Adult Basic Education

Science

Biology 3101C

Genetics and Evolution

Curriculum Guide

Prerequisites: Biology 2101A
Biology 2101C
Biology 3101A
Biology 3101B

Credit Value: 1

Biology Concentration

Biology 1101
Biology 2101A
Biology 2101B
Biology 2101C
Biology 3101A
Biology 3101B
Biology 3101C

Table of Contents

To the Instructor

I. Introduction to Biology 3101C

Biology 3101C is the third of the three courses (the others are Biology 3101A and Biology 3101B) that are equivalent to Biology 3201 in the current high school system.

Biology 2101A, *The Cell*, Biology 2101C, *Maintaining Dynamic Equilibrium I*, Biology 3101A, *Maintaining Dynamic Equilibrium II*, and Biology 3101B, *Reproduction and Development,* are **pre-requisites** for this course. However, before deciding to leave out any courses in the Biology concentration, you should ensure that students are aware of what courses they will need to complete in order to meet the entrance requirements for the receiving post-secondary institution that they plan to attend.

This is a **1 credit** course that is divided into 2 parts.

Part 1, ***Genetic Continuity***, will provide students with the basic information required for the comprehension of genetics. Much of the structure and function of every living organism is determined by deoxyribonucleic acid (DNA). It is important for a scientifically literate person to understand principles and fundamentals about DNA: what it is, how it works, how and for what purposes humans are manipulating it, and why this major area of scientific and technological endeavour has dramatic implications for humans and planet earth.

Part 2, ***Evolution, Change, and Diversity*****,** focuses on the history, importance and mechanisms of the process of evolution and how a change in the DNA blueprint creates new traits that propel evolution. It builds upon what students have learned about mutations and genetic variability and shows how these can lead to changes in species based upon natural selection.

II. Curriculum Guides

Each new ABE Science course has a Curriculum Guide for the instructor and a Study Guide for the student. The Curriculum Guide includes the specific curriculum outcomes for the course. Suggestions for teaching, learning, and assessment are provided to support student achievement of the outcomes. Each course is divided into units. Each unit comprises a **two-page layout of four columns** as illustrated in the figure below. In some cases the four-column spread continues to the next two-page layout.

To the Instructor

Curriculum Guide Organization:
The Two-Page, Four-Column Spread

Unit Number - Unit Title		Unit Number - Unit Title	
Outcomes Specific curriculum outcomes for the unit.	**Notes for Teaching and Learning** Suggested activities, elaboration of outcomes, and background information.	**Suggestions for Assessment** Suggestions for assessing students' achievement of outcomes.	**Resources** Authorized and recommended resources that address outcomes.

III. Study Guides

The Study Guide provides the student with the name of the text(s) required for the course and specifies the sections and pages that the student will need to refer to in order to complete the required work for the course. It guides the student through the course by assigning relevant reading and providing questions and/or assigning questions from the text or some other resource. Sometimes it also provides important points for students to note. (See the *To the Student* section of the Study Guide for a more detailed explanation of the use of the Study Guides.) The Study Guides are designed to give students some degree of independence in their work. Instructors should note, however, that there is much material in the Curriculum Guides in the *Notes for Teaching and Learning* and *Suggestions for Assessment* columns that is not included in the Study Guide and instructors will need to review this information and decide how to include it.

IV. Resources

Essential Resources

Text: Biology; Bullard, Chetty, et al; McGraw-Hill Ryerson, 2003.

McGraw-Hill Ryerson, Biology, Teacher's Resource.

To the Instructor

Recommended Resources

McGraw-Hill Ryerson, Biology, Teacher's Resource CD-ROM.

McGraw-Hill Ryerson, Biology 11/12 #D Science Animations.

McGraw-Hill Ryerson, Biology 11/12 Computerized Assessment Banks.

Department of Education web site:
www.gov.nl.ca/edu/science_ref/main.htm

Other Resources

Textbook web site:
http://www.mcgrawhill.ca/school/booksites/biology/

Center for Distance Learning and Innovation: http://www.cdli.ca/

V. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam *(entire course)*	50%
	100%

The overall pass mark for the course is 50%.

Part I - Genetic Continuity

Unit 1 - Genetics: Mendelian

Outcomes

1.1 Demonstrate an understanding of Mendelian genetics.

1.1.1 Define the terms heredity and genetics.

1.1.2 Explain the meaning of the following terms:
- (i) trait
- (ii) variations
- (iii) P generation (parent generation)
- (iv) F_1 and F_2 generation (first and second filial generation)
- (v) hybrid
- (vi) purebred
- (vii) dihybrid
- (viii) monohybrid
- (ix) dominant
- (x) recessive
- (xi) gene
- (xii) allele
- (xiii) homozygous
- (xiv) heterozygous
- (xv) punnett square
- (xvi) genotype
- (xvii) phenotype
- (xviii) complete dominance

1.1.3 Explain how Mendel's experiments support:
- (i) principle of dominance
- (ii) law of segregation
- (iii) law of independent assortment.

Notes for Teaching and Learning

The Genetics unit begins with a number of new terms and students should become proficient in using them.

Some possible strategies to cover the terminology effectively are:
- introduction of terminology through an explanation of Mendel's experiments.
- making connections between sets of terms, such as gene and allele, dominant and recessive, hybrid and heterozygous.
- explaining the purpose of a punnett square.

Discuss the importance of understanding how traits are inherited.

It should be noted that in the province of Newfoundland and Labrador we have an example of a purebred animal, a certified Newfoundland Dog.

Mendel's detailed experimentation could be emphasized as an example of exemplary scientific processes.

Unit 1 - Genetics: Mendelian

Suggestions for Assessment

The Teacher's Resource CD-ROM includes Blackline Masters that instructors may find useful. These Blackline Masters may be edited before use.

Questions 1.1 - 1.11 in the Study Guide should be assigned to cover Outcomes 1.1- 1.3. Students will find the answers to these questions in Sections 16.1 and 16.2 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Laboratory Activities

- Students could perform the activities provided that deal with the concept of heredity. Possibilities include examination of ears of genetic corn or performance of crosses of the fruit fly Drosophila to investigate the inheritance of particular characteristics. Assessment would depend on the nature and depth of the activities selected, ranging from the answering of questions to a more detailed discussion of procedures and results.

Paper and Pencil

- Students should develop a glossary of new terms that they discover and will use during their discussions in this genetics unit.
- Students should complete relevant section review and chapter review questions.

Resources

McGraw-Hill Ryerson Biology, pages 526-539.

McGraw-Hill Ryerson Biology, Teacher's Resource.

McGraw-Hill Ryerson Biology, Teacher's Resource CD-ROM.

Biology 11/12 Computerized Assessment Banks.

Biology 11/12 3D Science Animations.

www.gov.nl.ca/edu/science_ref/main.htm

http://www.mcgrawhill.ca/school/booksites/biology/

Unit 1 - Genetics: Mendelian

Outcomes

1.2 State a prediction and a hypothesis based on available genetic evidence using genetic problems.

1.2.1 Determine the outcome of monohybrid and dihybrid crosses.

1.3 Explain the meaning of the following terms:

(i) incomplete dominance
(ii) co-dominance
(iii) multiple alleles

1.4 Interpret patterns and trends in genetic data.

1.4.1 Predict the outcome of crosses for incomplete and co-dominance.

1.4.2 Demonstrate the inheritance of traits governed by multiple alleles by predicting the genotypic and phenotypic ratios in crosses involving human blood types (ABO groups).

Notes for Teaching and Learning

Students should use Punnett squares to determine genotypic and phenotypic ratios in monohybrid and dihybrid crosses. Instructors should use multiple resources to find genetic problems of this type.

Multiple alleles should be explained with reference to blood types.

The concepts of incomplete dominance and co-dominance are very similar with respect to phenotypic expression:

1. Co-dominance is the condition in which both alleles of a gene are expressed. Examples include: Roan horses (red and white hair) and barred plumage chickens (black and white feathers).

2. Incomplete dominance is inheritance in which an active allele does not entirely compensate for an inactive allele. Examples include: snapdragon flowers (heterozygous is pink) and Japanese four-o'clock flowers (heterozygous is pink).

There are a number of different methods to represent the alleles for incomplete and co-dominance. For example, in incomplete dominance for flower colour in snapdragons the following can be used:

(i) R - red R' - white
(ii) FR - red Fw - white
(iii) R - red W - white

For co-dominance, blood type may be represented as follows:

(i) IA - type A IB - type B
(ii) A - type A B - type B

Unit 1 - Genetics: Mendelian

Suggestions for Assessment

Laboratory Activities

- Human ABO blood type is an example of the expression of multiple alleles. Students could determine the blood type of the simulated blood sample which they are provided and list the potential genotypes that would correspond to this type.

Paper and Pencil

- Students could solve monohybrid and dihybrid genetics questions prepared for them. In each case, they should analyze the data as requested. Assessment should be based on the accurate solution of the problems using appropriate logic and procedures. Students often have difficulty with learning how to do Punnett squares and will need lots of practice.

- Blackline Master 16-2, "Monohybrid and Dihybrid Crosses", can be copied and given to students for practice.

Viewing

- Students could view a short movie on Punnett squares at the web site shown in Resources.

Resources

MGH Biology, pp. 529-543.

Web site for movie:
http://www.mcgrawhill.ca/school/booksites/biology/student+resources/toc/index.php

Blackline Master 16-2, "Monohybrid and Dihybrid Crosses".

High school text books and resource packages.

Many high schools have web sites that provide notes and practice material.

Unit 2 - Genetics: Modern Ideas

Outcomes

2.1 Describe and illustrate the role of the chromosomes in the transmission of hereditary information from one cell to another.

- 2.1.1 State and explain the chromosome theory of inheritance.
- 2.1.2 Explain the concepts of gene linkage (linked genes) and crossing-over.
- 2.1.3 Outline, in general terms, the gene-chromosome theory of inheritance.

2.2 Demonstrate an understanding of sex-linked inheritance.

- 2.2.1 Define sex-linked inheritance.
- 2.2.2 Explain why sex-linked defects are more common in males than females.
- 2.2.3 Distinguish between genotypes and phenotypes evident in autosomal and sex-linked inheritance.
- 2.2.4 Predict the outcome of monohybrid and dihybrid crosses involving sex-linked traits.

Notes for Teaching and Learning

Crossing over was introduced in Biology 3101B. The emphasis in this unit is on how crossing over breaks gene linkages and creates variation. Diagrams and simulations may be useful in illustrating these concepts.

Genes exist on specific sites on chromosomes. When pairs of homologous chromosomes separate during gamete formation, they form two gametes. Each gamete will contain a separate allele for each trait. During fertilization, chromosomes from one gamete will combine with another gamete.

Students should be introduced to the concept of the inheritance of certain characteristics (red-green colour blindness, hemophilia, muscular dystrophy) through the sex chromosomes. Colour blindness analysis charts are useful to illustrate this sex-linked characteristic.

Students should be aware that autosomal inheritance typically involves pairs of genes, with gender being irrelevant to gene expression. Sex-linked inheritance involves pairs of genes on the X chromosome in the female, and a single gene on the X in the male. In this case, gender is important in gene expression and gender must be considered a part of the phenotype.

Instructors should note that the answers for all the Section Review and Chapter Review questions are provided in the Teacher's Resource.

Unit 2 - Genetics: Modern Ideas

Suggestions for Assessment

Paper and Pencil

- Students could predict the general location or arrangement of genes within a chromosome from the analysis of crossing over data with which they have been provided.
- Blackline Master 16-4, "Chapter 16 Test", could be used to assess students' knowledge of the concepts that students studied in Chapter 16.

Resources

MGH Biology, pp. 546-549.

MGH Biology, pp. 558-559.

Blackline Master 16-4, "Chapter 16 Test".

Outcomes

2.3 Demonstrate an understanding of polygenic inheritance.

2.3.1 Explain the influence of polygenic traits on inheritance patterns.

Notes for Teaching and Learning

Students should solve genetic problems that involve sex-linked traits. In these problems they should predict the genotypes, phenotypes and ratios among offspring and compare specific genotypes and phenotypes for males and females. Students should be able to solve dihybrid crosses involving one trait that is completely dominant with one other trait that is sex-linked. Instructors should use multiple resources to find genetic problems of this type.

Polygenic inheritance is also known as multiple gene inheritance. Skin colour and eye colour are examples of polygenic inheritance where traits are determined by a number of different contributing genes present at different locations and expression depends on the sum of the influences of all of these. Other examples include animal and plant traits selected by breeders for improving livestock and crops, as well as human characteristics such as susceptibility to cardiovascular disease and athletic ability.

Suggestions for Assessment

Questions 2.1 - 2.6 in the Study Guide should be assigned to cover Outcomes 2.1- 2.3. Students will find the answers to these questions in Section 16.3 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Paper and Pencil

- Students should solve sex-linked genetics questions prepared for them. In each case, they should analyze the data as requested. Assessment should be based on the accurate solution of the problems using appropriate logic and procedures.

- Students could complete Investigation 16.B to illustrate variation in inheritance of traits.

Testing

- This is the end of the section of the course covering Mendelian genetics, including a lot of terminology and the use of Punnett squares. Instructors could give a test to be used as part of the evaluation for the course.

Resources

Biology 11/12 Computerized Assessment Banks.

Unit 3 - Genetics: Molecular

Outcomes

3.1 Describe the molecular components of nucleic acids (RNA and DNA).

- 3.1.1 Describe the general structure of a nucleotide
- 3.1.2 Distinguish between the nucleotide structure of DNA and RNA.

3.2 Explain how a major scientific milestone revolutionized thinking in the scientific communities.

- 3.2.1 Describe the Watson and Crick double helix model of DNA.

3.3 Identify and describe the structure and function of important biochemical compounds such as nucleic acids (DNA and RNA).

- 3.3.1 Compare and contrast the structure of DNA and RNA.
- 3.3.2 Describe complementary base pairings.

Notes for Teaching and Learning

Students should understand the structure of nucleotides and which ones are found in DNA and RNA to prepare them for studying nucleic acids in more detail.

Students should be aware of and be able to explain how knowledge of the structure, function and replication of DNA revolutionized the understanding of heredity. Students may design and/or construct models of DNA to illustrate the general structure and base arrangement of the molecule.

Unit 3 - Genetics: Molecular

Suggestions for Assessment

Questions 3.1 - 3.5 in the Study Guide should be assigned to cover Outcomes 3.1- 3.3. Students will find the answers to these questions in Sections 17.1 and 17.2 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Laboratory Activities

- Students could design and construct a three-dimensional model of a DNA molecule following these structural guidelines:
  - include a minimum number of six base pairs
  - show all possible base pair combinations
  - make the model self-supporting
  - include a key for part identification

  They will be assessed on accuracy and completeness of their model.

Paper and Pencil

- Students should develop a glossary of new terms that they discover and will use during their discussions in this unit.

- Using the processes of transcription and translation, students could be given a DNA strand and asked to convert it into its resulting protein.

Resources

MGH Biology, pp. 568-576.

Outcomes

3.4 Explain the semi-conservative model of DNA replication.

3.4.1 Describe the three main stages of DNA replication. Include:

(i) initiation

(ii) elongation

(iii) termination

3.5 Design and build a DNA model and use the model to simulate the process of DNA replication.

3.6 Explain the role of DNA and RNA (mRNA, tRNA, rRNA) in protein synthesis.

3.6.1 Explain transcription and translation.

Notes for Teaching and Learning

Students should realize that DNA replication is a process in which a molecule of DNA is made containing one strand of parental DNA and one strand of new DNA.

Students should understand that DNA replication is a three stage process. During initiation the DNA molecule unwinds and unzips. Elongation involves the addition of complementary nucleotides to the original DNA strand. During elongation, enzymes "proofread" the bases that have been inserted to make sure that they have been paired correctly. Termination is the completion of elongation when the new DNA molecules reform into helices.

If students have internet access, they could view the movies on DNA replication, transcription and translation.

The outcome 3.5 is addressed by completing Investigation 17.B, '*DNA Structure and Replication'*. Instructors could substitute another lab that satisfies the same outcome.

Instructors should note the error relating to transcription on page 591 of text. The anti-sense strand is the strand of the DNA molecule that transcribed the mRNA. The anti-sense strand is also referred to as the DNA template. See Teacher's Resource p. 209, section 17.4 (#'s 4-5).

Suggestions for Assessment

Paper and Pencil

- Students should record their observations as they complete the Lab. They may be asked to write answers to *Post Lab* questions and *Conclude and Apply* section.
- Instructors could copy Blackline Master 17-2, "Replication", and have students complete it to review the structure of the DNA molecule.

Viewing:

- Students could view short movies on DNA replication, transcription and translation at the web site shown in Resources.

Resources

MGH Biology, pp. 582-594.

Core Lab:
Investigation 17.B: "DNA Structure and Replication", pp. 586-587

Blackline Master 17-2, "Replication"

Web site for movies: http://www.mcgrawhill.ca/school/booksites/biology/student+resources/toc/index.php

Unit 3 - Genetics: Molecular

Outcomes

3.7 Predict the effects of mutations on protein synthesis, phenotypes, and heredity.

- 3.7.1 Explain the meaning of mutation and what causes it.
- 3.7.2 Distinguish between somatic and germ mutation and compare the inheritability of each.

Notes for Teaching and Learning

In particular, students could discuss the dangers of UV radiation as a carcinogenic agent. Students can hypothesize how an alteration may ultimately affect the individual involved. Students may investigate and discuss sources of embryo deforming (teratogenic) chemicals found in the environment (thalidomide, alcohol) and the responsibility of society, science and technology to ensure all children have a good quality of life.

Students should draw the connection between mutations in genetic information and how they may be expressed through human conditions (e.g., cancer, sickle cell anemia, human thallesemia). The critical role of proteins as the link between gene and the human condition should be emphasized.

Somatic mutations occur in somatic cells (body cells) and thus cannot be passed on to offspring. Germ mutations occur during meiosis (gamete production) and thus such mutations can be passed on to the offspring.

Suggestions for Assessment

Questions 3.6 - 3.14 in the Study Guide should be assigned to cover Outcomes 3.4- 3.7. Students will find the answers to these questions in Sections 17.3 and 17.4 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Paper and Pencil

- Using the processes of transcription and translation, students could convert the DNA strand given into its resulting protein. They should investigate what effect a change in one base in the DNA sequence might have on the resulting protein.

Resources

MGH Biology, pp. 596 - 600.

Outcomes

3.8 Describe factors that may lead to mutations in a cell's genetic information.

- 3.8.1 Distinguish among the different types of chromosome mutations Include:
  - (i) deletion
  - (ii) duplication
  - (iii) inversion
  - (iv) translocation
  - (v) nondisjunction (monosomy,trisomy)

3.9 Identify in general terms the impact of genetic diseases on the homeostasis of an organism.

- 3.9.1 Describe several examples of human genetic diseases caused by chromosomal mutations. Include:
  - (i) Down syndrome
  - (ii) Turner syndrome
  - (iii) Klinefelter syndrome (XXY syndrome)
  - (iv) Jacobs syndrome (XYY syndrome)

3.10 Interpret patterns and trends in genetic data.

- 3.10.1 Analyze and interpret models of human karyotypes.

Notes for Teaching and Learning

Students could apply their knowledge of nondisjunction by completing a thinking lab (page 552). This would help reinforce the concepts involved in nondisjunction.

Students should explore the severity of chromosomal mutations compared to that of gene mutations. Chromosomal mutations are more serious because they involve a larger portion of genetic material.

Students may also explore why there are relatively few syndromes in the human population involving nondisjunction. Most cases of nondisjunction prove to be fatal.

Outcome 3.10 is addressed by completing the lab, "Karyotyping" . Instructors should note that the lab includes three chromosome sets for karyotyping. Students are only required to complete two karyotypes. Instructors can choose any two of these chromosome sets so that the lab can be varied from student to student. Instructors can also create their own abnormal karyotypes if they wish to have further variations.

Unit 3 - Genetics: Molecular

Suggestions for Assessment

** This is a very lengthy course and some of the outcomes will be covered by completing assignments. The marks assigned should be used as part of the evaluation for the course. But the material covered in the assignments should **not** be used for testing purposes.

Assignment

- Outcomes 3.8 and 3.9 are covered by completing Assignment 1, Part 1, "Genetic Disorders". Students will find the answers to the assignment questions on pages 553 - 560 of the text. The assignment can be found in Appendix A of this guide

Laboratory Activities

- Instructors could provide students with a selection of human karyotypes. They should pair and arrange the chromosomes in the manner of a karyotype. Students should analyze the resulting karyotype for any inherent abnormalities and provide a brief written summary as to causes of the abnormality and what its possession means to the individual involved. Assessment should be based on accuracy and completeness of exercise.

Testing:

- Students have now completed the genetics portion of this course. Instructors could give a test to cover the material covered in Unit 3. The mark obtained on this test could be used as part of the final mark for the course.

Resources

MGH Biology, pp. 550 -553.

Assignment 1, "Genetic Disorders", Appendix A.

MGH Biology, pp. 553-560.

Core Lab:
"Karyotyping", found in Appendix B.

Answer Key for lab "Karyotyping", found in Appendix B.

Unit 4 - Genetics: Implications

Outcomes

4.1 Identify in general terms the impact of genetic diseases on the homeostasis of an organism and explain the circumstances that lead to genetic diseases. Include:

(i) autosomal recessive inheritance (Tay Sachs, PKU)

(ii) co-dominant inheritance (Sickle Cell Anemia)

(iii) x-linked recessive inheritance (color blindness, Muscular Dystrophy, Hemophilia)

Notes for Teaching and Learning

There are many current and relevant issues within the realm of biotechnology. Students can evaluate the data on genetic research obtained from Internet web sites. Students can evaluate, from a variety of perspectives (e.g., counselor, prospective parents, potential patient) the role of genetic counseling and gene testing for the identification and treatment of potentially debilitating genetic conditions (e.g., Tay Sachs, PKU, Huntington disease, Alzheimer's). Students could discuss the personal and ethical considerations faced by individuals as the identification of genes, possibility of prenatal diagnoses and predictive ability for particular disorders increases.

Questions such as the following could be considered:

- Would you, as an individual, want to know if you will suffer from a disabling disease later in life? Do you have a right to know?
- Do insurance companies have a right to accept/reject you for insurance coverage based on the results of voluntary and confidential genetic testing predicting your future health?
- Do employers have a right to know your genetic status determined from voluntary genetic testing? For example, suppose you are a heterozygous carrier for sickle cell anemia; you know there is a belief within the airline industry that carriers are more sensitive to a decrease in cabin air pressure. Do you inform the airline of your genetic status before accepting a job? As genetic testing becomes more common, and increases in availability, will potential employers have a right to know of your genetic status as a preliminary to hiring?

Exploring these questions provides an opportunity to link with the Language Arts program.

Unit 4 - Genetics: Implications

Suggestions for Assessment

Assignment

- The outcomes for Unit 4 are covered by completing Assignment 2 “Genetics: Implications”. Students will find the answers to the assignment questions on pages 555 - 559, 606 - 607, 618 - 619 of the text. The assignment can be found in Appendix A of this guide.

Resources

MGH Biology, pp. 555-559.

Unit 4 - Genetics: Implications

Outcomes	Notes for Teaching and Learning
4.2 Describe and evaluate the design of technological solutions and the way they function, using genetic principles.	Genetic counsellors study the medical histories of couples and their families and help parents-to-be by advising them of the frequencies of genetic disorders within affected families and by helping them to determine the probable risk factors associated with their particular case. It is suggested that Department of Health & Community Services sources be explored and appropriate literature be examined for additional information on this concept.
4.2.1 Discuss the importance of genetic counselling.	
4.2.2 Describe methods of detecting genetic disorders. Include: (i) amniocentesis (ii) fetoscopy	
4.3 Explain the importance of the Human Genome Project and why it was initiated.	Students should know what the Human Genome Project is, how and why it was conducted and what the implications of decoding the entire human genome are.
4.3.1 Describe the Human Genome Project.	
4.3.2 Describe the major findings of the project.	The two major findings of this project are that 99.9% of all human DNA is identical and that there are approximately 35 000 different genes in the human population.

Unit 4 - Genetics: Implications

Suggestions for Assessment

Paper and Pencil

- The Human Genome Project raises a number of important issues that might be considered. Students could reflect on these questions and develop, present, and defend their position based on scientific thinking. This provides a good opportunity to link with the Language Arts program.

  – Recently a Canadian futurist, Frank Ogden, applied to the U.S. Patent and Trademark office to have his DNA trademarked, in an effort to protect himself and his identity. He feels that his application is important because it paves the way for others to do the same, especially if they have a talent that may interest researchers wishing to study their DNA, the building blocks of life. Do you think Frank Ogden should be successful? Why or why not?

  – Is it ethical for private biotechnology companies to use research information gained through public funding for private profit? Should the individuals whose DNA was used for public research in the Human Genome Project be compensated for their contribution?

Resources

MGH Biology, pp. 606 - 607.

MGH Biology, pp. 618-620.

Part II - Evolution, Change, and Diversity

Unit 5 - Evolutionary Change: Historical Perspectives

Outcomes

5.1 Explain the process of adaptation of individual organisms to their environment.

5.1.1 Define the terms evolution, adaptation and variation.

5.2 Analyze evolutionary mechanisms such as natural selection, and artificial selection.

5.2.1 Explain the process of natural selection and artificial selection.

5.2.2 Use the Peppered Moth story as an example of evolution and adaptation

Notes for Teaching and Learning

Students should be aware that the topic of evolution is based on many different theories. Like all theories, there is no evidence that completely eliminates doubt. Since many of the topics relating to Earth origins, life origins, evolution, etc., may be addressed from various points of view, it is the suggested intent of this biology course to outline the topics from the scientific process approach. Instructors should be aware that many topics in biology, (and in medical research), especially evolution, may be appraised along the lines of personal value judgements, ethical assessments and religious beliefs. It should be emphasized that the purpose of learning about all views is so that the student can intellectually question each and make educated decisions about what s/he believes.

Students may examine an organism that has undergone artificial selection. They could explore the value of the trait that has been selected and compare any negative effects of its selection. Examples of organisms that have been artificially selected could include dogs, wheat, apples, roses, cattle, sheep, and so on.

Unit 5 - Evolutionary Change: Historical Perspectives

Suggestions for Assessment

Questions 5.1 - 5.4 in the Study Guide should be assigned to cover Outcomes 5.1 - 5.2. Students will find the answers to these questions in Section 19.1 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Paper and Pencil

- This part of the course provides the opportunity for individual research. This allows for linkage with the Language Arts program. For example, students could select a modern animal and investigate the evolutionary evidence that exists for its ancestry. The report on this work may be visual (e.g., videotape, poster, models) or written. Assessment should be based on accuracy and completeness of research and quality of presentation. Students could select an organism that has undergone artificial selection. Examine and prepare a report on the value of the traits that were artificially selected and compare to any negative effects that may have resulted from this form of selection.

- Students should begin to develop a glossary of new terms that they discover and will learn as they study Evolution.

- Students should complete relevant Section Review and Chapter Review questions.

Resources

MGH Biology, pp. 644-649.

Unit 6 - Evolutionary Change: Mechanisms of Evolution

Outcomes	Notes for Teaching and Learning
6.1 Explain the roles of evidence, theories and paradigms in the development of evolutionary knowledge.	Students should recognize that a paradigm shift had occurred when the evolution ideas of Lamarck were generally dropped in favour of the ideas of Darwin. Students could examine how a German biologist, August Freidrich Weismann, was able to disprove Lamarck's theory by cutting off the tails of mice and allowing them to reproduce. Weismann showed that after many generations the tails still remained on the offspring and, therefore, disproved that acquired traits could be inherited.
6.1.1 Describe the theories put forth by Larmarck and Darwin.	
6.1.2 Compare and contrast Lamarckian and Darwinian evolutionary theories.	
6.1.3 Explain why Darwin was unable to account for the mechanism of inheritance of traits in his theory.	
6.1.4 Illustrate how knowledge of Mendelian genetics and mutations supported Darwin's theory.	Students could be asked to explain how the work of Mendel provided support for Darwin's theory.
6.1.5 Explain the modern theory of evolution and its importance to biological sciences	Students should make reference to the modern theory as a meshing of Mendel's and Darwin's theories.

Suggestions for Assessment

Questions 6.1 - 6.3 in the Study Guide should be assigned to cover Outcomes 6.1.1 - 6.1.2. Students will find the answers to these questions in Section 19.2 of the text.

Questions 6.4 - 6.5 in the Study Guide should be assigned to cover Outcomes 6.1.3 - 6.1.5. Students will find the answers to these questions in Section 20.1 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Paper and Pencil

- Once again, Evolution provides good opportunities for individual research that could be done in conjunction with the Language Arts program. Students could prepare a report to compare the theories of Lamarck and Darwin.

- Students could use library and electronic research tools to collect information on a topic related to an evolutionary theory and prepare a written report. Sample topics may include:

  – contributions of individuals to the theory of evolution
  – types of evidence supporting or contradicting the theory of evolution
  – theories on the origin of life on Earth

Assessment will be based on the quality of the student presentation and the information researched.

Viewing

- Students could view a short movie on species diversity at the web site shown in Resources.

Resources

MGH Biology, pp. 651-658.

MGH Biology, pp. 674-675.

Web site for movie, "Galápagos Species Diversity":

http://www.mcgrawhill.ca/school/booksites/biology/student+resources/toc/unit+7+evolution/chapter+19+introducing+evolution/cool+stuff+to+see+and+do/movie+species+diversity.php

Unit 6 - Evolutionary Change: Mechanisms of Evolution

Outcomes

6.2 Evaluate the scientific evidence that supports the theory of evolution.

6.2.1 Describe current evidence that supports the modern theory of evolution. Include:

(i) fossil record

(ii) biogeography

(iii) comparative anatomy
- homologous structures
- analogous structures
- vestigial structures

(iv) comparative embryology

(v) heredity

(vi) molecular biology

Notes for Teaching and Learning

Students could use multimedia resources to investigate how scientists have used various pieces of evidence to support or refute the theory of evolution. An example of one site is:
www.pbs.org/wgbh/evolution/library/04/index.html

Instructors should provide students with fossils or pictures of fossils so that they can compare them with each other and living relatives. By observing similarities, students can understand why organisms may be classified together. By observing differences, students can understand how organisms have changed over time, becoming more complex. Comparative anatomy can be demonstrated in a similar way. Students can also research other organisms that have similar anatomy to themselves. They can then use this information to devise a "family tree" showing their findings. When discussing molecular biology, students should explain how nucleic acid sequences in the nucleus, mithochondria and chloroplast are being used to provide evidence for evolutionary relationships among species.

Suggestions for Assessment

Questions 6.6 - 6.10 in the Study Guide should be assigned to cover Outcome 6.2. Students will find the answers to these questions in Section 19.3 of the text.

Paper and Pencil

- Some further suggestions for student research that could be done in conjunction with the Language Arts program:

  * students could compare the amino acid and protein sequences of different organisms to compare their similarities (e.g., frog, human, chimpanzee, rabbit, cow).

  *the Shroud of Turin is a very important artifact for the Christian Religion. The Shroud has been dated through dating technologies. Students could research how it was dated and the controversy it caused. They should present their findings in a report.

- Students should add to the glossary of terms for Evolution.

- Students should complete relevant Section Review and Chapter Review questions.

Laboratory Activity

- Products are available from biological supply companies that contain simulated blood samples that allow comparison of simulated blood proteins from sources such as human, chimp, frog, chicken.

- Instructors could plan a field trip to a fossil site within the province. Students should observe these fossils only; they could take video and photographs but they should not remove any fossils from these sites.

Resources

MGH Biology, pp. 659-667.

Unit 7 - Evolutionary Change: Adaptation and Speciation

Outcomes

7.1 Understand the concept of speciation.

- 7.1.1 Define speciation.
- 7.1.2 Describe two general pathways that lead to the formation of a new species (transformation, divergence).
- 7.1.3 Explain the conditions under which speciation may occur.

7.2 Explain how geographic and reproductive isolation can contribute to speciation.

7.3 Evaluate adaptive radiation as a mechanism for speciation.

- 7.3.1 Explain adaptive radiation.
- 7.3.2 Distinguish between convergent and divergent evolution and explain their occurrence in certain groups of organisms.
- 7.3.3 Explain the process of coevolution.

Notes for Teaching and Learning

Examples of transformation are the peppered moth or antibiotic resistant microbes. An example of divergence is the finches from Galápagos Islands.

The rapid appearance of new antibiotic-resistant microbes and the development of pesticide-resistant insects can be considered studies in microevolution - rapid evolution due to intense selection. Students could investigate the causes of the appearance of these new strains and the environmental and societal implications they present. Students may discuss questions such as the following:

– If mutations play an important role in evolution, why are many scientists concerned about the mutagenic effects of X-rays, radiation from nuclear power plants, chemicals, etc?

– What would be the effect on the offspring if DNA polymerase were absolutely infallible in its proofreading capacity? What would be the long-term effect on biological evolution?

– What are the implications of the cloning process, if any, on evolution?

Students can investigate the evolutionary evidence that exists for the ancestry of a modern animal, such as the horse, cat, dog (and/or other household pet or domesticated animal used in agriculture). This may involve (in the example of the required in its evolution from a small woodland browser to a large, plains-dwelling grazer.

– examining illustrations (drawings, photos, art) that compare possible changes in anatomy such as size, leg and tooth anatomy that would allow them to evaluate evidence for the theory of evolution. Examination of the diagrams could lead to the question, "How are dietary changes linked to changes in tooth anatomy?"

– asking and discussing questions such as, "What advantages would a tall horse have as a plains-dweller?", "Why would running be necessary for a plains-dweller?".

Unit 7 - Evolutionary Change: Adaptation and Speciation

Suggestions for Assessment

Questions 7.1 - 7.6 in the Study Guide should be assigned to cover Outcomes 7.1 - 7.3. Students will find the answers to these questions in Sections 21.2 and 21.3 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback.

Paper and Pencil

- Students could explain, using modern evolutionary theory, the recent appearance of antibiotic-resistant bacteria populations.
- Students could explain, using modern evolutionary theory the recent appearance of pesticide-resistant insect populations.
- Students should complete relevant Section Review and Chapter Review questions.

Testing

- The final exam for this course should cover all the content. Students have already written a test on Units 1 and 2 and another on Unit 3.

Resources

MGH Biology, pp. 708-709.

MGH Biology, pp. 720 - 723.

Biology 11/12 Computerized Assessment Banks

Appendix A
Assignments

Assignment 1

Genetic Disorders

1. Explain what is meant by each of the following types of chromosome mutations:

   (i) deletion

   (ii) duplication

   (iii) inversion

   (iv) translocation

   (v) nondisjunction (monosomy, trisomy)

2. Give the genetic cause and a brief description of the symptoms for each of the following human genetic diseases:

   (i) Down syndrome

   (ii) Turner syndrome

   (iii) Klinefelter syndrome (XXY syndrome)

   (iv) Jacobs syndrome (XYY syndrome)

Assignment 2

Genetics: Implications

1. (a) What is meant by autosomal recessive inheritance?

   (b) Give an example of an autosomal recessive disorder and how it affects the individual who has it.

2. (a) Give an example of a co-dominant genetic disorder.

   (b) Explain how this disorder affects the individual.

3. (a) Give an example of x-linked recessive inheritance.

   (b) Explain why x-linked recessive disorders are more common in males than females.

4. Describe what is done by a genetic counselor and why the job of a genetic counselor is important.

5. Describe the following 2 methods of prenatal diagnosis:

   (i) amniocentesis
   (ii) fetoscopy

6. What is the Human Genome Project?

7. What were the 2 major initial findings of the project?

Appendix B
Lab

Karyotyping

Introduction

You are a genetic counselor whose job is to discuss with expecting parents any genetic disorder that may affect their child. Currently, you are working with two couples. The two expectant mothers are over thirty-five and are concerned that their unborn children may have chromosomal abnormalities. You have been given a chromosome spread of each of the children. For each couple, you must construct and analyze a karyotype. In addition, you will be expected to give each couple a brief explanation of the test results, including the characteristics of any genetic disorder that may affect their unborn child.

Purpose

To connect and analyze several karyotypes.

Materials

Glue (1)
Ruler (1)
Scissors (1 pair)
Chromosome Spread Sheets (2)
Karyotype Templates #'s 1 and 2

Procedure

1. Obtain two different chromosome spread sheets from your teacher.

2. Cut out the chromosomes of one of the chromosome spread sheets.

3. Arrange the chromosomes into 22 pairs on the karyotype template. The chromosomes of each pair should be the same length (use a ruler!) and have the same centromere position. They should also have similar banding patterns. The two remaining chromosomes are the sex chromosomes. Since the X and Y chromosomes are nonhomologous, they will not have similar lengths, centromere positions or banding patterns. (Refer to the normal human karyotype.)

4. Now, place the chromosomes in order, with the longest pair at position 1, the shortest at position 22, and the sex chromosomes at position 23.

5. Finally, glue each chromosome into position. Be sure to label your karyotype according to the chromosome spread you were given.

6. Use your constructed karyotype # 1 to answer the analysis question 1.

7. Repeat steps 1 to 5 for your second chromosome spread sheet.

8. Use your constructed karyotype #2 to answer the analysis question 2.

Analysis

1. Analyze karyotype #1 to determine if a chromosomal abnormality exists.

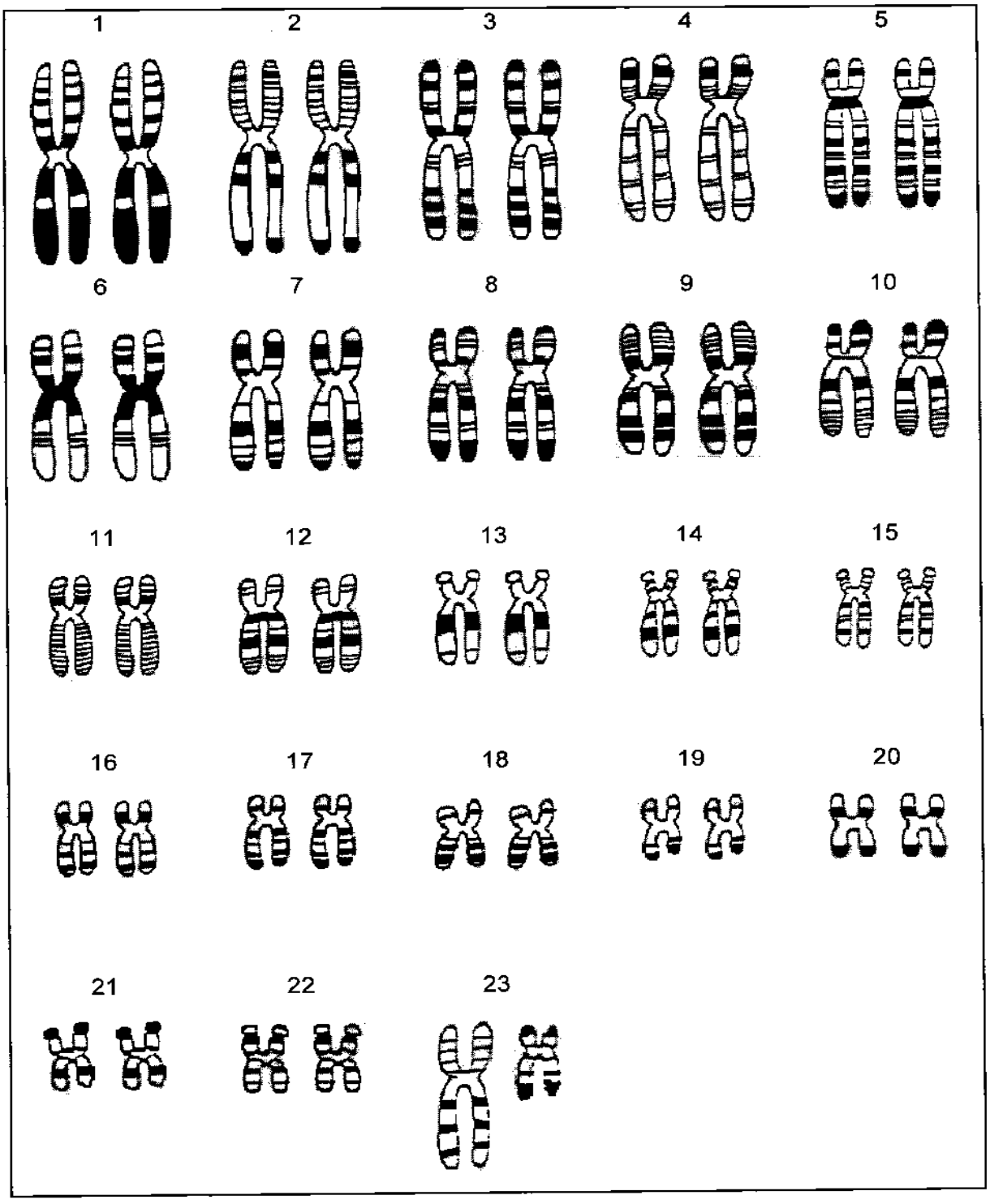
    a) Will the child have a genetic disorder?
    b) Explain the reason for your answer.
    c) Using the student chart, determine which genetic complication will affect the child.

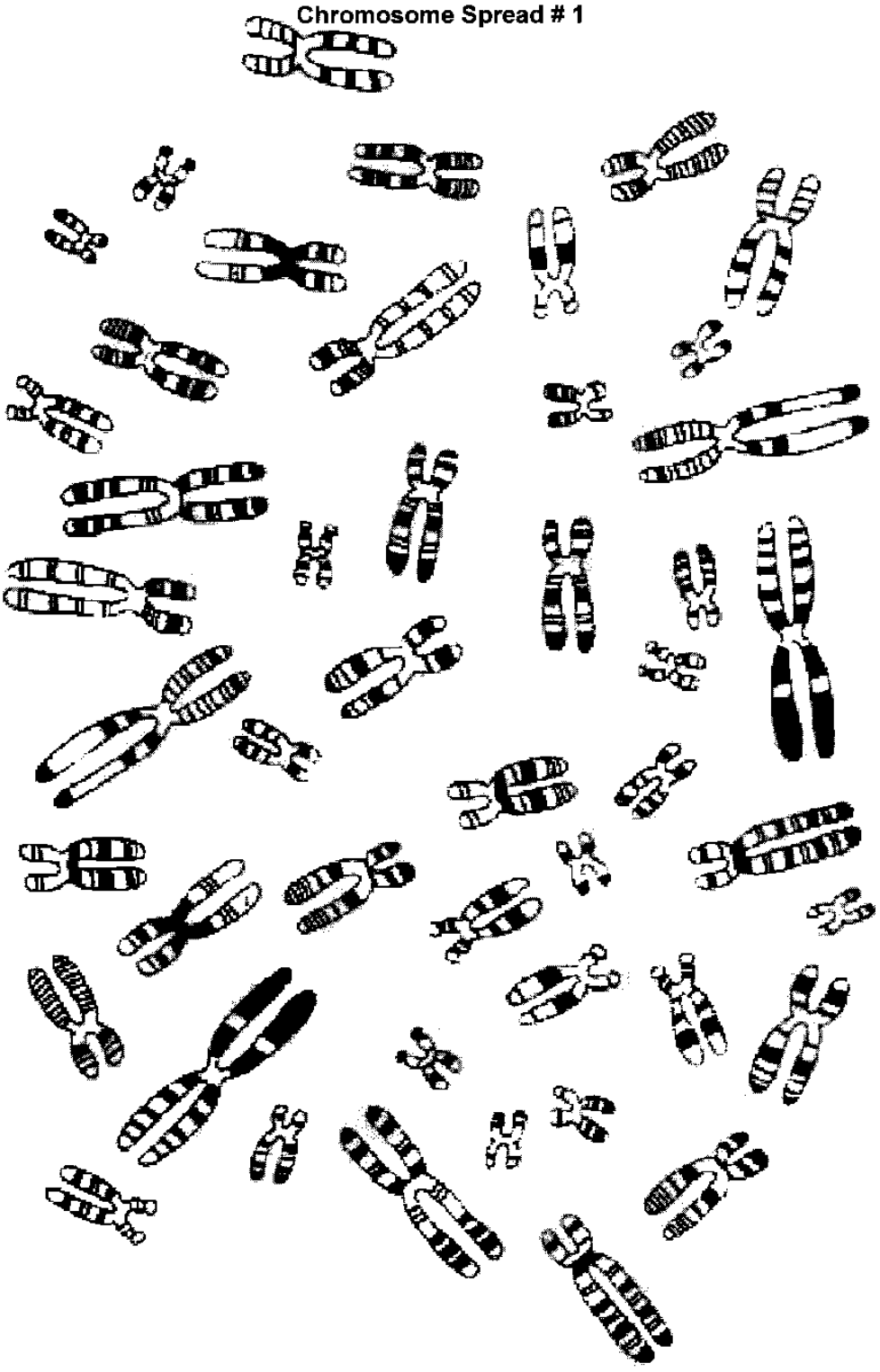
2. Analyze karyotype #2 to determine if a chromosomal abnormality exists.
    a) Will the child have a genetic disorder?
    b) Explain the reason for your answer.
    c) Using the student chart, determine which genetic complication will affect the child.

Genetic Disorders

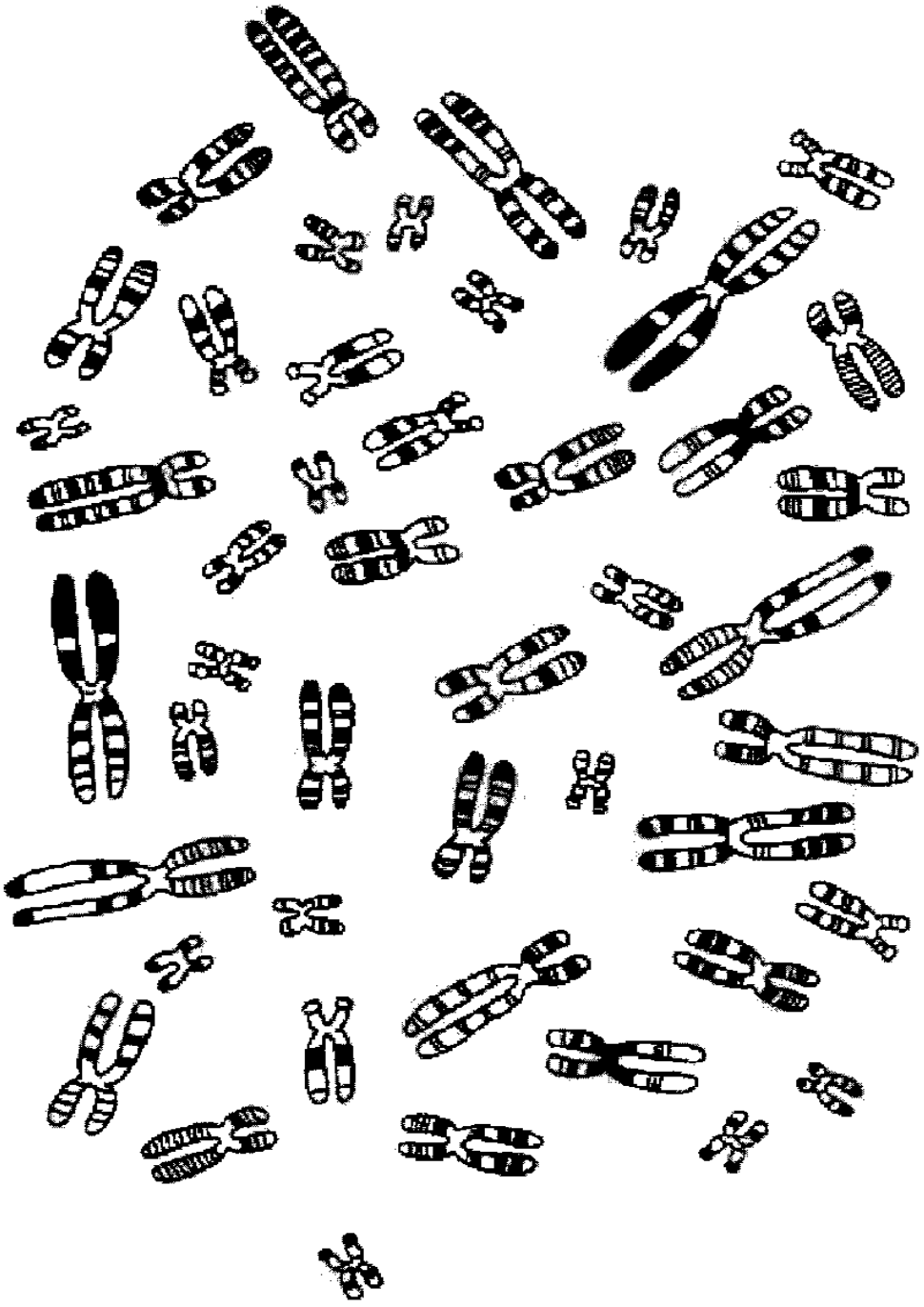
Genetic Disorder	Chromosome Affected	Description of Disorder
Down Syndrome	# 21	47 chromosomes, mild to severe developmental disabilities, almond - shaped eyes, large tongue, prone to heart defects and respiratory problems.
Turner Syndrome	Single X in female (XO)	45 chromosomes, female lacking an X chromosome, normal in childhood, normal intelligence, fails to develop secondary sex characteristics and remains infertile.
Klinefelter Syndrome	Extra X in Male (XXY)	47 chromosomes, male with an additional X chromosome, usually normal in appearance, normal intelligence, tall, underdeveloped testes, sterile, may also cause femalecharacteristics (breast development, feminine body shape).
Jacobs Syndrome	Extra Y in Male (XYY)	47 chromosomes, male with an additional Y chromosome, low mental ability, normal in appearance.
Triple X Syndrome	Extra X in Female (XXX)	47 chromosomes, female with an extra X chromosome, normal intelligence, normal in appearance, may be sterile.

Normal Human Karyotype

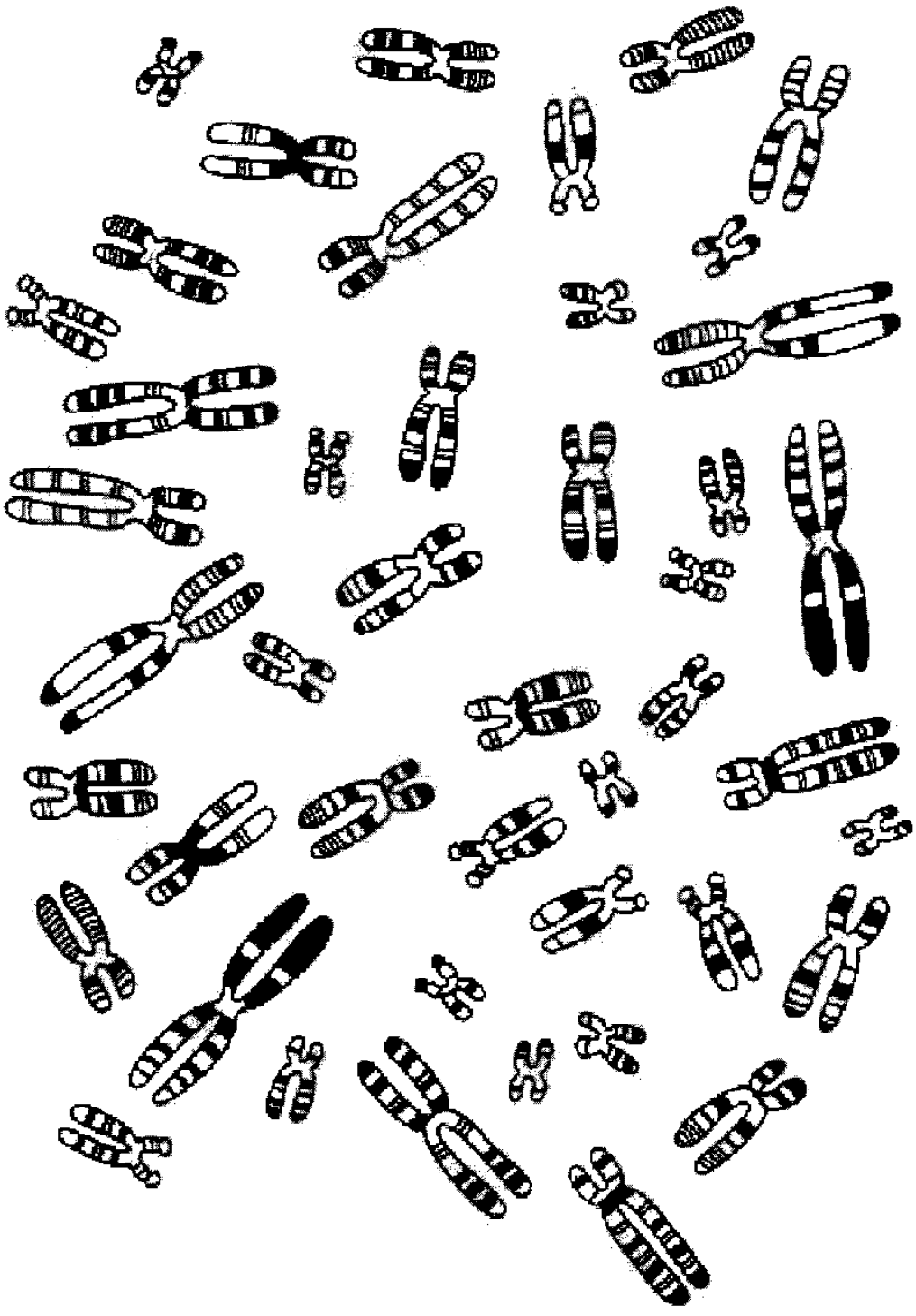



Chromosome Spread # 1

Chromosome Spread # 2



Chromosome Spread # 3



Karyotype # 1

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23		

Karyotype # 2

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23		