January 2000

Biology 30
Grade 12 Diploma Examination

Alberta
LEARNING

Biology 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination

- 2 written-response questions, of equal value, worth 30% of the examination

  This exam contains sets of related questions.

  A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

Note: The perforated pages at the back of this booklet may be torn out and used for your rough work. ***No marks*** *will be given for work done on the tear-out pages.*

Instructions

- You are expected to provide your own scientific calculator.

- Use only an HB pencil for the machine-scored answer sheet.

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.

- Read each question carefully.

- Consider all numbers used in the examination to be the result of a measurement or observation.

- If you wish to change an answer, erase **all** traces of your first answer.

- Do not fold the answer sheet.

- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Learning.

- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.

- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. biology
B. physics
C. science
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.

- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.

- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Round and record your **answer to one decimal place** in the numerical-response section on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666…
= 23.7 (rounded to one decimal place)

Record 23.7 on the answer sheet ⟶

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet ⟶

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┌─┬─┬─┬─┐
│3│2│1│4│
└─┴─┴─┴─┘
   ⊙ ⊙
 ⓪ ⓪ ⓪ ⓪
 ① ① ● ①
 ② ● ② ②
 ● ③ ③ ③
 ④ ④ ④ ●
 ⑤ ⑤ ⑤ ⑤
 ⑥ ⑥ ⑥ ⑥
 ⑦ ⑦ ⑦ ⑦
 ⑧ ⑧ ⑧ ⑧
 ⑨ ⑨ ⑨ ⑨
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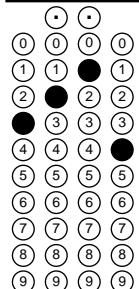
Selection Question and Solution

The birds in the following list are numbered _____.
(Record your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

1 dog
2 sparrow
3 cat
4 robin
5 chicken

Answer 245

Record 245 on the answer sheet ⟶

```
┌─┬─┬─┬─┐
│2│4│5│ │
└─┴─┴─┴─┘
   ⊙ ⊙
 ⓪ ⓪ ⓪ ⓪
 ① ① ① ①
 ● ② ② ②
 ③ ③ ③ ③
 ④ ● ④ ④
 ⑤ ⑤ ● ⑤
 ⑥ ⑥ ⑥ ⑥
 ⑦ ⑦ ⑦ ⑦
 ⑧ ⑧ ⑧ ⑧
 ⑨ ⑨ ⑨ ⑨
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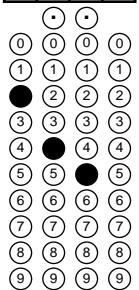
Written Response

- Write your answers in the examination booklet as neatly as possible.

- For full marks, your answers must address **all** aspects of the question.

- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.

- Your answers must be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

Additional Instructions for Students Using Word Processors

- Keep all work together. Diagrams, graphs, calculations, etc. should be placed directly on your word-processed pages.

- Staple your final printed work to the page indicated for each word-processed response.

- Indicate in the space provided on the back cover that you attached word-processed pages.

A group of psychologists wondered if inhaling pure oxygen could enhance a person's mental capacity. They tested forty-five students.

These students breathed through a face mask for one minute. They were either given pure oxygen or normal air, but they did not know which. Those receiving pure oxygen could recall twice as many words as those receiving normal air.

—from *Mihill, 1996*

1. The part of the brain that is directly responsible for the recall of previously learned words is the

    A. cerebrum
    B. cerebellum
    C. pituitary gland
    D. medulla oblongata

2. The part of the brain that controls the unconscious rate of breathing is the

    A. cerebrum
    B. cerebellum
    C. pituitary gland
    D. medulla oblongata

Movement of hair cells in normal ears opens tiny pores called ion channels in the nerve cell membrane. This process begins impulse transmission along the auditory nerve.

3. Nerve impulse transmission continues along the nerve cell membrane as

    A. a wave of depolarization
    B. a negative feedback loop
    C. a diffusing wave of summation
    D. the active transport of an electrical potential

4. The part of the ear **directly** responsible for stimulating the nerve endings that transmit sound impulses from the ear to the brain is the

    A. cochlea
    B. eardrum
    C. Eustachian tube
    D. semicircular canal

Many predatory birds such as eagles have two foveas in each eye. The fovea in predatory birds is similar in structure and function to the fovea in humans. In addition, these birds have strong powers of near and far accommodation.

—from *Curtis, 1983*

5. If an eagle's brain were similar in structure to a human brain, impulses that begin in the retina of the eagle's eye would travel first to the

    A. frontal lobe
    B. parietal lobe
    C. occipital lobe
    D. temporal lobe

6. Strong near and far accommodation in the eye require

    A. small blind spots
    B. a large number of rods
    C. a large number of cones
    D. highly developed ciliary muscles

A Reflex Arc

Stimulus
Skin
Spinal cord

1
2
3
4
5

—from *Marieb, 1987*
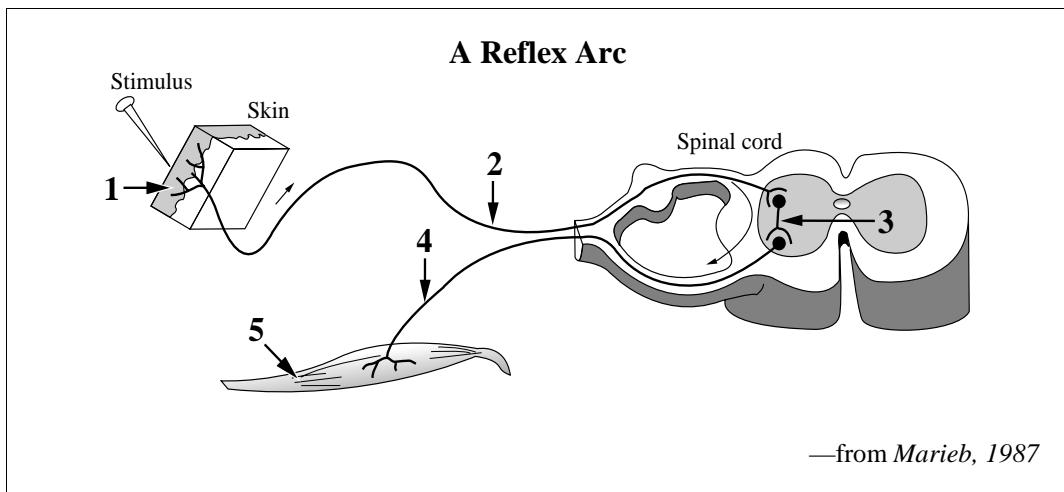
Numerical Response

1. Identify the structure, as numbered above, that performs each of the functions given below.

Structure: _____ _____ _____ _____

| **Function:**	**Transmits impulses to the central nervous system**	**Receives sensory stimulation**	**Carries out instructions from the central nervous system; is a muscle**	**Transmits impulses from the central nervous system to the effector**

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

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7. Jogging will cause heart rate to change because of

    A. increased sympathetic and decreased parasympathetic impulses
    B. decreased sympathetic and increased parasympathetic impulses
    C. increased sympathetic and decreased central nervous system impulses
    D. decreased sympathetic and increased central nervous system impulses

8. Damage to which of the following endocrine glands would **most affect** the reaction of the body to an emergency that stimulates the sympathetic nervous system?

    A. Thyroid gland
    B. Adrenal gland
    C. Anterior pituitary gland
    D. Posterior pituitary gland

Oxytocin and ADH are synthesized by neurosecretory cells in the hypothalamus. These hormones are stored in the posterior pituitary. They can then be released into the bloodstream where they circulate to target cells.

Hormones of the Pituitary and Hypothalamus
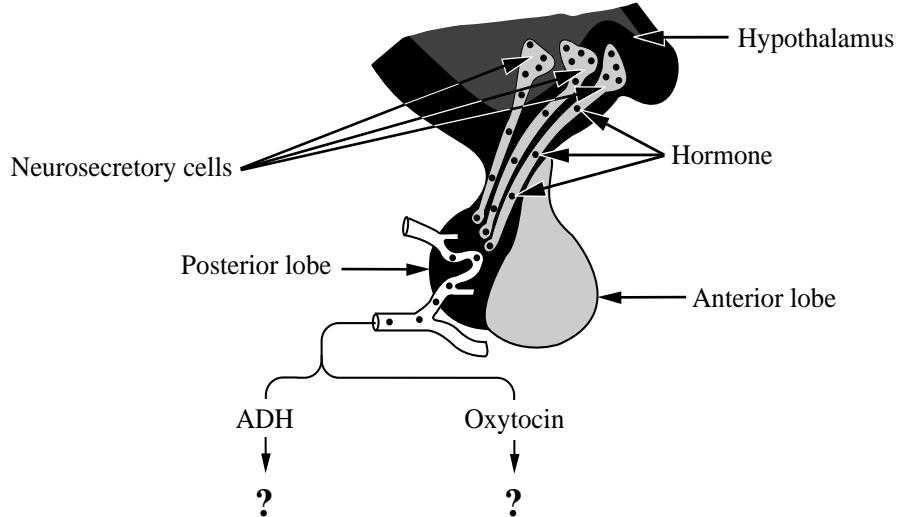
—from *Campbell, 1987*

9. In a human female, where are the target cells for ADH and oxytocin?

A. In the kidney tubules and ovaries
B. In the Bowman's capsule and the ovaries
C. In the kidney tubules and uterine muscles
D. In the Bowman's capsule and the uterine muscles
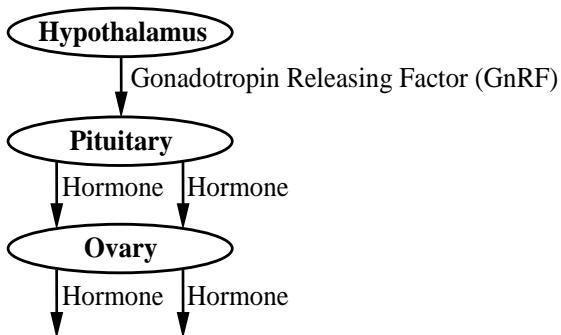
10. In humans, high levels of GnRF cause the pituitary to release

A. LH and FSH
B. LH and estrogen
C. progesterone and FSH
D. estrogen and progesterone

Responses Stimulated by Hormones

1 Release of thyroxine   **4** Development of follicle and sperm
2 Development of bones and muscles   **5** Ovulation and maintenance of the corpus luteum
3 Water reabsorption by kidneys   **6** Milk production

Numerical Response

2. Identify the response, as numbered above, that would be stimulated by each of the hormones given below.

 Response: _____   _____   _____   _____
 Hormone: STH(HGH)   LH   TSH   FSH

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next five questions.

> The spermicide nonoxynol-9, which is applied to contraceptive devices such as diaphragms and condoms, has been linked to increased urinary tract infections in women. Although nonoxynol-9 is helpful in fighting the herpes virus and HIV, it also destroys beneficial bacteria (lactobacilli) that moderate the acidity of a woman's vagina. As a woman's vagina and external genitalia become more acidic, another bacterium, *Escherichia coli* (*E. coli*), increases in number and invades her urethra. This overpopulation of *E. coli* causes a bladder infection.
>
> —from *Vergano, 1996*

11. The relationships described above between the human female, lactobacilli, and *E. coli* are identified in row

Row	Human female/lactobacilli	Human female/ *E. coli*	Lactobacilli/*E. coli*
A	parasitic	mutualistic	interspecific competition
B	mutualistic	mutualistic	intraspecific competition
C	mutualistic	parasitic	interspecific competition
D	parasitic	parasitic	intraspecific competition

12. The site of sperm production and the gland that produces an alkaline secretion that neutralizes the acidity of the vagina are given in row

Row	Site of Sperm Production	Gland that Produces an Alkaline Secretion
A	seminiferous tubules	testis
B	seminiferous tubules	prostate gland
C	seminal vesicles	testis
D	seminal vesicles	prostate gland

13. Testes are responsible for the production of sperm and testosterone. Cutting and tying the vas deferens (vasectomy) blocks the passage of sperm. After a vasectomy, the hormone testosterone

- **A.** reaches all the body tissues because it comes from exocrine tissue
- **B.** reaches all the body tissues because it comes from endocrine tissue
- **C.** does not reach all the body tissues because it comes from exocrine tissue
- **D.** does not reach all the body tissues because it comes from endocrine tissue

*Use the following additional information to answer the next question.*

Female Reproductive Structures
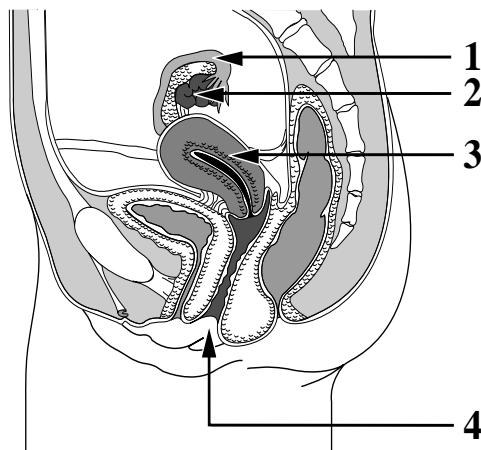
14. Some contraceptives, such as condoms, prevent fertilization. Fertilization usually occurs in the structure labelled

- **A.** 1
- **B.** 2
- **C.** 3
- **D.** 4

15. Another contraceptive, the birth control pill, causes negative feedback on the pituitary, which prevents the release of eggs. Typically, the hormones in the birth control pill are similar to

- **A.** FSH and LH
- **B.** oxytocin and prolactin
- **C.** estrogen and progesterone
- **D.** relaxin and gonadotropins

Research on sheep might explain what stimulates pregnant mammals, including humans, to give birth. Through research on pregnant sheep, scientists have developed the following scheme to explain normal events as birth begins.

Influence of Fetal Hormones on the Maternal Reproductive System

Hypothalamus
of a fetal lamb

↓

Adrenal gland
of a fetal lamb

|

Cortisol

Placenta

Progesterone — is converted to → Estrogen

(−)   (+)

Uterine
muscle contraction
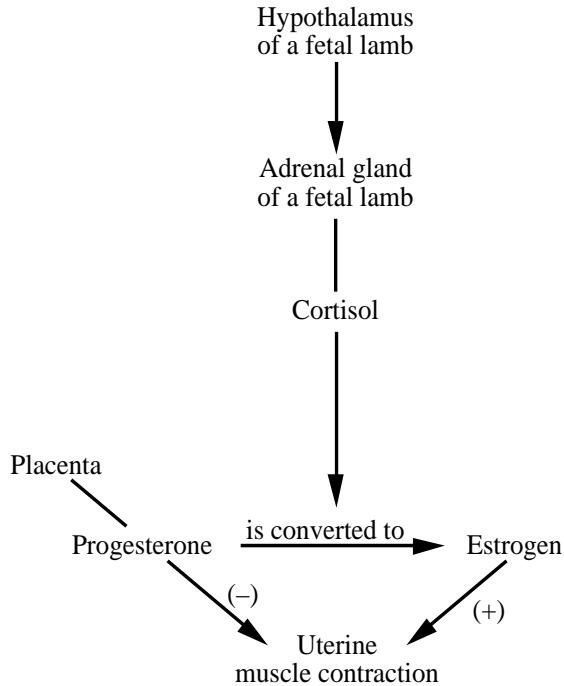
Note: The placenta produces progesterone throughout the pregnancy, but activation of the fetal hypothalamus only occurs as birth begins.

—from *Discover, 1992*

16. According to this diagram, the birth of a lamb is linked to

    A. increasing levels of estrogen in pregnant sheep
    B. decreasing production of cortisol by the fetal lamb
    C. increasing levels of progesterone in pregnant sheep
    D. decreasing activity of the hypothalamus by the fetal lamb

17. To maintain a pregnancy for a normal gestation period, the contraction of uterine muscles is inhibited. According to the diagram, this inhibition is brought about by

    A. high levels of estrogen from the placenta
    B. low levels of progesterone from the uterus
    C. high levels of cortisol from the adrenal gland
    D. high levels of progesterone from the placenta

18. Which of the following statements concerning human reproduction is supported by the findings of this research?

    A. Developments within the fetus determine when birth will begin.
    B. The production of fetal cortisol delays birth until gestation is complete.
    C. During early fetal development, fetal hormones do not pass into the mother.
    D. High levels of progesterone in the mother's blood are essential for birth to begin.

Use the following additional information to answer the next question.

Ingestion of a plant called skunk cabbage by pregnant sheep has been found to cause severe birth defects and to delay birth for several weeks.

19. A reasonable hypothesis is that skunk cabbage contains a chemical that

    A. increases uterine sensitivity to estrogen
    B. decreases placental production of progesterone
    C. inhibits the fetal hypothalamus or adrenal gland
    D. increases conversion of progesterone to estrogen

20. Cryptorchidism is the failure of one or both of the testes to descend from the abdominal cavity into the scrotum during human fetal development. Sterility results if both testes fail to descend. In this case, the likely cause of sterility is that

    A. lack of oxygen inhibits testosterone function
    B. gonadotropic hormones cannot stimulate the testes
    C. the testes are not connected to the external environment
    D. normal sperm do not readily develop at body temperature

Yaws, bejel, and syphilis are three diseases known to be caused by strains of bacteria in the genus *Treponema*. Syphilis is a sexually transmitted disease, whereas yaws and bejel are not sexually transmitted. Studies of 800-year-old to 1 600-year-old skeletons from Florida, Equador, and New Mexico show that these people suffered from syphilis. Studies on 6 000-year-old skeletons from Illinois, Virginia, and Ohio show that these people suffered from yaws.

—from *Zabludoff, 1996*

21. Which of the following conclusions can be made about these related diseases?

A. A person can easily contract syphilis in warm climates.

B. The syphilis strain of *Treponema* may have mutated from the yaws strain.

C. Non-sexually transmitted diseases have developed from sexually transmitted diseases.

D. Older people tend to suffer from yaws, and younger victims develop syphilis when exposed to *Treponema*.

The symptoms of untreated syphilis usually disappear within 12 weeks of the initial infection. However, new symptoms may appear many years later. These include damage to neurons of the central nervous system.

—from *Zabludoff, 1996*

22. The neurons damaged by syphilis are

A. interneurons
B. sensory neurons
C. somatic motor neurons
D. autonomic motor neurons

The Life Cycle of *Ulva*—a green alga

Mature sporophyte

Mitosis

Zygote

Meiosis

Gametes

Zoospores

Mitosis

Mitosis

Gametophytes

—from *Campbell, 1993*
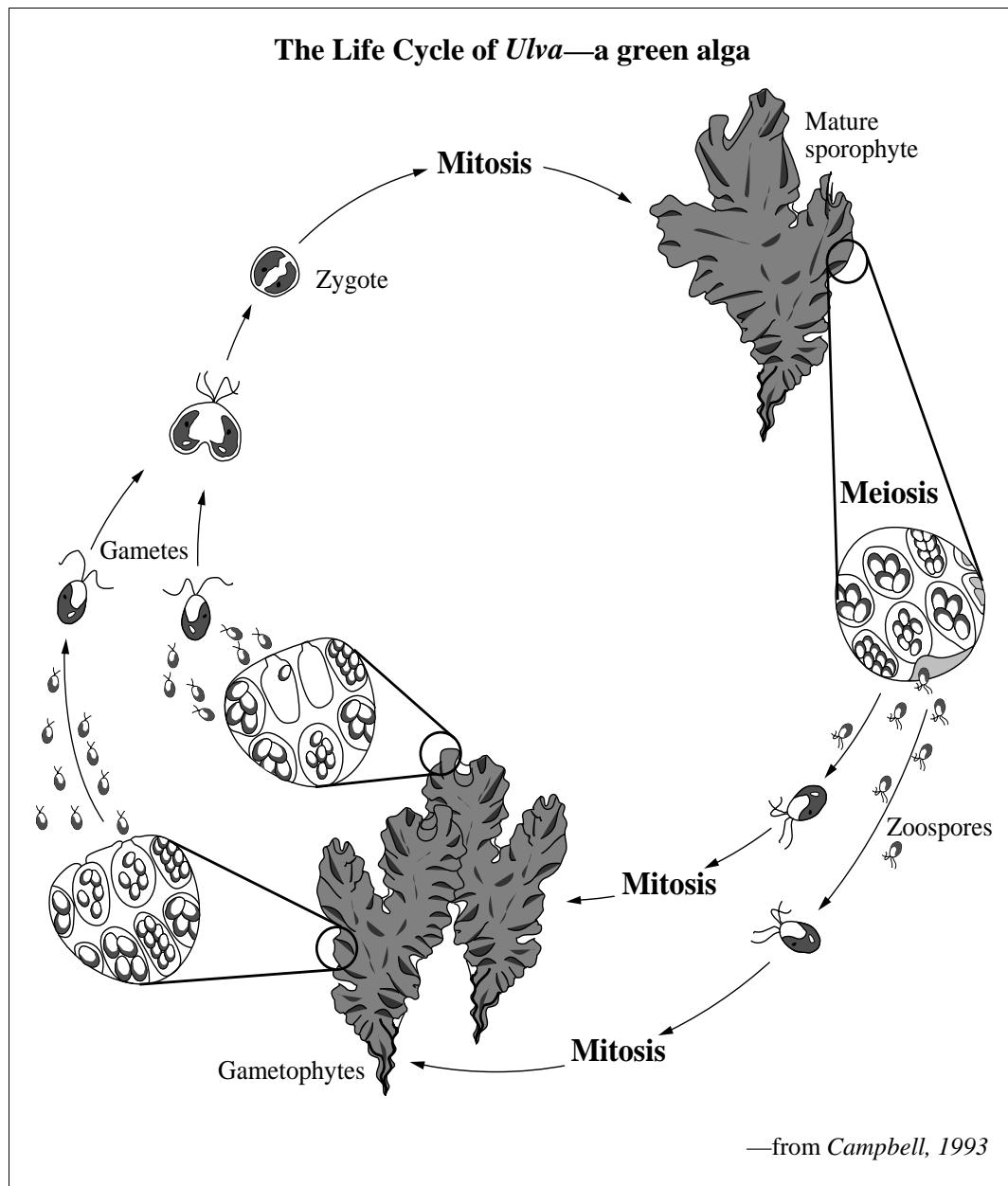
23. Which structures in the life cycle of the *Ulva* are haploid (monoploid)?

   A. Zoospores and the zygote
   B. The sporophyte and the zygote
   C. Zoospores and the gametophytes
   D. The sporophyte and the gametophytes

Chromosome Content of Human Cells During a Series of Events
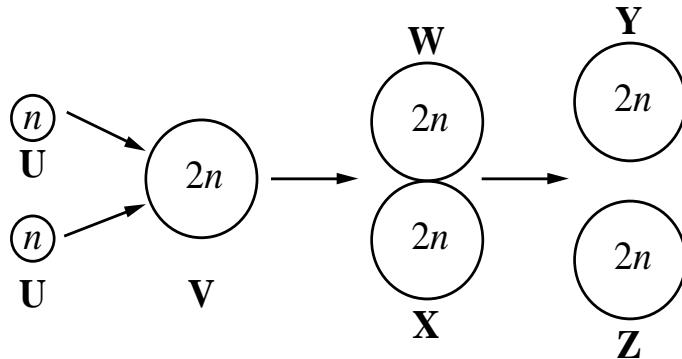
24. In humans, what process must have occurred to obtain the cells at **U**?

    A.   Mitosis
    B.   Meiosis
    C.   Fertilization
    D.   Differentiation

25. In humans, what process occurs between **U** and **V**?

    A.   Mitosis
    B.   Meiosis
    C.   Fertilization
    D.   Differentiation

26. In humans, what process must occur before cell **V** forms cells **W** and **X**?

    A.   Mitosis
    B.   Meiosis
    C.   Recombination
    D.   Nondisjunction

27. In humans, cells **Y** and **Z** represent individual cells that

    A.   are two eggs
    B.   will no longer divide
    C.   will become a $4n$ cell
    D.   could develop into identical twins

Use the following information to answer the next question.

Phases of Mitosis

    1   Anaphase
    2   Metaphase
    3   Prophase
    4   Telophase

Numerical Response

3. The phases of mitosis in the sequence in which they occur are
_____ , _____ , _____ , and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

The flowering plant, *Mirabilis jalapa* (*M. jalapa*) may have branches with all white leaves, all green leaves, and all variegated leaves (leaves with green and white patches) on the same plant. Leaf colour is dependent on the colour of plastids present in cytoplasm. As in the case of other plants, pollen (containing sperm nuclei) contribute chromosomes but almost no cytoplasm to the zygote. The ovule contributes both chromosomes and cytoplasm to the zygote. The following data of offspring phenotypes were collected from crosses between flowers from various branches.

Source of pollen (male)	Source of ovule (female)	
	White branch	**Green branch**
White branch	White offspring	Green offspring
Green branch	White offspring	Green offspring
Variegated branch	White offspring	Green offspring

—from Griffiths, 1993

28. These data indicate that, regardless of its branch source, pollen has no effect on the leaf colour of resulting offspring. A reasonable explanation for this observation is that

A. leaf colour is a codominant trait
B. leaf colour is a dominant–recessive trait
C. cell organelles or cytoplasm are active only in pollen
D. cell organelles or cytoplasm contain genetic information

Several geneticists studied *M. jalapa* plants with deep crimson flowers and *M. jalapa* plants with yellow flowers. Cross-pollinating these plants produced plants with scarlet-red flowers (F_1 generation).

These F_1 plants were allowed to self-pollinate, and the resulting seeds produced *M. jalapa* plants with three different flower colours. Data similar to the following were collected for flower colour:

140 deep crimson
310 scarlet-red
160 yellow

—from Engels, 1975

29. With respect to the alleles for flower colour, these results indicate

A. X-linked inheritance
B. gene-linked inheritance
C. dominant-recessive inheritance
D. incomplete dominance inheritance

Use the following additional information to answer the next two questions.

A different variety of homozygous *M. jalapa* produces flowers that are light crimson. Pure-breeding genotypes and phenotypes are:

$$R^P R^P - \text{deep crimson}$$
$$RR - \text{light crimson}$$
$$rr - \text{yellow}$$

When two pure-breeding P$_1$ plants are cross-pollinated, only scarlet-red-flowered offspring ($R^P r$) are produced.

When another pair of pure-breeding P$_1$ plants are cross-pollinated, only orange-flowered offspring (Rr) are produced.

—from *Engels, 1975*

30. The likely genotypes of the P$_1$ plants for these two crosses is represented in row

Row	P$_1$ genotypes scarlet-red-flowered offspring	P$_1$ genotypes orange-flowered offspring
A	$R^P R \times rr$	$RR \times rr$
B	$R^P R^P \times rr$	$RR \times rr$
C	$R^P r \times R^P r$	$Rr \times Rr$
D	$R^P R^P \times RR$	$R^P R \times Rr$

31. Which of the following phenotypes is the predicted flower colour of *M. jalapa* with the genotype $R^P R$?

A. Yellow
B. Orange
C. Crimson
D. Scarlet-red

15

Feather colour in parakeets is controlled by two genes. For one pigment gene, the *B* allele produces blue colour and the *b* allele does not produce any colour. For the other pigment gene, the *Y* allele produces yellow colour and the *y* allele does not produce any colour. Any genotype containing at least one *B* allele and one *Y* allele will produce a green parakeet.

32. Which of the following parental genotypes could produce offspring with the **four** different colour patterns?

    A. *BBYy* × *BbYy*
    B. *BbYY* × *Bbyy*
    C. *bbYY* × *bbyy*
    D. *Bbyy* × *bbYy*

33. What is the probability of obtaining a blue parakeet when two green heterozygous parakeets are crossed?

    A. 0

    B. $\dfrac{3}{16}$

    C. $\dfrac{1}{4}$

    D. $\dfrac{9}{16}$

Parakeet   —from *Macrich, 1998*

Use the following information to answer the next question.

A community of Pima Indians in the American Southwest has a very high rate of diabetes in their adult population. Of the population of adults over the age of 35, 42% to 66% develop diabetes. The recessive trait that causes diabetes in this population is a distinct disadvantage to individuals whose diets are rich in carbohydrates.

—from *Cummings, 1993*

Numerical Response

4. If 42% of the population have diabetes, then the percentage of the population who are carriers is calculated to be _____%.

(Record your **answer as a whole number** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Portion of the Insulin Protein

Phenylalanine – Valine – Asparagine – Glutamate – Histidine

Assume that a mutation occurred in the strand of DNA that codes for the portion of protein shown above. The protein was altered in structure and no longer performed its function.

—from *Campbell, 1987*

34. Which of the following effects would this mutation have on an individual's body?

A. A chronic increase in blood sugar after meals
B. A chronic decrease in blood sugar after meals
C. A decrease in the body's metabolic rate after meals
D. An increase in the body's metabolic rate after meals

> Erwin Chargaff found that the relative amount of each of the base pairs that make up DNA varies from species to species. He analyzed a sample of DNA from *Escherichia coli* (a bacterium) and found that 23.6% of the nitrogen base molecules present in this sample were thymine.
>
> —from *Curtis, 1983*

35. In this sample of *Escherichia coli* DNA, the percentage of the nitrogen base molecules that would be adenine is

    A. 76.4%
    B. 38.2%
    C. 23.6%
    D. 11.8%

> A condition called "situs inversus" causes the internal organs of an animal to be reversed and end up on the wrong side of the body. Researchers have shown that insertion of a DNA fragment in one particular structural gene of mice may lead to this condition. Mice homozygous for this insertion are born with their organs reversed and die within a week of their birth. Mice heterozygous for this insertion are born with their organs in normal positions.
>
> —from *Oliwenstein, 1993*

36. Which of the following statements is a **reasonable** conclusion based on this information?

    A. The gene with the inserted DNA fragment is recessive.
    B. The gene with the inserted DNA fragment is dominant.
    C. The affected gene produces a protein that influences embryonic development.
    D. The affected gene cannot be transcribed after foreign DNA has been inserted.

37. If two heterozygous mice were mated, what percentage of their offspring would be predicted to die?

    A. 0%
    B. 25%
    C. 50%
    D. 75%

Although most strains of the bacterial species *Vibrio cholera* are harmless, the 01 strain produces a toxin that binds to cells of the small intestine, causing rapid depletion of salts and water, which, if not replaced, can be lethal in humans. This disease is known as cholera.

The transformation from harmless to harmful bacterial strains is thought to be caused by a virus that transfers the cholera toxin gene (CTX) from one bacterial strain and places it into another. Researchers can mimic this process by using current technologies.

—from *Glausiusz, 1996*

38. The sequence of events that would enable researchers to incorporate the CTX gene into bacterial DNA would be to

    A. first open the bacterial DNA with ligase enzymes, then position the CTX gene in the DNA, and then join the DNA by restriction enzymes

    B. first open the bacterial DNA with restriction enzymes, then position the CTX gene in the DNA, and then join the DNA by ligase enzymes

    C. first position the CTX gene in the DNA, then open the DNA with ligase enzymes, and then join the DNA by restriction enzymes

    D. first position the CTX gene in the DNA, then open the DNA with restriction enzymes, and then join the DNA by ligase enzymes

39. The overall effects of cholera toxin are opposite to the physiological effects of which of the following hormones?

    A. Oxytocin
    B. Thyroxine
    C. Aldosterone
    D. Epinephrine

Some people have condemned the use of food preservatives because they may cause cancer. A researcher has found contradictory evidence that suggests that two widely used food preservatives actually increase levels of natural cancer-fighting agents in laboratory animals. The preservatives BHA and BHT increase the activity of a gene that controls the production of an enzyme. This enzyme helps destroy cancer-causing substances (carcinogens) before they trigger the development of tumours.

—from *Pearson et al, 1983*

40. The most **direct** relationship between a gene and an enzyme is that

A. an enzyme causes a gene to destroy carcinogens
B. the sequence of nucleotides in a gene determines the structure of an enzyme
C. each gene contains the code needed to construct many different types of enzymes
D. the sequence of amino acids in an enzyme is unrelated to nucleotide sequence in a gene

Some Events that Occur Following BHA or BHT Exposure

1 The polypeptide folds into an enzyme shape.
2 tRNAs transport amino acids to the ribosomes.
3 A polypeptide is released from the ribosomes.
4 mRNA leaves the nucleus and attaches to ribosomes in the cytoplasm.

Numerical Response

5. The sequence of events that results in the production of the cancer-fighting enzyme is _____ , _____ , _____ , and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

The Amish are a group of people who rarely marry outside of their community. In one group of Amish in Ohio, the incidence of cystic fibrosis was 19 in 10 816 live births. A second group of Amish in Ohio had no affected individuals in 4 448 live births. No members of either group are related. These data illustrate what population geneticists refer to as the "founder effect."

—from *Klinger, 1983*

41. The "founder effect" seems to occur when

    A.   the environment favours one population over another population

    B.   a non-representative subpopulation forms the basis for an isolated population

    C.   individuals from one population move into and become part of a second population

    D.   two similar populations exist in the same community without being reduced in number

---

Use the following information to answer the next question.

The fathead minnow is a small fish common in Alberta waters and is used as a food source by many different predators. When injured, some minnows secrete a chemical (called schreckstoff) that both attracts predators and causes other minnows to huddle in large groups. Approaching predators tend to be distracted by the mass of minnows and by each other. Often, the injured minnow can escape.

—from *Gonick, 1996*

42. The frequency of the gene that controls the production of schreckstoff by minnows is likely

    A.   to increase in the gene pool of the population

    B.   to decrease in the gene pool of the population

    C.   to stay the same in the gene pool of the population because natural selection is occurring

    D.   to stay the same in the gene pool of the population because natural selection is not occurring

In winter, snowshoe hares found in Jasper National Park create pathways in the snow between feeding and resting sites. These travel lanes are then used by porcupines, making the porcupines' movement through deep snow easier.

43. What relationship exists between the snowshoe hare and the porcupine?

A. Mutualism
B. Predator–prey
C. Commensalism
D. Intraspecific competition

In areas where moose and caribou share habitat, they are both preyed upon by wolves. The population cycle of the moose is affected by the presence of a second prey species, the caribou.

—from *Mech, 1996*

44. A reasonable prediction based on these predator–prey relationships is that

A. predator species would not show population changes caused by density-dependent factors

B. low numbers of caribou would cause wolf starvation if the moose population was also low

C. wolf and prey populations would decline as the same diseases spread through the three populations

D. an area would have the same carrying capacity for moose as it has for caribou, even though each species has different food preferences

A group of ecologists have studied the Jasper National Park animal populations and gathered data related to the growth of these populations.

J- and S-shaped Growth Curves of Theoretical Populations
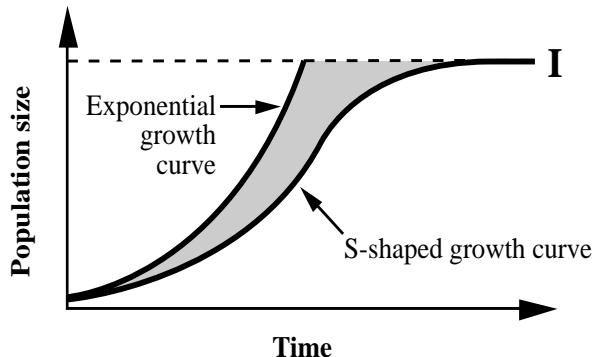
—from *Levine and Miller, 1991*

45. Ecological data gathered over a 20-year period indicate that the elk population fluctuates around the level marked **I** on the graph. The biotic factors that keep this population stabilized are

A. density dependent
B. density independent
C. independent of natality and mortality
D. independent of emigration and immigration

46. The level marked **I** on the graph represents the effect of factors such as climate, nutrients, soils, and water on the size of the elk population. A term to describe this section of the growth curve is

A. lag phase
B. biotic potential
C. carrying capacity
D. climax community

Use the following additional information to answer the next two questions.

Data generated by ecologists working in Jasper National Park are used by park planners. Identifying a population as *r*-selected or K-selected may aid in wildlife management. Populations of caribou, elk, and wolves have been studied extensively.

Population Characteristic	Population Descriptors
Offspring Number	1 Few offspring 2 Large numbers of offspring
Body Size	3 Small in size 4 Large in size
Reproductive Maturity	5 Early reproductive maturity 6 Delayed reproductive maturity
Lifespan	7 Long lifespan 8 Short lifespan

Numerical Response

6. Identify the population descriptor, as numbered above, that **best** matches each of the population characteristics below for a K-selected population such as the caribou or elk.

Population Descriptor: _____ _____ _____ _____

Population Characteristic: Offspring   Body Size   Reproductive   Lifespan
                   Number   Maturity

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next question.

Predator–Prey Relationships

Location	Animal 1	Animal 2	Density of Predators (number per 100 km^2)	Number of Prey
Jasper National Park	Wolf	Elk	0.6	1 200
Northwest Territories	Wolf	Caribou	0.3	500 000

Numerical Response

7. The size of the wolf population in an area of 6 000 km^2 of the Northwest Territories is calculated to be _____ wolves.

(Record your **answer as a whole number** in the numerical-response section on the answer sheet.)

Many elk live in and around an 80 km^2 area that includes the Jasper town site.

47. If a disease were to kill 90% of these elk (an epidemic), what would be the likely consequence?

    A.   The genetic variability in the population would decrease.
    B.   The population's resistance to all diseases would increase.
    C.   The mutation rate in genes for disease resistance would increase.
    D.   The population's gene frequencies would return to pre-epidemic values through genetic drift.

48. The elk population of this area at the beginning of a study year was 500. If there were 35 births and 5 deaths throughout the year, what was the per capita growth rate for the elk population during that year?

    A.   0.03
    B.   0.06
    C.   6
    D.   30
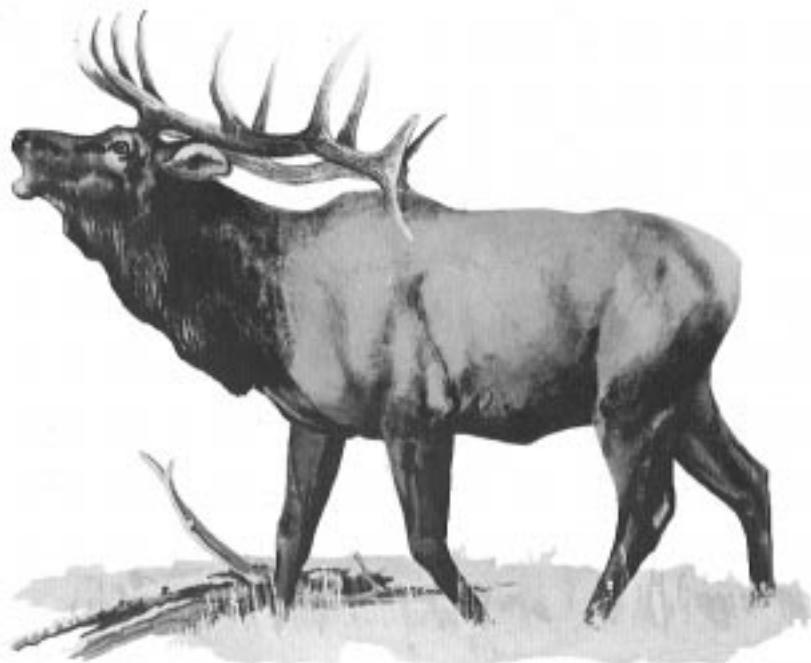
Elk   —from *Alberta Recreation, Parks and Wildlife*

Use the following information to answer the next question.

The following table describes characteristics of communities.

A	B	C
Possible location	**Community present**	**Number of species**
1 in an area clear cut by logging	**1** pioneer	**1** increase
2 on land bared by a forest fire	**2** climax	**2** decrease
3 on land released from a retreating glacier		

Numerical Response

8. Use the numbered phrases or words from columns *A*, *B*, and *C* above to complete the statements below.

Primary succession would occur __A__, where the first organisms present are called a __B__ community. During the first 20 years in the development of a community, the number of species would be expected to __C__.

Answer: _____ _____ _____
  Letter: A   B   C

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Scientists are working hard to learn about causes of cancers. It is known that in general terms, cancer-causing agents produce mutations in a variety of genes that control cell reproduction.

Cancer can be caused by organisms. For example, when some viruses infect a human cell, the viral DNA may insert itself randomly into the DNA of human cells.

Of all the cancer-causing agents to which humans are commonly exposed, tobacco smoke appears to have caused the greatest harm. It is directly responsible for 30% of all cancer deaths in North America. Heavy smoking increases the likelihood of getting lung cancer by 2 000%. Passive (second-hand) smoke is less likely to cause cancer. It is about as harmful as all other forms of air pollution.

—from *Trichopoulos, Li, and Hunter, 1996*

Written Response – 15% | Staple your word-processed response for **this** question to this page.

1. **a.** A reasonable question for a researcher to ask would be "What percentage of smokers will die from cancer caused by tobacco smoke?" Assume that in a study to answer this question, you gather two groups of subjects and observe them over a long period of time.

    i. Identify the manipulated variable and the responding variable for your study. (**2 marks**)

    ii. Identify two variables that you would be unable to control, and explain why these variables would influence the conclusions of your study. (**3 marks**)

b. Hypothesize how viral infection of human cells may lead to cancer. **(2 marks)**

Use the following additional information to answer the next part of the question.

> Four percent of all cancer deaths can be linked to the reproductive history of a woman. Researchers have discovered that if a woman begins to menstruate at an early age and experiences late menopause, she is more likely to develop cancer in her reproductive organs. If a woman has several children and gave birth to them at a younger age, she is less likely to develop cancer of the ovary, breast, or endometrium.
>
> —from *Trichopoulos, Li, and Hunter, 1996*

c. i. Identify a social or economic change in Canadian society over the past few decades that could have had an impact on the rate of cancer in women's reproductive systems. **(1 mark)**

ii. Describe how this change could affect the frequency of cancer in the reproductive systems of women in the Canadian population. **(1 mark)**

Scientists have been learning about a mechanism called the "cell cycle clock" that collects information from outside the cell. This information influences the activities of molecules within the cell that determine whether or not a cell will undergo mitosis. Some molecules take the form of "go" signals, stimulating a cell to go through mitosis. Other molecules take the form of "stop" signals to ensure that the cell does not start cell division. For example, some cyclins and CDKs are molecules that act as "go" signals. If these are present in appropriate amounts, DNA replication will occur.

—from *Trichopoulos, Li, and Hunter, 1996*

d. At which phase of the cell cycle do these cyclins and CDKs appear to operate?
(1 mark)

e. Drug companies are working on developing a drug that blocks the activities of these cyclins and CDKs. Predict how such a drug could act at the molecular level to prevent cancer. **(1 mark)**

f. A mutation could disrupt the production or activation of molecules that act as "stop" or "go" signals. Describe how such a disruption could lead to cancer.
(1 mark)

Adrenoleukodystrophy (ALD) is a rare disease of the central nervous system. ALD is characterized by the accumulation of very-long-chain fatty acids in the white matter of the brain and in the adrenal glands. These fatty acids cause the myelin sheath on nerve fibres within white matter of the central nervous system to degenerate. Symptoms of this degeneration become more severe as more and more fatty acids accumulate. Symptoms start with tantrums and other behavioural problems; then motor function, speech, and hearing are impaired; and finally blindness, mental deterioration, and death occur. ALD also affects the endocrine system by causing adrenal gland degeneration. ALD can be partially diagnosed by abnormally high ACTH levels in the blood.

Hereditary diseases have diverse causes. For example, the disease mutation may be dominant or recessive, or the mutated gene may be present on the X chromosome or on an autosome. In some cases, similar diseases are caused by mutations in two different genes. One such case is ALD, where one gene is autosomal and the other is X-linked. In both forms of inheritance, the disease mutation is recessive. Scientists continue to research the causes of ALD. The X-linked recessive form of ALD can be diagnosed prenatally.

ALD has not been treated successfully; however, bone marrow transplants and a diet restricted in very-long-chain fatty acids have shown promise. One dietary substance, oleic acid (Lorenzo's oil), has been successful in normalizing levels of very-long-chain fatty acids in blood plasma. However, the results of clinical trials on ALD patients showed little improvement in symptoms, particularly in brain degeneration. Lorenzo's oil did produce positive clinical results when the treatment of patients began before neurologic symptoms were present.

—from *McKusick, et al, 1997*

Written Response – 15% | Staple your word-processed response for **this** question to this page.

2. Write a unified response that addresses the following aspects of adrenoleukodystrophy.

- **Explain** how the degeneration of the myelin sheaths on cells in the white matter of the central nervous system could result in any of the impaired brain functions of ALD patients. **Identify** one hormone secreted by the adrenal gland, and **describe** how a decrease in secretion of this hormone would affect the body.

- **Describe** one piece of evidence obtained from the analysis of a pedigree chart that could be used to determine whether the mode of inheritance of a human genetic disorder is X-linked or autosomal **and** one piece of evidence that could be used to determine whether it is recessive or dominant. **Construct** a pedigree of four generations that clearly illustrates **one** of the two types of inheritance of ALD. Clearly **label** where your pedigree shows evidence of X-linked recessive or autosomal recessive inheritance.

- **Describe** one procedure that could be used to collect fetal cells for genetic screening. **Describe** a benefit and a risk to the individual and/or to society of early diagnosis of disorders like ALD.

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You have now completed the examination.
If you have time, you may wish to check your answers.

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BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in a population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\dfrac{\Delta N}{\Delta t}$	a change in population size during time interval
$>$	greater than, dominant over
$<$	less than, recessive to

Symbol	Description
♂	male
♀	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F_1, F_2	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \dfrac{N}{A}$
Change in population size	$\Delta N = $ (factors that increase pop.) $-$ (factors that decrease pop.)
Per capita growth rate (time will be determined by the question)	$cgr = \dfrac{\Delta N}{N}$
Growth rate	$\dfrac{\Delta N}{\Delta t} = rN$ $\qquad$ $\dfrac{\Delta N}{\Delta t} = rN\,\dfrac{(K - N)}{K}$

Fold and tear along perforation.

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols

Male

Female

Mating

Mating between close relatives

I Roman numerals symbolize generations

II 1 2 3 Arabic numbers symbolize individuals within a given generation

Birth order, within each group of offspring, is drawn left to right, oldest to youngest

Identical twins

Non-identical twins

Affected individuals

Known heterozygotes for autosomal recessive

Known carrier of X-linked recessive

Deceased individuals

Sex unknown

Fold and tear along perforation.

Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine*	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

No marks will be given for work done on this page.

Biology 30
Diploma Examination
January 2000

Sample Answers to
Written Response Questions

Biology January 2000 Diploma Examination
Multiple Choice and Numerical Response Keys

1.	A		25.	C
2.	D		26.	A
3.	A		27.	D
4.	A		28.	D
5.	C		29.	D
6.	D		30.	B
7.	A		31.	C
8.	B		32.	D
9.	C		33.	B
10.	A		34.	A
11.	C		35.	C
12.	B		36.	A
13.	B		37.	B
14.	A		38.	B
15.	C		39.	C
16.	A		40.	B
17.	D		41.	B
18.	A		42.	A
19.	C		43.	C
20.	D		44.	B
21.	B		45.	A
22.	A		46.	C
23.	C		47.	A
24.	B		48.	B

1.	2154
2.	2514
3.	3214
4.	46
5.	4231
6.	1467
7.	18
8.	311

Biology 30 January 2000 Diploma Examination Scoring Guide

Use the following information to answer the next question.

Scientists are working hard to learn about causes of cancers. It is known that in general terms, cancer-causing agents produce mutations in a variety of genes that control cell reproduction.

Cancer can be caused by organisms. For example, when some viruses infect a human cell, the viral DNA may insert itself randomly into the DNA of human cells.

Of all the cancer-causing agents to which humans are commonly exposed, tobacco smoke appears to have caused the greatest harm. It is directly responsible for 30% of all cancer deaths in North America. Heavy smoking increases the likelihood of getting lung cancer by 2 000%. Passive (second-hand) smoke is less likely to cause cancer. It is about as harmful as all other forms of air pollution.

—from *Trichopoulos, Li, and Hunter, 1996*

| **Written Response – 15%** | Staple your word-processed response for **this** question to this page. |

1. **a.** A reasonable question for a researcher to ask would be "What percentage of smokers will die from cancer caused by tobacco smoke?" Assume that in a study to answer this question, you gather two groups of subjects and observe them over a long period of time.

   i. Identify the manipulated variable and the responding variable for your study. **(2 marks)**

   - *mv – whether or not smokers die of cancer caused by smoking*
   - *rv – percentage of smokers dying of cancer caused by smoking*
   or
   - *mv – whether or not a subject smokes*
   - *rv – death rate due to cancer*

   ii. Identify two variables that you would be unable to control, and explain why these variables would influence the conclusions of your study. **(3 marks)**

   - *not able to control diet, type of tobacco, exposure to radiation, environmental chemicals and secondhand smoke, genetic predisposition to cancer or other aspects of lifestyle (any 2 variables – 2 marks)*
   - *other factors may influence the incidence of cancer, so conclusions about smoking may only be partly valid (1 mark)*

b. Hypothesize how viral infection of human cells may lead to cancer. **(2 marks)**

If the viral DNA is inserted into a gene (1 mark) it could lead to uncontrolled cell division (mitosis). (1 mark)
or
The virus attacks cells in the immune system (1 mark) and therefore the immune system is ineffective in destroying cancerous cells. (1 mark)

Use the following additional information to answer the next part of the question.

Four percent of all cancer deaths can be linked to the reproductive history of a woman. Researchers have discovered that if a woman begins to menstruate at an early age and experiences late menopause, she is more likely to develop cancer in her reproductive organs. If a woman has several children and gave birth to them at a younger age, she is less likely to develop cancer of the ovary, breast, or endometrium.

—from *Trichopoulos, Li, and Hunter, 1996*

c. i. Identify a social or economic change in Canadian society over the past few decades that could have had an impact on the rate of cancer in women's reproductive systems. **(1 mark)**

Any one of the following:
• women are living longer
• women are having fewer children
• women are having children later
• birth control pills are widely used
• nutrition has improved
• healthcare has improved
• environmental estrogens have increased
or
• any other acceptable social or economic changes

ii. Describe how this change could affect the frequency of cancer in the reproductive systems of women in the Canadian population. **(1 mark)**

Any one of the following linked to the corresponding change above.
• if women live longer the chances are greater that they will develop cancer
• having fewer children is linked to a higher rate of cancer in reproductive organs
• having children later is linked to a higher rate of cancer in reproductive organs
• birth control pills allow women to reduce number of offspring, to have their children later, and effect hormone levels. These could all lead to higher cancer rates in reproductive organs.
• better nutrition has resulted in earlier sexual maturity which is linked to a higher rate of cancer in reproductive organs or better nutrition has reduced exposure to carcinogens which leads to a lower rate of cancer in reproductive organs
• exposure environmental estrogens are linked to a higher rate of cancer in reproductive organs
• better healthcare increases longevity which leads to a higher rate of cancer in reproductive organs or better healthcare has decreased the rate of cancer in reproductive organs (e.g. Pap smears)

Use the following additional information to answer the next three parts of the question.

> Scientists have been learning about a mechanism called the "cell cycle clock" that collects information from outside the cell. This information influences the activities of molecules within the cell that determine whether or not a cell will undergo mitosis. Some molecules take the form of "go" signals, stimulating a cell to go through mitosis. Other molecules take the form of "stop" signals to ensure that the cell does not start cell division. For example, some cyclins and CDKs are molecules that act as "go" signals. If these are present in appropriate amounts, DNA replication will occur.
>
> —from *Trichopoulos, Li, and Hunter, 1996*

d. At which phase of the cell cycle do these cyclins and CDKs appear to operate?
(1 mark)

The phase in the cell cycle likely affected by cyclins and CDKs is interphase
(G_1, S-phase, G_2)

e. Drug companies are working on developing a drug that blocks the activities of these cyclins and CDKs. Predict how such a drug could act at the molecular level to prevent cancer. **(1 mark)**

If the drug blocked the CDKs or cyclin molecules then DNA replication would not occur and the cell would not divide.
or
The drug could block receptor sites within the cell (act as a competitive inhibitor) for CDKs or cyclins so that cell division is decreased (normal).
or
The drug could prevent the production of CDKs or cyclin molecules so that cell division is decreased (normal).
or
The drug could destroy the CDKs or cyclin molecules so that cell division is decreased (normal).

f. A mutation could disrupt the production or activation of molecules that act as "stop" or "go" signals. Describe how such a disruption could lead to cancer.
(1 mark)

Too many "go" signals, or not enough "stop" signals, could lead to increased cell division and thus cancer.

Adrenoleukodystrophy (ALD) is a rare disease of the central nervous system. ALD is characterized by the accumulation of very-long-chain fatty acids in the white matter of the brain and in the adrenal glands. These fatty acids cause the myelin sheath on nerve fibres within white matter of the central nervous system to degenerate. Symptoms of this degeneration become more severe as more and more fatty acids accumulate. Symptoms start with tantrums and other behavioural problems; then motor function, speech, and hearing are impaired; and finally blindness, mental deterioration, and death occur. ALD also affects the endocrine system by causing adrenal gland degeneration. ALD can be partially diagnosed by abnormally high ACTH levels in the blood.

Hereditary diseases have diverse causes. For example, the disease mutation may be dominant or recessive, or the mutated gene may be present on the X chromosome or on an autosome. In some cases, similar diseases are caused by mutations in two different genes. One such case is ALD, where one gene is autosomal and the other is X-linked. In both forms of inheritance, the disease mutation is recessive. Scientists continue to research the causes of ALD. The X-linked recessive form of ALD can be diagnosed prenatally.

ALD has not been treated successfully; however, bone marrow transplants and a diet restricted in very-long-chain fatty acids have shown promise. One dietary substance, oleic acid (Lorenzo's oil), has been successful in normalizing levels of very-long-chain fatty acids in blood plasma. However, the results of clinical trials on ALD patients showed little improvement in symptoms, particularly in brain degeneration. Lorenzo's oil did produce positive clinical results when the treatment of patients began before neurologic symptoms were present.

—from *McKusick, et al, 1997*

Written Response – 15% | Staple your word-processed response for **this** question to this page.

2. Write a unified response that addresses the following aspects of adrenoleukodystrophy.

- **Explain** how the degeneration of the myelin sheaths on cells in the white matter of the central nervous system could result in any of the impaired brain functions of ALD patients. **Identify** one hormone secreted by the adrenal gland, and **describe** how a decrease in secretion of this hormone would affect the body.

- **Describe** one piece of evidence obtained from the analysis of a pedigree chart that could be used to determine whether the mode of inheritance of a human genetic disorder is X-linked or autosomal **and** one piece of evidence that could be used to determine whether it is recessive or dominant. **Construct** a pedigree of four generations that clearly illustrates **one** of the two types of inheritance of ALD. Clearly **label** where your pedigree shows evidence of X-linked recessive or autosomal recessive inheritance.

- **Describe** one procedure that could be used to collect fetal cells for genetic screening. **Describe** a benefit and a risk to the individual and/or to society of early diagnosis of disorders like ALD.

Myelin Sheath Function

The myelin sheath surrounds the axons of neurons in the white matter of the central nervous system. It increases the speed of transmission of an action potential along the axon. Damage to the myelin sheath would slow down nervous response time or result in uneven nerve impulse transmission (if the myelin sheath were partially damaged). This would lead to the symptoms of motor function inhibition, impaired hearing, impaired speech, blindness, and mental deterioration.

Adrenal Gland Hormone

*Damage to the **adrenal cortex** is indicated by high levels of ACTH in the blood.*

***Aldosterone** is secreted by the adrenal cortex. It controls sodium ion concentration in the blood and helps regulate blood volume and pressure. With a decrease in aldosterone secretion, sodium ion concentration in the blood would decrease, blood volume would decrease, and blood pressure would decrease. Since sodium ions are not reabsorbed in the kidney nephrons, sodium ions in the urine and urine volume would both increase.*
or
***Cortisol** is secreted by the adrenal cortex. It stimulates the liver to increase secretion of glucose into the blood. It does this by converting amino acids and glycerol into glucose. Cortisol also plays a role in stress control and in immune responses. It increases free amino acids in the blood. These can be used by cells for protein synthesis to repair damaged cells. A decrease in cortisol would lead to decreased use of amino acids and fats in metabolism. It would also decrease amino acids available to cells. This would cause fatigue and weakness. It could also result in failure to cope with physical or mental stress.*
or
***Adrenal androgens** are produced by the adrenal cortex. These have the same effects as male testosterone but are secreted in much smaller amounts. A decrease in secretion has little if any noticeable effects since other sex hormone secretions are responsible for primary and secondary sexual characteristics.*
or
Adrenal medulla hormones, i.e. epinephrine, could be described although it is the adrenal cortex that is affected.

Example:
Epinephrine (norepinephrine) is released in response to stress (real or imagined). It increases the conversion of fuels to glucose, increases heart rate and breathing rate, increases blood flow to skeletal muscles and to the heart and reduces blood flow to other areas of the body, and dilates the pupils. A decreased secretion of epinephrine would reduce the response to stress.

Determining Form of Inheritance

Evidence of X-linked inheritance (autosomal)
• *A greater number of males than females have the disorder. (The number of males and females with the disorder is roughly equal.)*
• *The disorder appears to be inherited from the maternal side of the family. (The disorder appears to be inherited from either gender parent equally.)*

Evidence of recessive inheritance (dominant)
• *Two parents without the disorder have a child with the disorder. (Two parents with the disorder have a child without the disorder.)*
• *The disorder skips generations. (The disorder is present in each generation or disappears completely from successive generations.)*

Sample Pedigree for an Autosomal Recessive Disorder
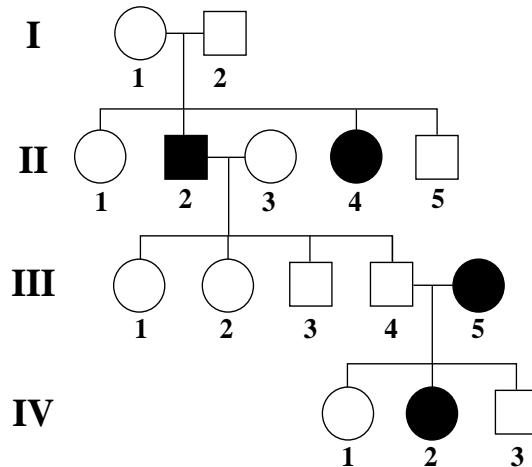
Labelling of this pedigree should indicate the following evidence:
This pedigree does not show any evidence that males or females inherit the disease more often, so there is no evidence that it is sex-linked. The first generation (parents) do not have the disorder but two of their children have the disorder. This indicates that it is a recessive disorder which is not expressed in the parents who are carriers of the disease allele.

Sample Pedigree for an Sex-linked Recessive Disorder
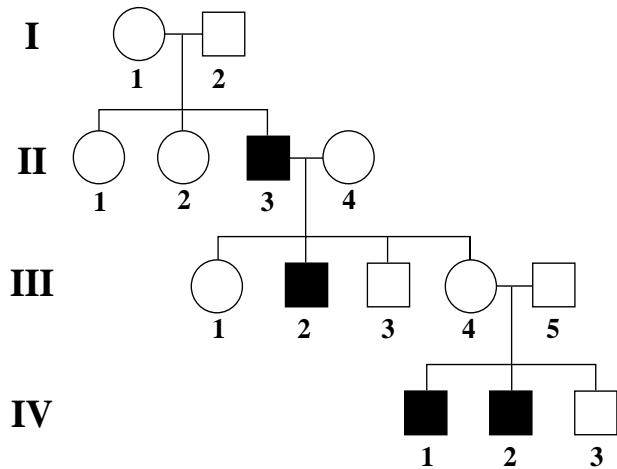
Labelling of the pedigree should indicate the following evidence:
This pedigree shows evidence that males inherit the disorder more often than females. This is consistent with a disease allele that is carried on the X chromosome. It is recessive since II-3 does not pass on the disease to any of his daughters, even though they would have a copy of his X chromosome with the disease allele.

Collection of Fetal Cells

Chorionic villus sampling *(CVS) can be used to obtain fetal cells. In this procedure a catheter is inserted through the cervix to the chorion and a sample of the chorionic villi is obtained. These cells are fetal cells.*
or
Amniocentesis *can be used to obtain fetal cells. In this procedure a hollow needle is inserted through the abdominal wall into the amniotic cavity. Amniotic fluid and some sloughed off fetal cells are withdrawn.*

Risks/Benefits of Early Diagnosis

(One risk and one benefit from the list below.)
Benefits

The individual who has a disorder like ALD diagnosed early can use any treatments or lifestyle modifications that may alleviate the disease symptoms or progression, sooner.
or
Early fetal diagnosis could lead to abortion of an affected fetus with a disorder. This would decrease the cost to the society of treating a medical disorder.
or
Any other reasonable benefit to society or the individual.

Risks

An individual who has a disorder like ALD diagnosed early will have to live with the knowledge of their inheritance of a progressively degenerative disease before the onset of any symptoms. This could cause increased stress.
or
Early diagnosis of disorders like ALD may be used inappropriately by outside sources if the diagnosis is not kept in confidence. This would harm society if it led to discrimination against these individuals, and therefore threatened the common good.
or
Any other reasonable risk to society or the individual.

Science

Score	Scoring Criteria **The student…**
5 **Excellent**	• clearly explains the effect of myelin degeneration on the CNS that results in ALD symptoms related to impaired brain function. • identifies an adrenal hormone and clearly describes the symptoms resulting from a decreased secretion of this hormone. • clearly describes two pieces of evidence used to determine the mode of inheritance illustrated by a pedigree. • draws an accurate four generation pedigree chart that clearly illustrates the mode of inheritance selected and labels the evidence.
4 **Proficient**	• explains the effect of myelin degeneration on the CNS. • identifies an adrenal hormone and describes some of the symptoms resulting from a decreased secretion of this hormone. • clearly describes one piece of evidence and suggest one piece of evidence used to determine the mode of inheritance illustrated by a pedigree. • draws a four generation pedigree chart that could illustrate the mode of inheritance selected.
3 **Satisfactory**	• partially explains the effect of myelin degeneration. • identifies an adrenal hormone and describes one of the symptoms resulting from a decreased secretion of this hormone. • describes one piece of evidence used to determine the mode of inheritance illustrated by a pedigree **or** suggests two pieces of evidence. • draws a partially correct pedigree chart that could illustrate either autosomal recessive or X-linked inheritance.
2 **Limited**	• describes the function of the neuron or a part of the neuron. • identifies an adrenal gland hormone **or** describes the function of this hormone **or** describes one symptom of decreased secretion of an adrenal hormone. • partially describes one piece of evidence used to determine the mode of inheritance illustrated by a pedigree. • draws a partial pedigree chart.
1 **Poor**	• addresses only one of the four scoring bullets at 2, 3, or 4 level.

INSUFFICIENT is a special category. It is not an indication of quality. It should be assigned to papers that do not contain a discernible attempt to address the questions presented in the assignment or that are too brief to assess in this or any other scoring category.

Technology and Society

Score	Scoring Criteria
	The student…
5 **Excellent**	• identifies either amniocentesis or CVS **and** clearly describes the technology. • clearly describes a risk **and** a benefit of early diagnosis of ALD to an individual and/or to society.
4 **Proficient**	• identifies either amniocentesis or CVS **and** partially describes the technology. • clearly describes a risk or a benefit **and** partially describes another risk or benefit of early diagnosis of ALD.
3 **Satisfactory**	• identifies either amniocentesis or CVS **or** partially describes one of the two technologies. • clearly describes either a risk **or** a benefit of early diagnosis of ALD **or** partially describes both a risk and a benefit.
2 **Limited**	• identifies **or** describes a technology that may have been used in genetic screening or ALD research. • partially describes a risk or a benefit of early diagnosis of ALD **or** describes a risk or a benefit of the ALD disorder or of research into the ALD disorder.
1 **Poor**	• addresses one of the two scoring bullets at a 2 level.

INSUFFICIENT is a special category. It is not an indication of quality. It should be assigned to papers that do not contain a discernible attempt to address the questions presented in the assignment or that are too brief to assess in this or any other scoring category.