2 - Biodiversity**

### **Unit 3 - Evolutionary Theory and Biodiversity**

1. Define the term evolution, explaining how evolution has led to biodiversity by altering populations and not individuals.  
Include: gene pool, genome
2. Describe and explain the process of discovery that led Darwin to formulate his theory of evolution by natural selection.  
Include: the voyage of the Beagle, his observations of South American fossils, the impact of the Galapagos Islands on his thinking. the work of other scientists.
3. Outline the main points of Darwin's theory of evolution by natural selection. Include: overproduction, competition, variation, adaptation, natural selection, speciation.
4. Demonstrate, through examples, what the term "fittest" means in the phrase "survival of the fittest".  
*Examples: Walking Stick insect blending with its environment, sunflowers bending towards sunlight, antibiotic resistant bacteria.*
5. Explain how natural selection leads to changes in populations.  
*Examples: Industrial melanism, antibiotic resistant bacteria, pesticide resistant insects...*
6. Describe how disruptive, stabilizing and directional natural selection act on variation.
7. Distinguish between natural selection and artificial selection.
8. Outline how scientists determine if a gene pool has changed, according to the criteria for genetic equilibrium.  
Include: large population, random mating, no gene flow, no mutation, no natural selection.

9. Discuss how genetic variation in a gene pool can be altered.  
*Examples: natural selection, gene flow, genetic drift, non-random mating, mutation ...*
10. Describe how populations can become reproductively isolated.  
*Examples: geographic isolation, niche differentiation, altered behaviour, altered physiology...*
11. With the use of examples, differentiate between convergent evolution and divergent evolution (adaptive radiation).
12. Distinguish between the two models for the pace of evolutionary change: punctuated equilibrium and gradualism

#### **Unit 4 - Organizing Biodiversity**

1. Define the concept of biodiversity in terms of ecosystem, species and genetic diversity.
2. Explain why it is difficult to determine a definition of species.  
*Examples: hybrids such as mules, phenotypic variations in a species, non-interbreeding sub-populations...*
3. Describe the dynamic nature of classification.  
Include: different systems, current debates
4. Describe types of evidence used to classify organisms and determine evolutionary relationships.  
*Examples: fossil record, DNA analysis, biochemistry, embryology, morphology...*
5. Compare the characteristics of the domains.  
Include: Archaea (Archaeobacteria), Bacteria (Eubacteria), Eukarya.
6. Compare the characteristics of the kingdoms in the Eukarya domain.  
Include: cell structure, major mode of nutrition, cell number, motility.
7. Investigate an evolutionary trend in a group of organisms.  
*Examples: hominid evolution, vascularization in plants, animal adaptations for life on land...*

## **Unit 5 - Conservation of Biodiversity**

1. Discuss a variety of reasons for maintaining biodiversity.  
Include: maintaining a diverse gene pool, economic value, sustainability of an ecosystem.
2. Describe strategies used to conserve biodiversity.  
*Examples: habitat preservation, wildlife corridors, species preservation programs, public education*
3. Select and use appropriate tools or procedures to determine and monitor biodiversity in an area.  
*Examples: field guides, dichotomous keys, quadrats, transects, mark and recapture...*
4. Investigate an issue related to the conservation of biodiversity.  
*Examples: heritage seeds, water quality in Lake Winnipeg, land use designations, hydroelectric development...*