Grade 12 Biology (40S)

A Course for Independent Study

Field Validation Version

Manitoba

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GRADE 12 BIOLOGY (40S)

Introduction

INTRODUCTION

Welcome

Welcome to Grade 12 Biology: A Course for Independent Study.

In this course, you will learn about biological inheritance, evolutionary theory, and biodiversity. You will uncover the methods by which parents pass on traits to their offspring, focusing on how new lives are created and what forces determine an individual's appearance and capabilities. You will also explore how scientists classify living organisms and how they have revised classification systems in the wake of new discoveries, such as DNA and genomes.

By enrolling in a distance learning course, you take on the roles and responsibilities of both student and teacher. As a student, you are responsible for mastering the lessons and completing the learning activities and assignments. As a teacher, you are responsible for checking your work carefully, noting areas in which you need to improve and motivating yourself to succeed.

What Will You Learn in This Course?

This course focuses on biological inheritance, evolutionary theory, and biodiversity. It is divided into the following five modules:

- Module 1: Understanding Biological Inheritance
- Module 2: Mechanisms of Inheritance
- Module 3: Evolutionary Theory and Biodiversity
- Module 4: Organizing Biodiversity
- Module 5: Conservation of Biodiversity

Each module in this course is made up of several lessons. In each lesson, you will read a few pages and then complete a learning activity and an assignment. Some lessons require you to do some investigative research or observation work in the community.

The lessons in this course are organized as follows:

- **Lesson Focus:** The Lesson Focus at the beginning of each lesson identifies one or more specific learning outcomes (SLOs) that are addressed in the lesson. The SLOs identify the knowledge and skills you should have achieved by the end of the lesson. For a complete list of the SLOs identified for Grade 12 Biology, refer to the Appendix at the end of this course.
- **Introduction:** Each lesson begins by outlining what you will be learning in that lesson.
- **Lesson:** The main body of the lesson consists of the content and processes that you need to learn. It contains information, explanations, diagrams, and completed examples.
- **Learning Activities:** Each lesson has a learning activity that focuses on the lesson content. Your responses to the questions in the learning activities will help you to practise or review what you have just learned. Once you have completed a learning activity, check your responses with those provided in the Learning Activity Answer Key found at the end of the applicable module. Do not send your learning activities to your tutor/marker for assessment.
- **Assignments:** An assignment is found at the end of each lesson within this course. At the end of each module, you will mail or email all your completed assignments from that module to your tutor/marker for assessment. All assignments combined will be worth a total of 60 percent of your final mark in this course.
- **Lesson Summary:** Each lesson ends with a brief review of what you just learned.

What Will You Need for This Course?

To complete this course, you should have access to the following:

- Make sure you have a notebook for recording your responses to learning activities.
- You will need access to books, magazines, newspapers, and/or the Internet to find information about a variety of topics for your assignments:
  - In Assignment 2.1, you will compare several scientists and their contributions to science.
  - In Assignment 2.5, you will examine the application of gene technology in either biological resource management or human health and welfare.
  - In Assignment 4.2, you will do some research on North American bear species.
  - In Assignment 5.4, you will research an environmental issue of your choice and write a paper on your findings.

- You will also need some materials for investigations:
  - For Learning Activity 5.3, you will need a textbook, a ruler, and a microscope cover slip (or index card).
  - For Assignment 5.3, you will need white rice (uncooked), a marker, a calculator, and a clean tin can or jar with a lid.

How Will You Know How Well You Are Learning in This Course?

You will know how well you are learning in this course through your completion and assessment of the following: learning activities, assignments, and midterm and final examinations.

Learning Activities

One of the easiest and fastest ways of finding out how much you have learned is by completing the learning activities found at the end of all the lessons, and then assessing them yourself by comparing your responses with those provided in the Learning Activity Answer Key found at the end of each module. You will need to write down your answers in a notebook.

Besides giving you feedback, the learning activities will help you to practise what you have learned and prepare you to complete your assignments and examinations successfully. To do well on the assignments, you should complete the learning activities first and then check your responses with those provided in the Learning Activity Answer Key. Many of the questions on the examinations will be similar to the questions in the learning activities. Remember that you **will not submit learning activities to your tutor/marker**.

Assignments

At the end of each lesson, you will complete an assignment. Once you have completed all the assignments in a module, you will send them to your tutor/marker for assessment. Your tutor/marker will mark your assignments and return them to you. Remember to keep all assignments that have been marked and returned to you by your tutor/marker, as you will need to review them for the midterm and final examinations. The assignment component of this course is worth 60 percent of your final mark in this course.

Midterm and Final Examinations

The midterm examination is based on Modules 1 and 2, and the final examination is based on Modules 3, 4, and 5. Examination review lessons are found at the end of Modules 2 and 5. Each examination is worth 20 percent of the final mark for the course, for a total of 40 percent. To do well on each examination, you should review all the work you have completed from the modules, including all learning activities and assignments.

You are responsible for making arrangements to have the examinations sent to your proctor from the Independent Study Option office. Please make arrangements before you finish Module 2 to write the midterm examination. Likewise, you should begin arranging for your final examination before you finish Module 5. When you write your examinations, you will be supervised by a proctor.

To write your examinations, you need to make the following arrangements:

- **If you are attending school,** ask your school's Independent Study Option (ISO) school facilitator to add your name to the ISO examination eligibility list. Do this at least three weeks prior to the next scheduled examination week.
- **If you are not attending school,** check the **Examination Request Form** for options available to you. The form was mailed to you with this course. **Three weeks before** you are ready to write the examination, fill in the Examination Request Form and mail or fax it to

  ISO Registration
  555 Main Street
  Winkler MB R6W 1C4
  Fax: 204-325-1719
  Toll-Free Telephone: 1-800-465-9915

Who Can Help You with This Course?

There are two people who can help you to succeed in this course: your tutor/marker and your learning partner.

Your Tutor/Marker

Tutor/markers are experienced educators who tutor independent students and mark assignments and examinations. When you are having difficulty with something in this course, be sure to contact your tutor/marker, who is there to help you. Your tutor/marker's name and contact information were sent to you with this course. If you are not sure how to contact your tutor/marker, phone the ISO office at 1-800-465-9915.

Your Learning Partner

A learning partner is someone **you choose** who will help you learn. It may be someone who knows something about science, but it doesn't have to be. A learning partner could be someone else who is taking this course, a teacher, a parent or guardian, a sibling, a friend, or anybody else who can help you. Most importantly, a learning partner should be someone with whom you feel comfortable, and who will support you as you work through this course.

Your learning partner can help you keep on schedule with your course work, read the course with you, check your work, look at and respond to your learning activities, or help you make sense of assignments. You may even study for your examinations with your learning partner.

How Much Time Will You Need to Complete This Course?

Learning through independent study has several advantages over learning in the classroom. You are in charge of how you learn and you can choose how quickly you will complete the course. You can read as many lessons as you wish in a single session. You do not have to wait for your teacher or classmates.

From the date of your registration, you have a maximum of **12 months** to complete the course, but the pace at which you proceed is up to you. Read the following charts for suggestions on how to pace yourself.

Chart A: Semester 1

Here is a **suggested timeline** that you can follow if you start this course in September and need to complete it by the end of January.

Module	Completion Date
Module 1	end of September
Module 2 and Midterm Examination	end of October
Module 3	end of November
Module 4	mid-December
Module 5 and Final Examination	mid-January

Chart B: Semester 2

Here is a **suggested timeline** that you can follow if you start this course in January and need to complete it by June.

Module	Completion Date
Module 1	end of January
Module 2 and Midterm Examination	end of February
Module 3	end of March
Module 4	mid-April
Module 5 and Final Examination	mid-June

Chart C: Full School Year (Not Semestered)

Here is a **suggested timeline** that you can follow if you start this course in September and need to complete it by June.

Module	Completion Date
Module 1	end of October
Module 2 and Midterm Examination	mid-December
Module 3	end of February
Module 4	mid-April
Module 5 and Final Examination	end of May

Do not wait until the last minute to complete your work, since your tutor/marker may not be available to mark it immediately. Make sure that you leave enough time for your work to be processed through the mail, as it might take more than a week. It may also take a few weeks for your tutor/marker to mark everything and return the marked work to you.

If you need this course to graduate this school year, remember to schedule and complete your final examination by June 1.

When and How Do You Send Assignments to Your Tutor/Marker?

While working on this course, you will mail or email completed assignments to your tutor/marker five times. Each time you send assignments, you must include the applicable Cover Sheet, which you will find at the end of this Introduction. The following chart shows you exactly what you will be mailing or emailing at the end of each module.

Submission of Assignments		
Mailing	Modules	Assignments You Will Mail or Email
Mailing 1	Module 1	Assignments 1.1 to 1.5
Mailing 2	Module 2	Assignments 2.1 to 2.5
Mailing 3	Module 3	Assignments 3.1 to 3.5
Mailing 4	Module 4	Assignments 4.1 to 4.5
Mailing 5	Module 5	Assignments 5.1 to 5.4

Ways to Submit Assignments

In this course, you have the choice of either mailing or emailing your assignments.

- Each time you **mail** something, you must include the print version of the applicable Cover Sheet (found at the end of this Introduction).
- Each time you **email** something, you must include the electronic version of the applicable Cover Sheet (found at <www.edu.gov.mb.ca/k12/dl/downloads/index.html>).

Complete the information at the top of each Cover Sheet before mailing or emailing it along with your assignments.

Mailing Your Assignments

If you choose to mail your completed assignments, please photocopy all the materials first so that you will have a copy of your work in case your package goes missing. You will need to place the applicable module Cover Sheet and assignments in an envelope, and address it to

ISO Tutor/Marker
555 Main Street
Winkler MB R6W 1C4

Your tutor/marker will mark your work and return it to you by mail.

Emailing Your Assignments

If you choose to email your assignments, make sure you have saved copies of them before you send them. That way, you can refer to your assignments when you discuss them with your tutor/marker.

To email your completed assignments, you will first need to do one of the following:

- **If you are attending school,** please ask your ISO school facilitator (the person who signed your ISO Registration/Admission Form) for permission to email your assignments and to determine your school's procedure for emailing assignments. Contact your tutor/marker to confirm that the course material can be marked electronically.
- **If you are not attending school,** please obtain permission directly from your tutor/marker to submit your assignments electronically.

How to Submit Your Work *(files must not exceed 5 MB)*

Please submit your work in the file types shown below:

- **Written work:** Microsoft Word files (doc) or RTF files
- **Spreadsheets:** Microsoft Excel files (xls)
- **Pictures and graphics:** JPEG or GIF files
- **Scanned work:** PDF files (save multiple pages in one file)

How to Send Your Email

1. Use the following format to compose your email.

To:	distance.learning@gov.mb.ca
cc:	[*your ISO school facilitator's email address, if you attend school*]
Subject:	[*Your Name*] Grade 12 Biology
Attachments:	Assignment 1.1.doc; Assignment 1.2.doc; Assignment 1.3.doc; Assignment 1.4.doc; Assignment 1.5.doc
Message:	Assignments 1.1, 1.2, 1.3, 1.4, and 1.5
Tutor/marker:	_____
School:	_____

2. Attach your files (files must not exceed 5 MB).
3. Email your assignments to <distance.learning@gov.mb.ca>. Do not email your assignments directly to your tutor/marker. Email sent directly to the tutor/marker will be returned unread.

Your tutor/marker will mark your work and return it to you by email.

What Are the Guide Graphics For?

Guide graphics are used throughout this course to identify and guide you in specific tasks. Each graphic has a specific purpose, as described below.

Specific Learning Outcomes (SLOs): This graphic appears in the Lesson Focus at the beginning of each lesson beside the SLOs that will be addressed within the lesson. A complete list of the Grade 12 Biology SLOs can be found in the Appendix at the end of this course.

Internet: If you have access to the Internet, you can use it to get more information. Internet access is optional for this course.

Learning Partner: Ask your learning partner to help you with this task.

Learning Activity: Complete this learning activity to help you review or practise what you have learned in a lesson and to prepare for an assignment or an examination. You will not send learning activities to your tutor/marker. Instead, you will compare your responses with those provided in the Learning Activity Answer Key found at the end of the modules.

Check Your Work: Check your work in the Learning Activity Answer Key found at the end of a given module.

Assignment: Complete an assignment and send it to your tutor/marker for assessment at the end of a given module.

Submit Assignments: It is now time to mail or email your completed assignments to your tutor/marker for assessment.

Examination: It is time to write your midterm or final examination.

Note: Take note of and remember this important information or reminder.

Good luck with the course!

Remember, if you need help at any point during this course, contact your tutor/marker.

Notes

Lesson 1: Introduction to Genetics

Lesson Focus

In this lesson, you will

- ❑ outline Gregor Mendel's principles of inheritance, stating their importance to the understanding of heredity

  Include: principles of segregation, dominance, and independent assortment
- ❑ explain what is meant by the terms *heterozygous* and *homozygous*
- ❑ distinguish between *genotype* and *phenotype*, and use these terms appropriately when discussing the outcomes of genetic crosses

Introduction

Have you ever wondered why human eye colour can vary so much? It is rarely easy to predict a child's eye colour correctly based on knowledge about the eye colour of that child's parents. And yet, the child will resemble his or her parents in many ways. Why are some children born with traits that neither parent possesses? Why do some children look more like their fathers than like their mothers? These are only a few questions about how humans pass their traits from one generation to the next. And humans are only one of the millions of species on Earth.

In this lesson, you will learn about the work of Gregor Mendel (1822–1884). His ideas about inheritance serve as the foundation of current understanding of genetics. Mendel drew some amazing conclusions about inheritance without ever knowing how or where the "instructions" for inherited traits were packaged in the cells of living things.

You will also learn principles of genetics that were discovered after the time of Mendel. Genetics is an area of study that has grown since Mendel's time and continues to grow now as new discoveries are made.

The Work of Gregor Mendel

The story of Gregor Mendel and his work provides a fascinating glimpse into the nature of science. Mendel, shown in Figure 1.1, was born in 1822 and, as a young man, attended the University of Vienna. There he studied chemistry, biology, and physics, but left the university before graduating, probably for health reasons. He entered the Augustinian monastery in Brno (Brünn) and, with the support of the abbot, began his investigation of the inheritance of certain traits in pea plants (*Pisum sativum*). His choice of pea plants as the experimental subject was fortunate, as peas grow and reproduce quickly, their mating can be easily controlled, and the plants have a number of distinct traits that are readily observed.

Over the course of the next eight years, Mendel conducted experiments and maintained detailed records of his results. His university training led him to design simple experiments that permitted him to observe the inheritance of one trait at a time. His use of mathematics allowed him to formulate conclusions based on his results.

Mendel presented his conclusions in a paper entitled "Experiments in Plant Hybridization" at a meeting of the Association for Natural Research in Brno in 1865. The scientific community of the time did not seem to grasp the significance of Mendel's work. As a result, it was largely ignored. Mendel abandoned his research upon his election as abbot in 1868, due in part to his heavy workload, as well as to the lack of recognition for his research. Gregor Mendel died in 1884, not knowing whether the world would acknowledge the importance of his work.

It was not until 1900 that the inheritance concepts put forth by Gregor Mendel were again found to be supported by experimental data. In that year, three scientists working independently of one another rediscovered and confirmed Mendel's laws or principles of inheritance. Hugo de Vries, Carl Correns, and Erich von Tschermak-Seysenegg gave credit to Gregor Mendel in the publications of their papers, thereby giving him the recognition he long deserved.

Figure 1.1 **Gregor Mendel**

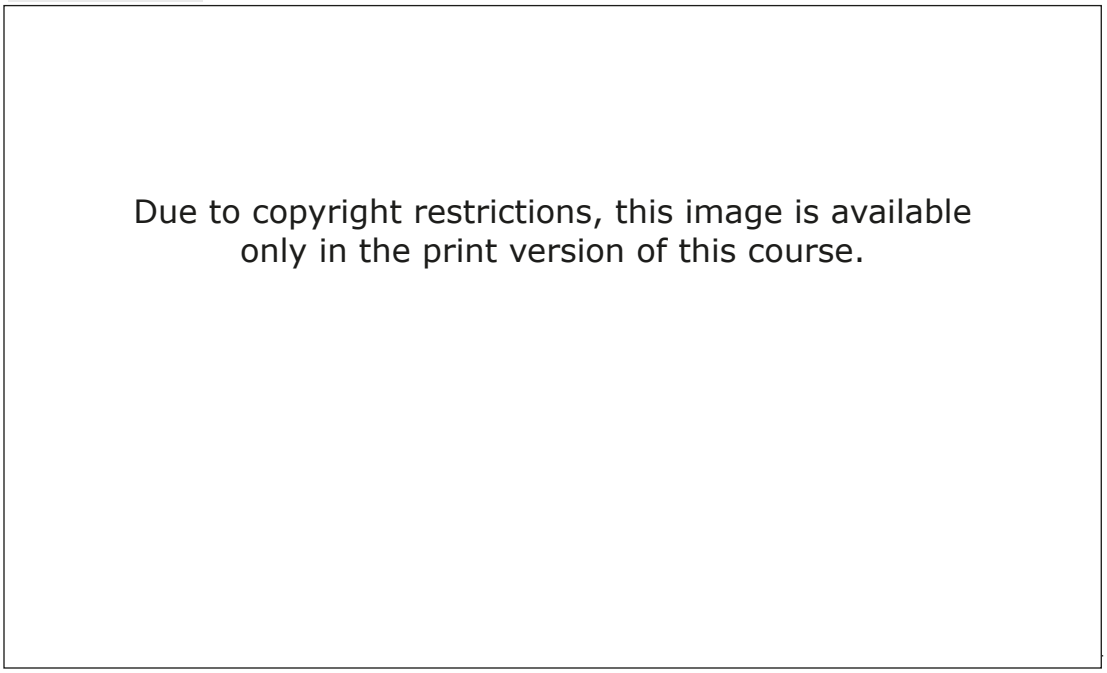

Photo credit: Bettmann/CORBIS

Source: Biggs, Alton, et al. *Glencoe Science Biology*. Columbus, OH: Glencoe/McGraw-Hill, 2009. 277. Reproduced in accordance with *Access Copyright Elementary and Secondary School Tariff*.

Mendel's Fundamental Laws of Inheritance

Remember that Mendel's conclusions were based on his own experiments with garden peas at the monastery in which he lived. His ideas were clearly based on mathematical analyses of his experimental results. He had no preconceptions about chromosomes, genes, or deoxyribonucleic acid (DNA).

Mendel's conclusions, based on detailed records of the results of his experiments, are known as Mendel's laws or principles of inheritance, which are summarized below.

- **The law of dominance:** Mendel found that some traits have the ability to mask other traits when both traits appear in the parents. For example, he found that it was possible for pea plants with red flowers to be crossed with pea plants with white flowers and get, in the offspring, only pea plants with red flowers. Apparently, the information for white flowers was being ignored in the offspring. Mendel believed that each pea plant possesses two factors for each trait in each cell. (The current name for *factor* is *gene*.) One of those factors came from the plant's female parent and the other from the plant's male parent. Mendel found that *dominance* actually occurs regularly in the normal traits of garden peas. For example, tall is dominant over short in pea plants. The trait that is expressed is called the *dominant* trait and the one that is covered up is called the *recessive* trait.

- **The law of segregation:** During the formation of reproductive cells, egg and sperm, the paired factors separate or segregate from one another; the offspring, as a result, receives a random assortment of genes for different traits from its parents. For example, if a pea plant received a factor for red flowers from its female parent and a factor for white flowers from its male parent, that plant would possess two factors for flower colour. In this case, one factor covers up the other factor so that it is not expressed.
- **The law of independent assortment:** During the formation of egg and sperm, segregating pairs of factors assort independently of each other. (You will learn more about this law in Lesson 2 of Module 1.)

Basic Concepts of Genetics

A number of terms used in the study of genetics are fundamental to a solid understanding of how inheritance occurs. These terms include the following:

allele

Refers to the different forms that a given gene can take. For example, if there were two types of genes for flower colour in pea plants, the gene coding for red flowers could be represented by the allele *R*. Typically, dominant alleles are represented by upper case letters and recessive alleles by lower case letters. The allele coding for white flowers in pea plants could be represented by the allele *r* because it is recessive.

chromosome

The structure in living cells that carries genetic information. One chromosome carries many genes.

diploid cell

A cell possessing two genes for every trait. In humans, the diploid chromosome number is 46. Most human body cells are diploid.

gamete

A haploid sex cell such as an egg cell or a sperm cell.

gene

The current name for Mendel's term *factor*. Genes are responsible for the traits that are expressed in the individual.

genotype

The particular genes that an organism possesses for a given trait. The genotype of a diploid organism will consist of two factors, one from each of that organism's parents. The genotype of a haploid gamete consists of only one factor.

haploid cell

A cell possessing only one gene for every trait. In humans, the haploid chromosome number is 23. Egg and sperm cells are haploid cells.

heterozygous

Possessing different alleles for a trait. A heterozygous genotype is one in which the two alleles present are not identical. *Rr* is a heterozygous genotype.

homozygous

Possessing identical alleles for a trait. A homozygous genotype is one in which the two alleles present are identical. *RR* is a homozygous genotype.

hybrid

An offspring possessing two different alleles for a given trait. One of these alleles may be dominant over the other. For example, a pea plant hybrid for flower colour would have the genotype *Rr*, and the phenotype red flowers.

maternal chromosome

In a diploid organism, the chromosome in each pair that originated in that organism's female parent; it was located in the egg cell at the time of fertilization.

meiosis

The type of cell division in which the chromosome number is reduced from diploid to haploid. Meiosis results in the production of gametes—egg and sperm cells.

mitosis

The type of cell division in which the chromosome number is preserved. Diploid cells reproduce by mitosis to produce more identical diploid cells.

paternal chromosome

In a diploid organism, the chromosome in each pair that originated in that organism's male parent; it was located in the sperm cell at the time of fertilization.

phenotype

The particular trait expressed in a given organism. This trait can be either structural or functional. Phenotype results from genotype.

Punnett square

A tool used to predict the offspring of a cross between two particular parental organisms. Punnett squares clearly illustrate Mendel's principle of segregation and principle of independent assortment.

purebred

An offspring in which the two alleles for a trait are identical.

zygote

The diploid cell that is formed when two haploid cells join in fertilization.

Learning Activity 1.1: Introduction to Genetics

This learning activity will give you an opportunity to review and practise what you have learned in this lesson. Please record your responses in your notebook.

1. Assume that, in garden peas, round seeds are the dominant trait and wrinkled seeds are the recessive trait. The alleles for this trait are *R* for round and *r* for wrinkled.
   a) What is the genotype of a plant with wrinkled seeds?
   b) What is the genotype of a plant with round seeds?
   c) What is the genotype of a hybrid plant?
   d) What is the genotype of a purebred plant?
   e) What is the genotype of a heterozygous plant?
   f) What is the genotype of a homozygous plant?
   g) What is the genotype of a homozygous dominant plant?
   h) What is the phenotype of a hybrid plant?
   i) What is the phenotype of a homozygous recessive plant?
   j) If a parent plant with the genotype *Rr* produces gametes, what genes will the gametes carry?
   k) If a plant has the genotype *Rr*, did it receive the *R* allele or the *r* allele from its female parent?
2. Name the three laws of inheritance that Gregor Mendel discovered while studying pea plants. Briefly define each law.

When you have completed this learning activity, compare your responses with those provided in the Learning Activity Answer Key found at the end of this module. Remember that you do not need to submit learning activities to your tutor/marker.

It is now time to do Assignment 1.1. The assignment details can be found after the Lesson Summary.

Lesson Summary

In this lesson, you have learned about the fundamental concepts of genetics first suggested by Gregor Mendel. In particular, Mendel stated three laws of inheritance, which are still useful today. You also learned several definitions of terms that are commonly used in genetics. Understanding these terms will help you as you continue to study genetics in the lessons that follow.

In the next lesson, you will learn how to predict the genotypes of the offspring that a given pair of parents can produce; you will learn to make such predictions using a tool called a *Punnett square*.

You will also learn that not all traits are controlled by dominant and recessive alleles. In some traits, two alleles are possible and, when both are present, both are shown in the phenotype of that individual. In other traits, more than two alleles are possible—although each individual organism still possesses only two alleles in its body cells.

Notes

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