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*June 1996*

# ***Biology 30***

## ***Grade 12 Diploma Examination***

### ***Description***

Time: 2.5 h. 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
- 80 total possible marks worth 100% of the examination

This examination contains sets of related questions.

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

When required, a grey bar is used to indicate the end of a set.

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

The blank 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***

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- 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. chemistry
- D. science

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 three significant digits in the numerical-response section of the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
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<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is \_\_\_\_\_.  
(Record all four digits in the numerical-response section of the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet →

3	2	1	4
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○

### Selection Question and Solution

The birds in the following list are numbered \_\_\_\_\_.  
(Record your answer in ascending numerical order in the numerical-response section of the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

Record 245 on the answer sheet →

2	4	5	
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○
○	○	○	○

### Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

Nervous and endocrine systems maintain internal equilibrium while humans interact with their external environment. The study of disease processes has helped extend our knowledge of these systems.

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

Multiple sclerosis (MS) is a disorder that causes the destruction of myelin sheaths surrounding neurons. People with MS display many symptoms, including slurred speech, double vision, and poor muscle coordination.

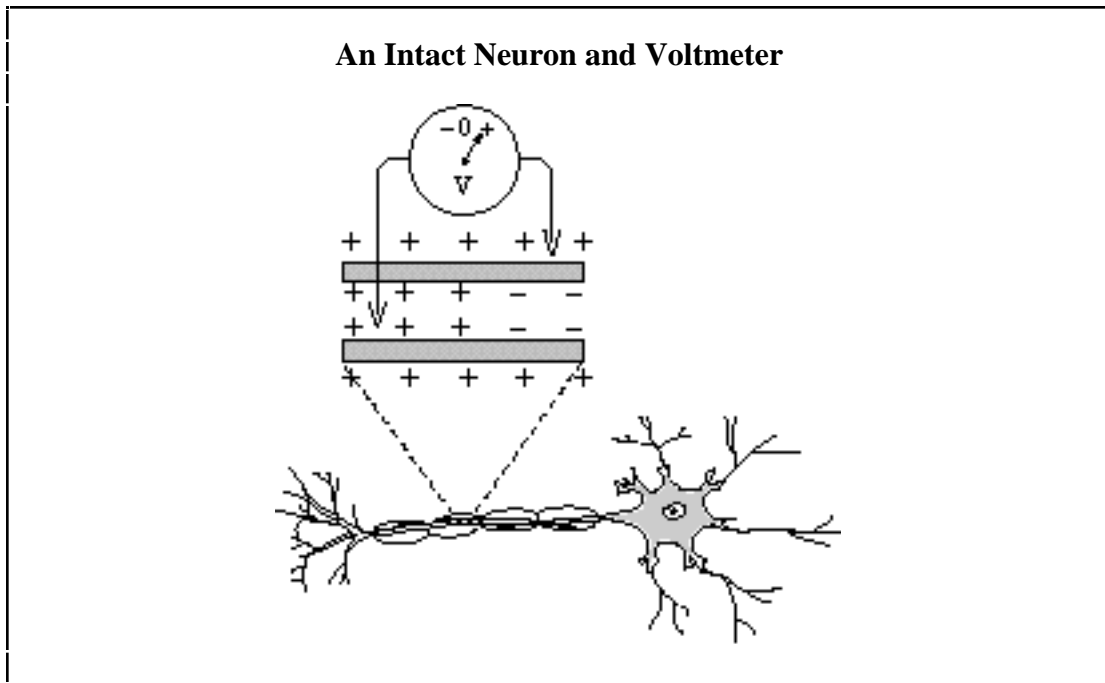
1. What is the direct effect of MS on nerve impulse transmission?
    - A. Dendrites cannot be stimulated by acetylcholine, therefore impulses are not generated in neurons.
    - B. Axons cannot secrete acetylcholine, therefore impulses are not able to travel across synapses.
    - C. The threshold level of stimulation for neurons is greater than normal.
    - D. The movement of impulses along neurons is slower than normal.
- 

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

Alzheimer's disease is associated with the deterioration of memory and mental capacity due to decreased production of acetylcholine and loss of up to three-quarters of the neurons in parts of the brain.

2. Which phase of impulse transmission would be lacking in a person with Alzheimer's disease?
  - A. Restoration of polarity in neurons
  - B. Excitation of postsynaptic neurons
  - C. Maintenance of resting potentials in neurons
  - D. Active transport of sodium and potassium in neurons

Use the following information to answer the next question.



3. The voltage polarity is positive when
- A. the neuron is resting
  - B. an impulse is being transmitted
  - C. an impulse dies out before reaching the axon
  - D. the neuron has a high concentration of  $K^+$  ions

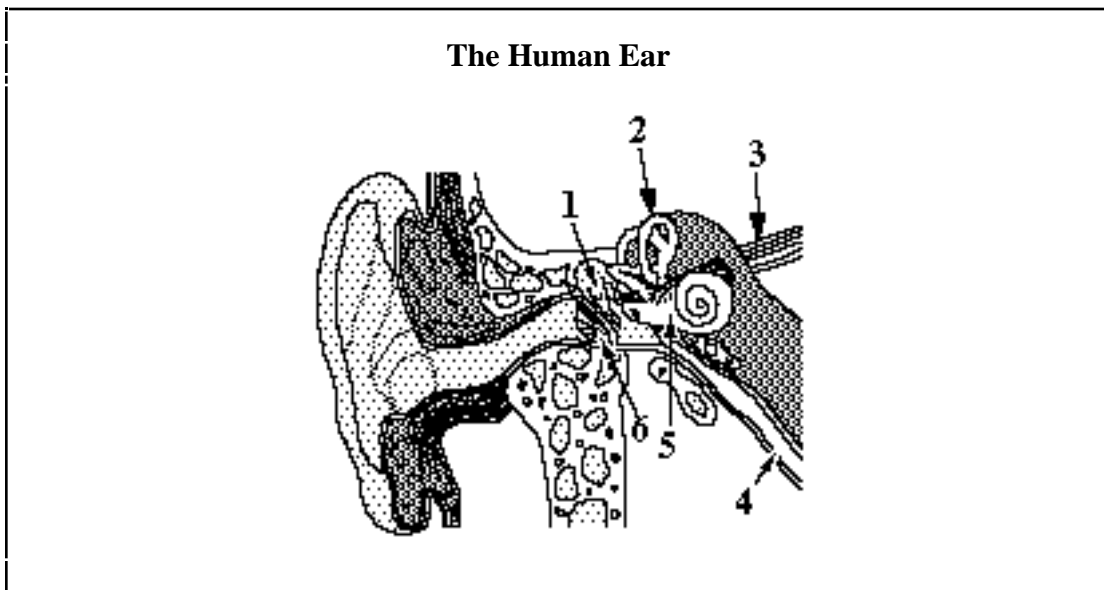
*Use the following information to answer the next two questions.*

The tips of fingers are sensitive enough to discriminate raised points on a surface, as well as the locations of these points. Knowing this, in the 19th century Louis Braille invented the Braille system of reading for the blind. Each letter of a language alphabet is represented by up to six raised dots. A blind person who has learned the Braille system can read up to 50 words a minute.

4. Would a person preparing Braille script have to know if the blind reader was left- or right-handed, and thus change the order of the script accordingly?
- A. No, because the sensations from both the right and left hand are carried by the spinal cord into the same hemisphere of the cerebrum.
  - B. No, because the sensations received separately by the left and right cerebral hemispheres from the right and left hands are integrated before they are interpreted into language.
  - C. Yes, because the sensations from the right and left hands are carried to the left and right cerebral hemispheres respectively, and therefore the information is interpreted in reverse order.
  - D. Yes, because the movements of the right and left hands are initiated by opposite sides of the cerebral cortex.
5. This sentence can be read using the eyes, but it could also be read using the fingertips if the sentence was printed in Braille. This fact **illustrates** that
- A. the brain can form the same meaning from different sensations
  - B. nerve impulses initiated by touch are identical to the nerve impulses initiated by sight
  - C. receptors for touch and receptors for sight respond to the same environmental stimuli
  - D. the lobe of the brain that receives sensations from the eyes is the same as the lobe that receives sensations from the fingers

6. Which is a correct description of some sensory receptors in the eye?
- A. Rods are concentrated in the fovea of the retina and function well in dim light.
  - B. Cones are concentrated near the periphery of the retina and function well in dim light.
  - C. Cones are concentrated in the fovea of the retina and function to detect colours.
  - D. Rods are concentrated near the periphery of the retina and function to detect colours.

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



7. The detection of rotation of the head and the equalization of air pressure between the external environment and the middle ear are, respectively, functions of structures
- A. 1 and 3
  - B. 1 and 4
  - C. 2 and 3
  - D. 2 and 4



8. In humans, ADH and oxytocin can have similar effects. Therefore, a correct inference is that an increase in the concentration of ADH in the blood may result in
- A. increased urine volume
  - B. decreased metabolic rate
  - C. increased contraction of uterine muscle
  - D. decreased release of milk from the breasts

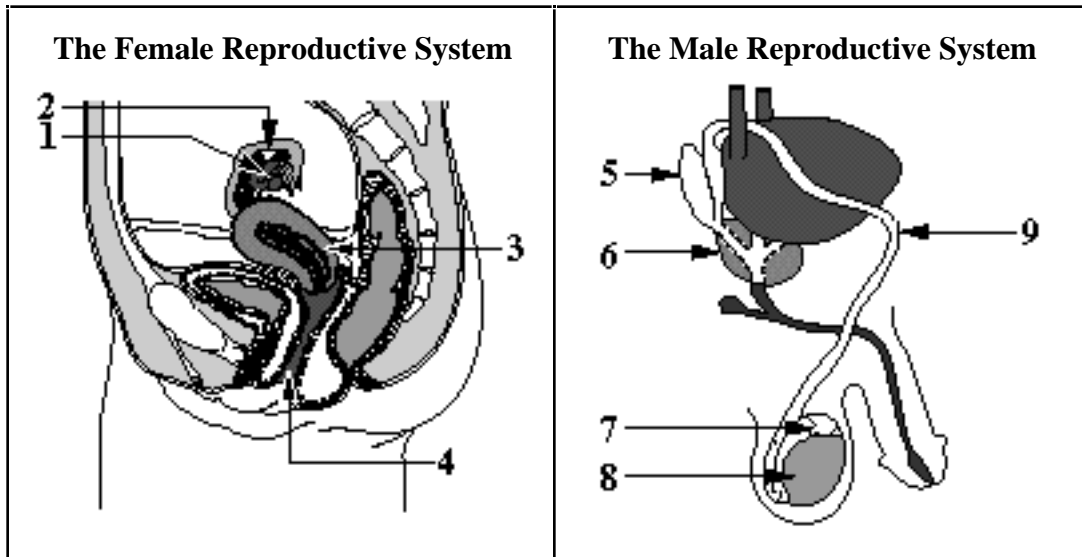
*Use the following information to answer the next three questions.*

Vegetables such as cabbage, rutabaga, and turnips contain goitrin, a substance that inhibits iodine uptake by the body.

9. A person with a diet high in vegetables containing goitrin may gain weight fairly rapidly. A possible explanation for this weight gain would be
- A. increased protein metabolism
  - B. decreased blood sugar levels
  - C. increased glycogen release
  - D. decreased metabolic rate
10. The function of which gland would be **most** affected by goitrin?
- A. Anterior pituitary
  - B. Adrenal cortex
  - C. Pancreas
  - D. Thyroid
11. An increase in goitrin consumption would likely cause a person to experience increased
- A. fatigue
  - B. heart rate
  - C. breathing rate
  - D. urine production

Reproductive processes may be affected by disease, the environment, or the use of technology.

Use the following diagrams to answer the next question.



**Numerical Response**

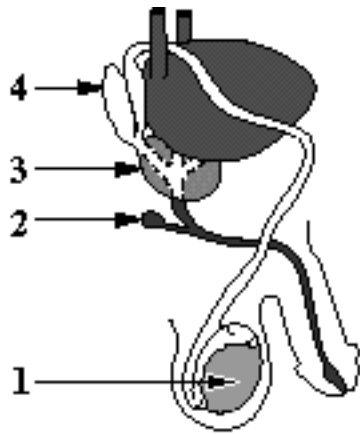
1. Choose the correct number for the reproductive structure where each of the functions described below occurs.

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

**Reproductive  
Structure:**

**Function:**                                                                  
                           Spermatogenesis      Oogenesis      Fertilization      Implantation

Use the following information to answer the next two questions.

<b>Prostate Cancer</b>	<b>The Male Reproductive System</b>
<p>Treatment for prostate cancer may include radiation, drug therapy, or surgical removal of the gland. Cancerous growth of the prostate is stimulated by testosterone and inhibited by estrogen. Early detection and treatment often prevent the spread of this type of cancer.</p>	

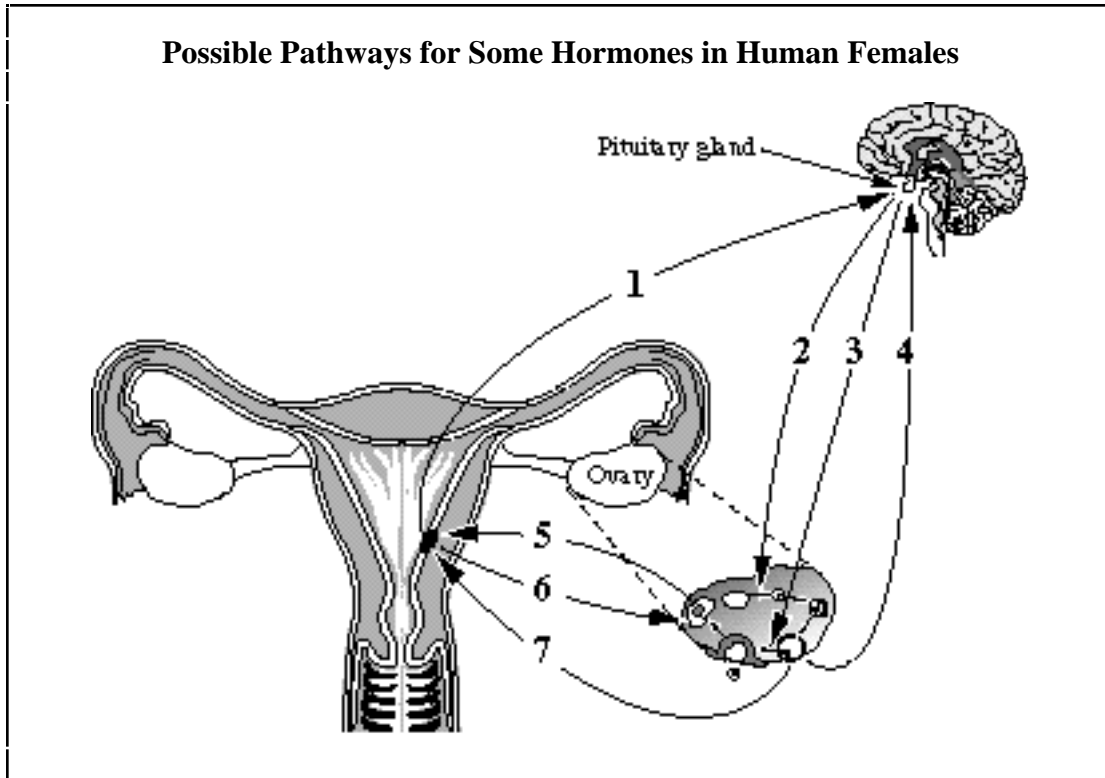
12. Which structure in the diagram is the prostate gland?

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

13. A symptom of an enlarged prostate gland may be

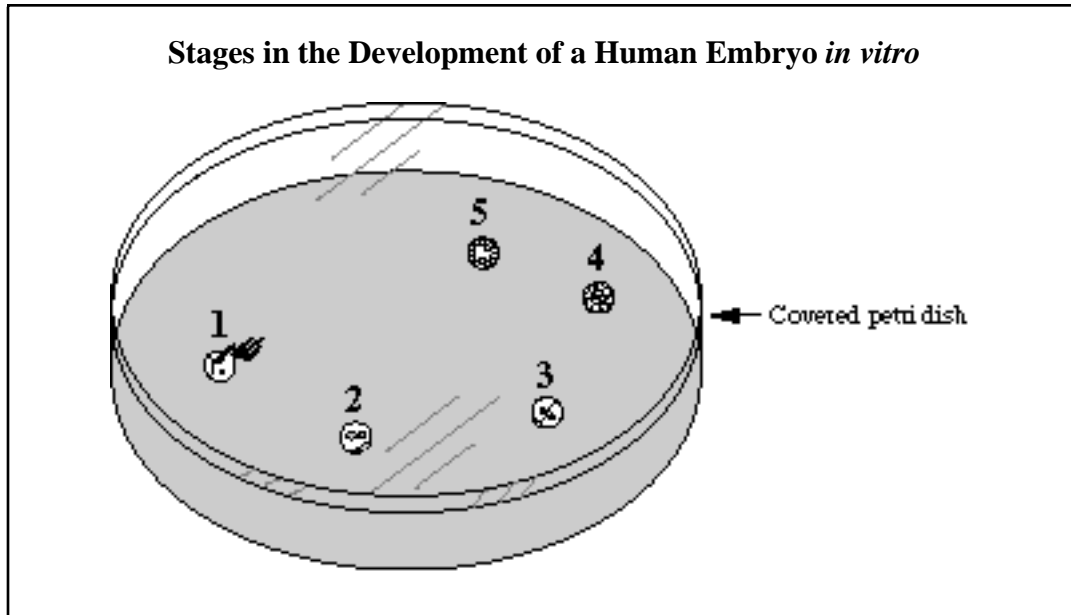
- A. enlarged testes
- B. abdominal pain
- C. reduced urine flow
- D. decreased sperm production

Use the following information to answer the next two questions.



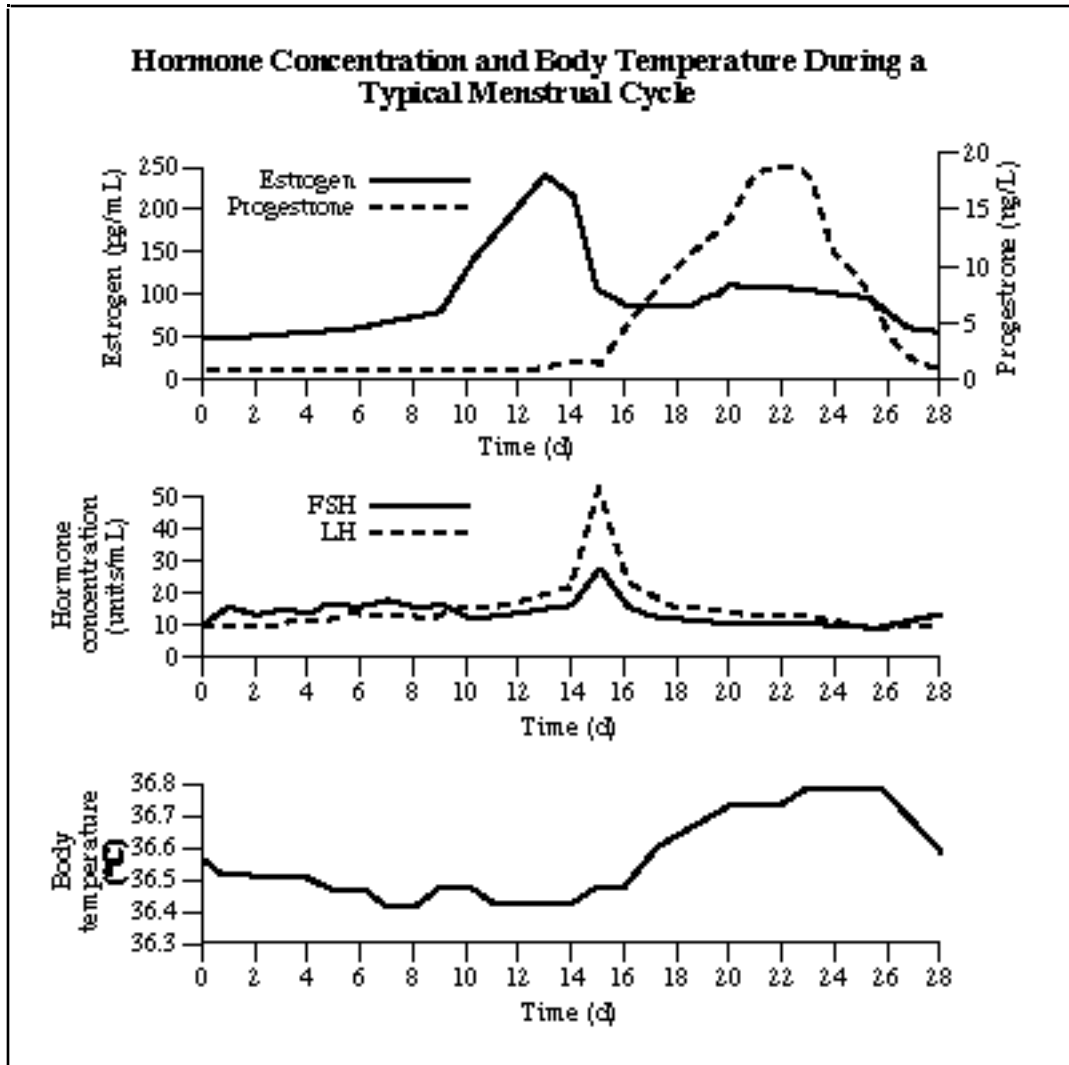
14. During a normal menstrual cycle, FSH production is inhibited when high levels of estrogen travel along pathway
- A. 1
  - B. 4
  - C. 5
  - D. 7
15. Pathway 6 likely represents the pathway followed by
- A. pituitary gonadotropins
  - B. chorionic gonadotropin
  - C. oxytocin
  - D. relaxin

Use the following information to answer the next question.



16. Medical geneticists are able to remove one cell from the structure shown at stage 4 and test it for the presence of the recessive gene for cystic fibrosis. If the cell is found to carry both genes, then the pre-embryo could potentially be altered by gene therapy. Gene therapy is likely used at this early stage of development because
- A. mitosis has not yet occurred
  - B. extra embryonic membranes are forming
  - C. meiosis during later stages may cause genetic variation
  - D. cell differentiation and tissue formation have not yet occurred

Use the following information to answer the next two questions.



17. Based on the data, a possible inference is that
- A. body temperature is highest during ovulation
  - B. body temperature is lowest during menstruation
  - C. increased estrogen concentrations cause increased body temperature
  - D. increased progesterone concentrations cause increased body temperature

**18.** Over time, which **sequence** would result from the administration of large doses of synthetic estrogen and progesterone to a female?

- A.** Reduction of FSH and LH secretion    no follicle development  
no ovulation
  - B.** Reduction of FSH and LH secretion    no ovulation  
no follicle development
  - C.** No follicle development    no ovulation    reduction of  
FSH and LH secretion
  - D.** No follicle development    reduction of FSH and LH secretion  
no ovulation
- 

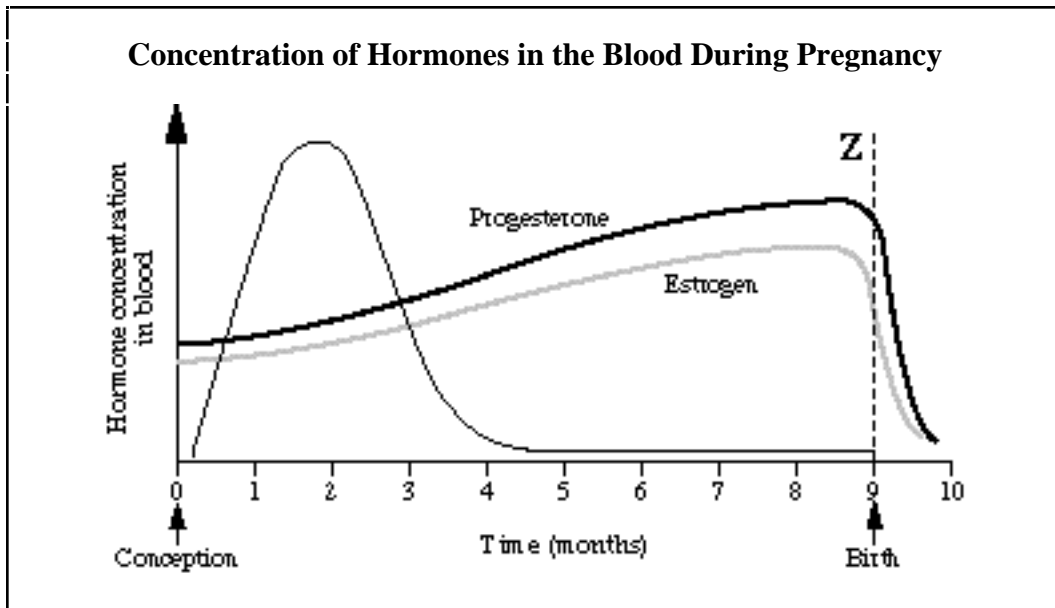
**19.** Compared with cow's milk, human's milk is more advantageous to a child because human's milk contains a useful source of

- A.** lipids
- B.** calcium
- C.** antibodies
- D.** lactose sugar

**20.** At the onset of labour, strong uterine contractions are initiated by increased levels of

- A.** oxytocin, which is released by the pituitary gland
- B.** HCG, which is released by the pituitary gland
- C.** oxytocin, which is secreted by the placenta
- D.** HCG, which is secreted by the placenta

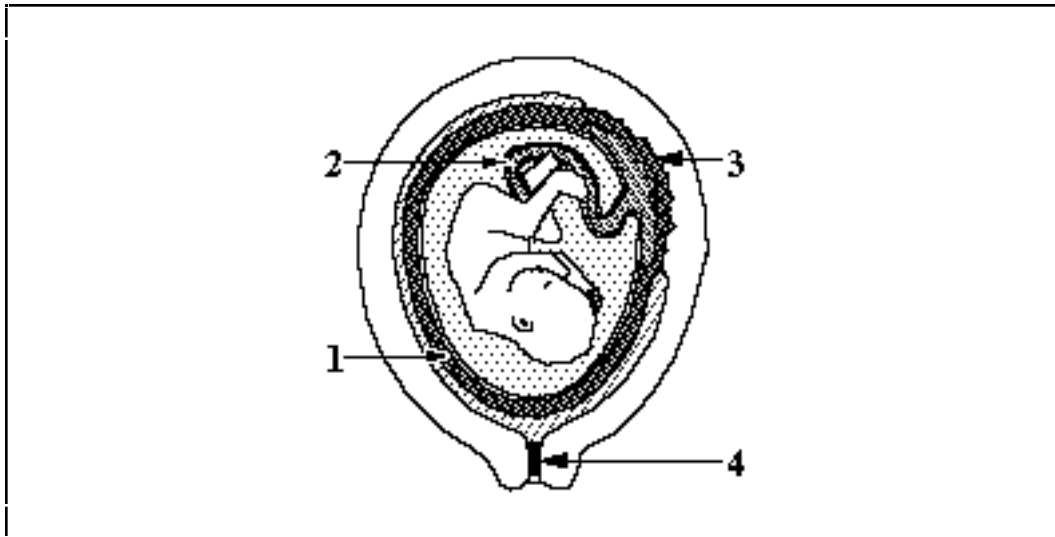
Use the following information to answer the next question.



21. Why do the levels of estrogen and progesterone fall rapidly after time Z?
- A. The pituitary is inactive during birth.
  - B. The ovaries are inactive during birth.
  - C. During pregnancy, these hormones are produced by the fetus, which is absent after birth.
  - D. During pregnancy, these hormones are produced by the placenta, which is absent after birth.



Use the following diagram to answer the next question.



22. If a physician performed an amniocentesis during pregnancy, the hypodermic needle used to obtain a sample of fetal cells would have to penetrate structure
- A. 1
  - B. 2
  - C. 3
  - D. 4
- 

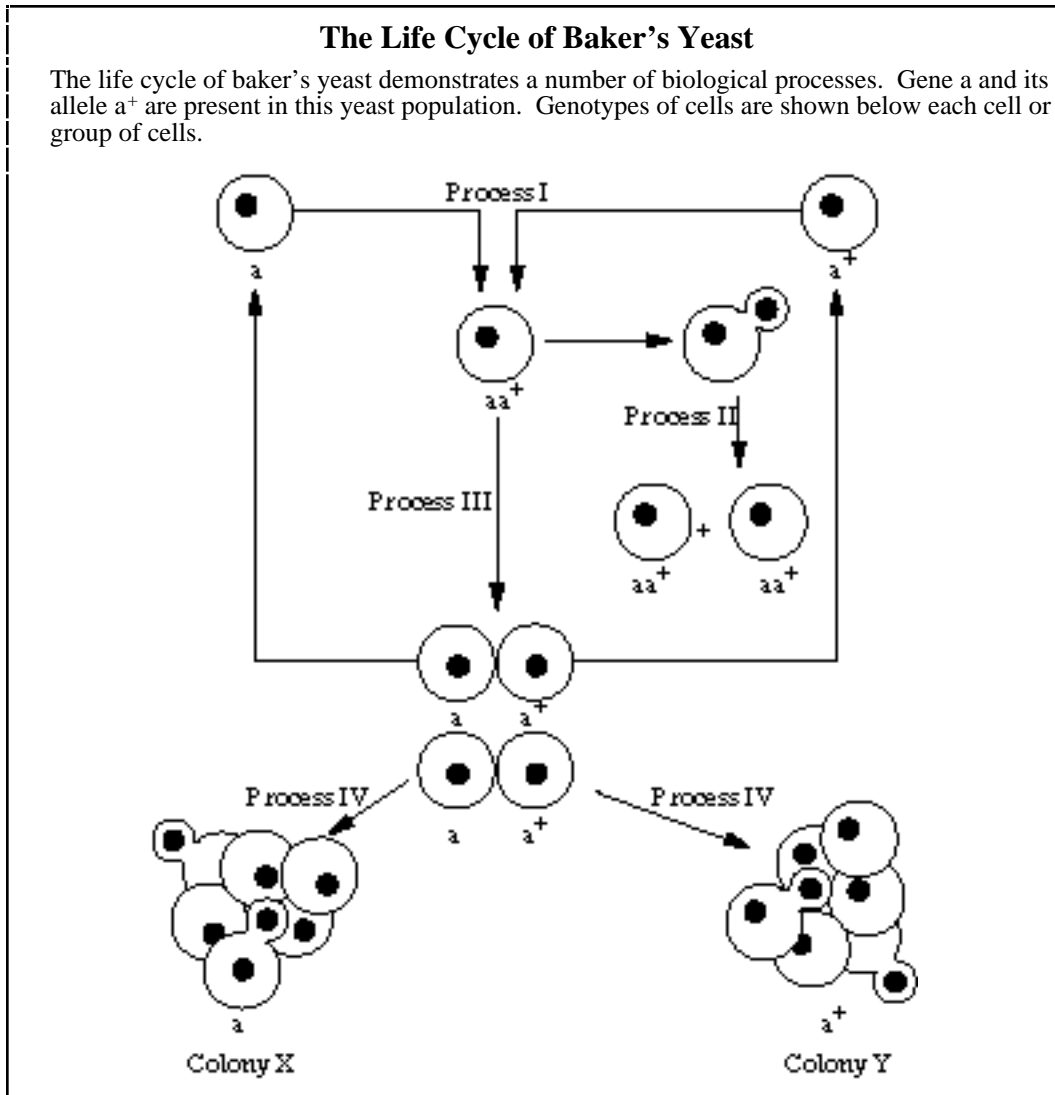
Use the following information to answer the next question.

Chorionic villus sampling (CVS) is used to test for genetic disorders in the fetus and can be performed early in gestation (8–10 wks). The recommended method of CVS is to insert a probe with a needle on the end through the cervix and remove a small sample of the chorionic villi to be analyzed.

23. Which is a correct description of chorionic villi?
- A. They form part of the placenta.
  - B. They are developed from the endometrium.
  - C. They are found in the digestive tract of the fetus.
  - D. They contain cells whose nuclei differ genetically from cells of the fetus.

The study of cell division, chromosome composition, and the structure and function of DNA increases understanding of growth, genetic continuity, and diversity of organisms.

Use the following information to answer the three next questions.



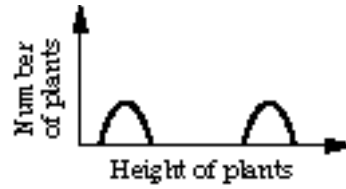
24. Which row correctly identifies processes I, II, III, and IV?

Row	Process			
	I	II	III	IV
A	fusion	mitosis	meiosis	mitosis
B	fusion	meiosis	mitosis	mitosis
C	fission	meiosis	mitosis	meiosis
D	fission	mitosis	meiosis	meiosis

25. Processes **II** and **IV** illustrate budding. The information in the diagram indicates that budding is a type of
- A. asexual reproduction that produces haploid or diploid cells
  - B. asexual reproduction that produces diploid cells
  - C. sexual reproduction that produces haploid or diploid cells
  - D. sexual reproduction that produces haploid cells
26. Which genetic principle is **best** demonstrated by process **III**?
- A. Dominance
  - B. Segregation
  - C. Crossing-over
  - D. Incomplete dominance

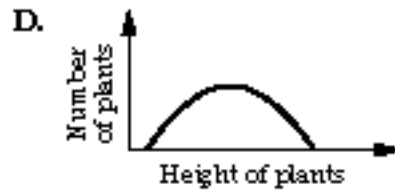
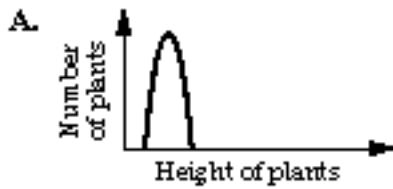
Use the following information to answer the next question.

When conducting his research into the genetics of pea plants, Gregor Mendel crossed true-breeding, tall pea plants with true-breeding, short pea plants.



The offspring of this  $P_1$  generation, the  $F_1$  generation, were interbred and produced the  $F_2$  generation. The height of each plant in the  $F_1$  and the  $F_2$  generations was recorded.

27. In pea plants, if tall is dominant over short, which graph best represents the expected distribution of offspring in the  $F_2$  generation?



Use the following information to answer the next question.

Mendel also found that in peas, yellow seeds (Y) are dominant over green seeds (y), and round seed shape (R) is dominant over wrinkled seed shape (r). The alleles for these traits are located on **independent** chromosomes.

### Numerical Response

2. When a YyRr parent and a YYrr parent are crossed, what percentage of their offspring are expected to have yellow seed-coat colour and wrinkled seed shape?

(Record your **answer** in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_ %

---

Use the following information to answer the next question.

In his work with the fruit fly (*Drosophila*), Thomas Morgan bred normal red-eyed female flies with white-eyed males. He bred enough flies to have acceptable statistical significance and reliability. The F<sub>1</sub> generation were all red-eyed. All the females of the F<sub>2</sub> generation had red eyes, but one-half of the males of the F<sub>2</sub> generation had white eyes.

28. A conclusion that may be drawn from Morgan's work is that the gene for white eyes is located on the
- A. Y chromosome and is recessive
  - B. Y chromosome and is dominant
  - C. X chromosome and is recessive
  - D. X chromosome and is dominant

Use the following information to answer the next question.

In *Drosophila*, the genes for eye colour (pr), wing shape (vg), and body colour (eb) are all found on the same chromosome. The following crossover frequencies for these genes were determined by experimentation.

Genes	Crossover Frequency
pr and vg	12.5%
pr and eb	6.0%
vg and eb	18.5%

29. Which is the correct sequence of the genes pr, vg, and eb on the chromosome?
- A. pr–vg–eb
  - B. vg–eb–pr
  - C. eb–pr–vg
  - D. eb–vg–pr
- 

Use the following information to answer the next question.

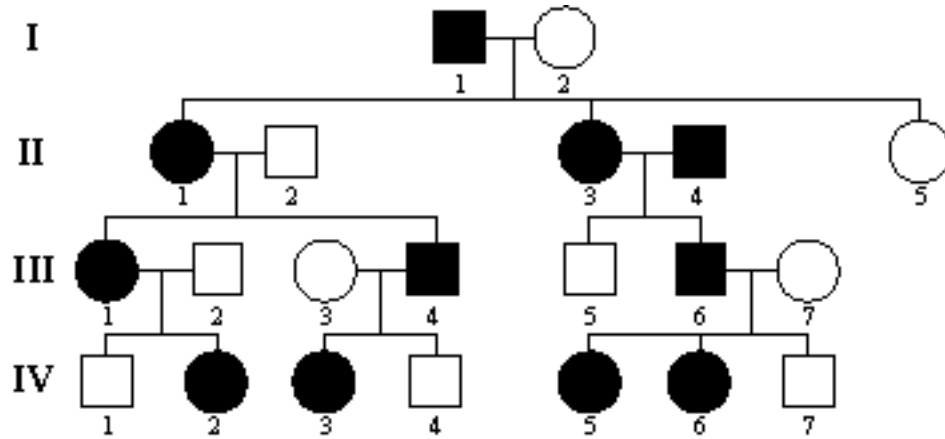
A homozygous, brown-bodied female *Drosophila* and a black-bodied male *Drosophila* were introduced into a natural habitat. After 20 generations of random mating, the resulting population of 10 000 flies is in Hardy-Weinberg equilibrium. Some of the population have the brown body colour. The remainder have the autosomal-recessive black body colour.

30. In this population, the expected allele frequency for brown body colour was 0.50, but the actual frequency is 0.60. Since these frequencies do not match, one might conclude that the phenotype controlled by the
- A. recessive allele has a naturally selected advantage
  - B. dominant allele has a naturally selected advantage
  - C. recessive allele has an artificially selected advantage
  - D. dominant allele has an artificially selected advantage

Use the following information to answer the next two questions.

### A Pedigree Showing the Incidence of Opalescent Dentin in a Family

This pedigree shows the incidence of opalescent dentin in a family. People with this trait have insufficient enamel on their teeth. The dentin inside the teeth shows through, giving the teeth a mottled, pearl-like appearance.



31. The pedigree indicates that the trait for opalescent dentin is controlled by a gene that is
- X-linked
  - recessive
  - dominant
  - codominant

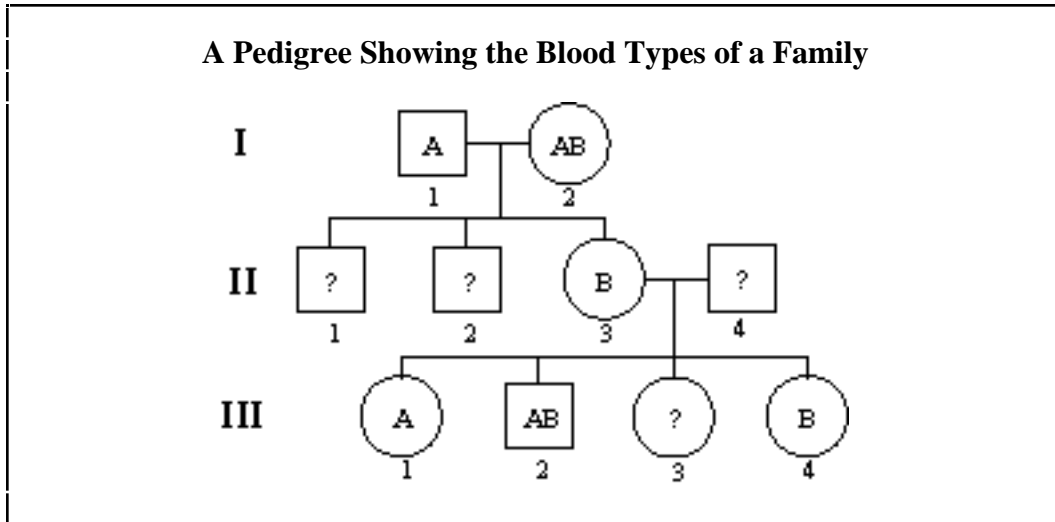
### Numerical Response

3. If individual **III 1** and individual **III 2** had another child, what is the probability that this child would be a **female with opalescent dentin**?

(Record your **answer as a value from 0 to 1**, rounded to two decimal places, in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_

Use the following information to answer the next two questions.



32. Which row provides correct information about the genotypes for individuals **I 1**, **II 1**, and **II 4**?

Row	Individual I 1	Individual II 1	Individual II 4
A	$I^A i$	$I^A I^A$ or $I^A i$	$ii$
B	$I^A I^A$	$I^A I^A$ or $I^A i$	$I^A i$
C	$I^A i$	$I^A I^A$ or $I^A i$ or $I^A I^B$ or $I^B i$	$I^A i$
D	$I^A I^A$	$I^A I^A$ or $I^A i$ or $I^A I^B$ or $I^B i$	$ii$

33. Which row correctly shows the probability of individuals **II 2** and **III 3** having type O blood?

Row	Probability of individual II 2 having type O blood	Probability of individual III 3 having type O blood
A	0.00	0.00
B	0.00	0.25
C	0.25	0.00
D	0.25	0.25



34. Protanopia, or red colour blindness, is a recessive X-linked characteristic. A woman with normal colour vision who carries the allele for red colour blindness and a man who is red colour-blind are expecting a child. Which statement about the child is likely correct?
- A. If the child is a boy, there is a 100% chance that he will be colour-blind.
  - B. If the child is a girl, there is a 100% chance that she will not be colour-blind.
  - C. There is a 25% chance that the child will be colour-blind.
  - D. There is a 50% chance that the child will be colour-blind.

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

The ability to taste the chemical phenylthiocarbamide (PTC) is controlled by the dominant allele  $T$ . Individuals who have the allele  $T$  find that PTC tastes bitter. Homozygous recessive individuals find that PTC has no taste. In a sample of 320 people, 218 could taste PTC and 102 could not taste PTC.

35. Which row provides the probable percentage of this population with each genotype indicated?

	<b>Genotype</b>		
<b>Row</b>	<b><math>TT</math></b>	<b><math>Tt</math></b>	<b><math>tt</math></b>
<b>A</b>	15%	29%	56%
<b>B</b>	44%	37%	19%
<b>C</b>	19%	49%	32%
<b>D</b>	23%	45%	32%

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

A plant breeder was trying to produce a true-breeding variety of radishes with an oval shape. However, each time plants with oval radishes were self-fertilized, only half of the offspring were oval. The rest of the plants produced either round or long radishes.

36. What would be the expected phenotype ratio if plants with round radishes were crossed with plants with oval radishes?
- A. All round
  - B. All oval
  - C. 1 round : 1 oval
  - D. 1 round : 1 long

Use the following information to answer the next question.

In guinea pigs, black coat (B) is dominant over white coat (b), and straight hair (S) is dominant over curly hair (s). Each pair of alleles assort independently.

Two guinea pigs were crossed. The gametes produced by the parents are shown in the Punnett square.

♀ ♂	BS	Bs	bS	bs
Bs				
bs				

Note: ♂ Male  
♀ Female

**Numerical Response**

4. What was the phenotypic **ratio** of the offspring (including all eight possible genotypes) produced by the parents?

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

**Answer:** \_\_\_\_\_  
 black-straight      black-curly      white-straight      white-curly  
 \_\_\_\_\_

Use the following information to answer the next question.

In some cattle, coat colour and pattern is controlled by an autosomal gene locus that may contain one of four alleles. The dominance hierarchy for these alleles is

$$S \text{ (Dutch belt)} > s^h \text{ (Hereford)} > s^c \text{ (Solid)} > s \text{ (Holstein)}$$

**Numerical Response**

5. A Dutch belt bull carrying the allele for Hereford was crossed with a pure-breeding Holstein cow. What is the probability that the offspring would be a Hereford?

(Record your **answer as a value from 0 to 1**, rounded to two decimal places, in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_

## Numerical Response

6. Snapdragons may be tall or short, and they may be red, white, or pink. The allele for short is recessive and the alleles for colour display incomplete dominance. A plant, heterozygous for both traits, was self-pollinated and produced 200 offspring. How many of these 200 offspring would be expected to be both tall and pink?

(Record your **answer** in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_ plants

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

When a gene that directs cells of the human anterior pituitary to synthesize HGH is transplanted into bacteria, it will cause the bacteria also to synthesize HGH. This HGH can be used to treat slowed skeletal growth in children.

37. The phenomenon described illustrates that
- A. gene therapy can be used to cure inherited diseases in humans
  - B. DNA is a universal language that can be read by all organisms
  - C. bacteria, like humans, use insulin to regulate their sugar metabolism
  - D. humans have acquired some bacterial genetic traits through symbiotic relationships

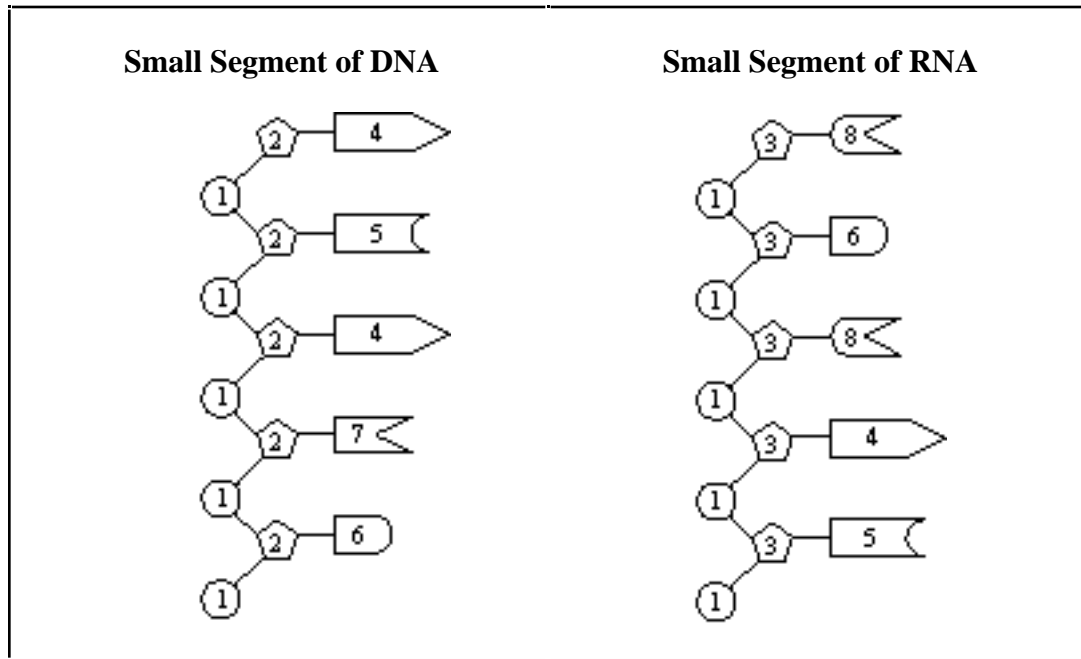
*Use the following information to answer the next question.*

### Some Events that Occur in a Cell During the Manufacture of Proteins

- 1 mRNA nucleotides are fused into a long chain
- 2 Amino acids join in a chain
- 3 Double helix of DNA uncoils
- 4 Polypeptide is released
- 5 tRNA anticodons match with mRNA codons
- 6 mRNA attaches to a ribosome

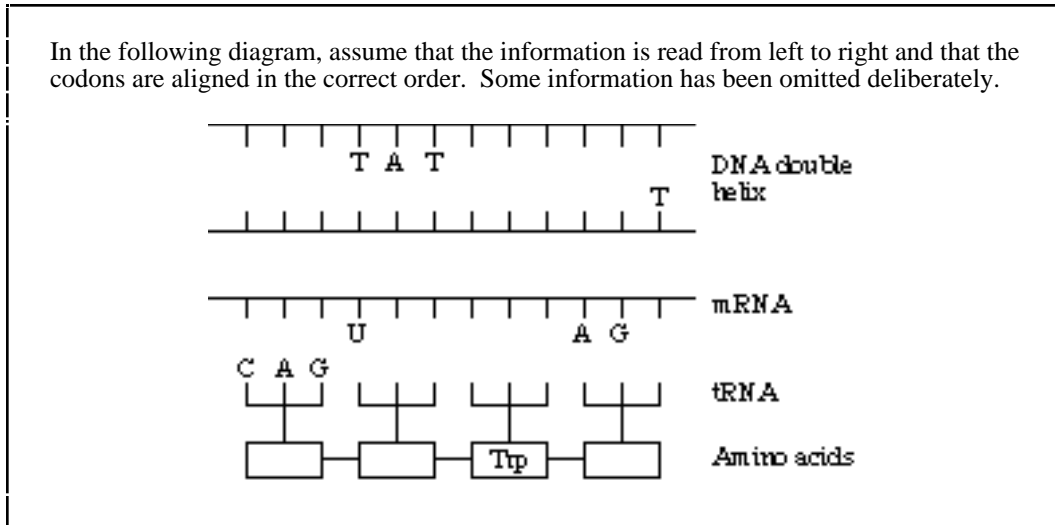
38. The sequence in which these events occur is
- A. 1, 3, 5, 6, 4, 2
  - B. 1, 3, 6, 5, 2, 4
  - C. 3, 1, 5, 6, 4, 2
  - D. 3, 1, 6, 5, 2, 4

Use the following information to answer the next two questions.



39. If structure 1, structure 3, and structure 8 were combined to form a molecule, it would be
- A. an amino acid
  - B. a nucleic acid
  - C. a uracil nucleotide
  - D. an adenine nucleotide
40. One likely result of a mutation could be the
- A. replication of the DNA segment
  - B. transcription of the RNA segment
  - C. replacement of structure 3 in the RNA segment with structure 2
  - D. replacement of structure 4 in the DNA segment with structure 7

Use the following information to answer the next two questions.



41. The first codon in the mRNA strand is
- A. CAG
  - B. GTC
  - C. CUG
  - D. GUC

Use this additional information to answer the next question.

Some Amino Acids	
1	Alanine
2	Arginine
3	Cysteine
4	Glycine
5	Isoleucine
6	Lysine
7	Phenylalanine
8	Serine
9	Threonine

### Numerical Response

7. The second codon in the DNA double helix is TAT. What is the amino acid coded by this triplet?

(Record your **answer** in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_

Populations determine the composition of communities and may reach equilibrium or change over time.

*Use the following information to answer the next three questions.*

<p>The peppered moth occurs in two “morphs”; that is, it may have one of two distinct forms. One morph is light and mottled (or light-peppered), and the other morph is black. The black morph’s colour is controlled by a dominant allele. A British naturalist performed an experiment on moth mortality. He released known numbers of marked black and light-peppered moths in unpolluted woodlands and in polluted, soot-blackened woodlands. He then recaptured a portion of the released moths. The following data were recorded.</p>		
	Light-peppered morph	Black morph
Unpolluted woodland		
Marked and released	496	476
Recaptured later	62	30
Percent recaptured	12.5%	6.3%
Soot-blackened woodland		
Marked and released	137	447
Recaptured later	18	?
Percent recaptured	13.1%	27.5%

42. Based on the data, a valid prediction is that within 100 years, the frequency of the dominant allele for body colour in a peppered moth population would likely
- become zero in soot-blackened woodlands
  - increase in soot-blackened woodlands
  - become zero in unpolluted woodlands
  - increase in unpolluted woodlands
43. Which is a correct interpretation of the data?
- Because of inheritance of a lethal gene, light-peppered morphs are more susceptible to predation than are black morphs.
  - Because of inheritance of a lethal gene, black morphs are more susceptible to predation than are light-peppered morphs.
  - Black morphs are more susceptible to predation in soot-blackened woodlands than are light-peppered morphs.
  - Light-peppered morphs are less susceptible to predation in unpolluted woodlands than are black morphs.

## Numerical Response

8. What is the actual number of black morph moths recaptured in the soot-blackened woodland?

(Record your **answer** in the numerical-response section of the answer sheet.)

**Answer:** \_\_\_\_\_ **moths**

\_\_\_\_\_

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

Symbiotic Relationships		
Relationship	Species 1	Species 2
I	+	-
II	+	0
III	+	+

**Note:** + means that the species benefits from the relationship  
- means that the species is harmed by the relationship  
0 means that the species shows no effect because of the relationship

44. Relationships **I**, **II**, and **III**, are called, respectively,
- A. commensalism, parasitism, and mutualism
  - B. mutualism, parasitism, and commensalism
  - C. parasitism, mutualism, and commensalism
  - D. parasitism, commensalism, and mutualism

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

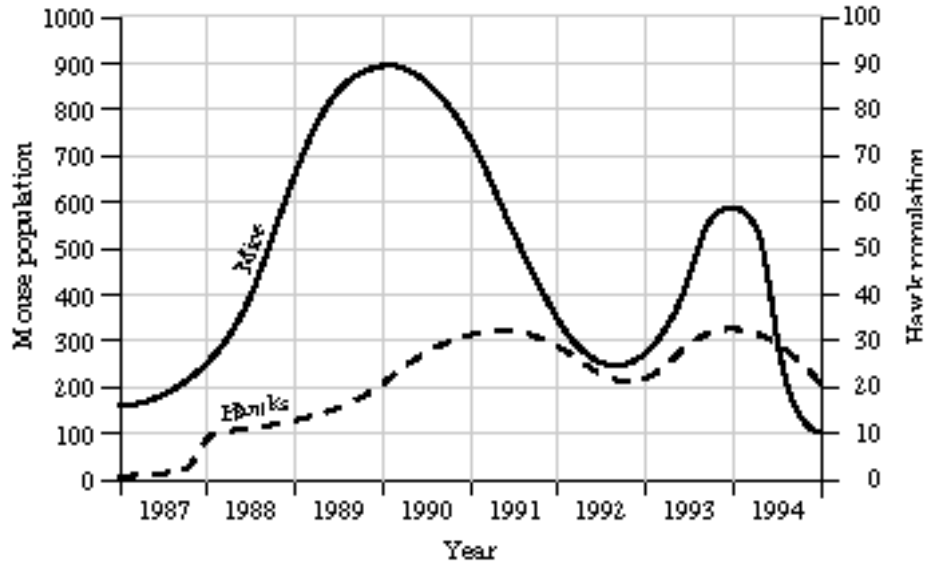
Many European species of cuckoos lay only a single egg in the nest of another species of bird. The cuckoo's egg closely matches the colour and size of the eggs of the host species.

45. The matching of the colour and size of a cuckoo's egg to the eggs of a host species is a good example of
- A. intraspecific competition
  - B. interspecific competition
  - C. camouflage
  - D. mimicry
- 
46. Under experimental conditions, when there are no limiting factors affecting their population growth, most bacteria will double their population size every 20 minutes. Under these conditions, the population exhibits its
- A. biotic potential
  - B. carrying capacity
  - C. density dependence
  - D. environmental resistance



Use the following information to answer the next question.

On a newly formed island, successful populations of grasses and a species of mouse appeared. Later, a species of hawk flew in. The hawk feeds on mice and fish. The population levels of mice and hawks are represented in the graph.



47. In 1991, the data for the mice indicates that
- A.  $r$  is positive because  $b < d$
  - B.  $r$  is positive because  $b > d$
  - C.  $r$  is negative because  $b < d$
  - D.  $r$  is negative because  $b > d$

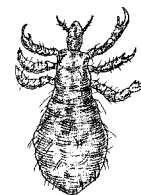
Use the following information to answer the next question.

Deer are very adaptable and have been invading many habitats in the western provinces of Canada. Some deer even live in wooded parks in towns and cities. Deer populations are increasing dramatically because, to protect their livestock, farmers have reduced the number of natural predators that feed on deer.

48. When deer move into wooded lots in some towns or cities, the size of the population in surrounding wilderness areas decreases. In this case, the main factor affecting the population size of deer in the wilderness areas is
- A. predation
  - B. emigration
  - C. competition
  - D. immigration

Millions of children from around the world are infested with lice and nits, the eggs of lice. Lice are tiny blood-sucking insects that live in the hair on the head or body. Different species of lice prefer different locations. Recently, the incidence of infestation by lice has increased dramatically among children in France and the United States.

To treat an infestation of lice, lotions that contain the insecticides **malathion** or **d-phenothrin** are applied to the head or body. Either insecticide can inhibit the action of cholinesterase in lice. Although factors such as the frequency, duration, or dosage of the application can influence the effectiveness of a treatment, it is suspected that lice have developed resistance to the insecticides in the lotions.



**A Louse**

Some researchers in France conducted two experiments to compare the effectiveness of lotions that contain either **malathion** or **d-phenothrin**.

**Experiment I**

**Procedure**

- Lotions were tested on three groups of body lice *Pediculus humanus humanus* that were raised under laboratory conditions using rabbits as hosts and treated as follows:
  - Group 1—immersed in 0.5% malathion lotion for 3 min
  - Group 2—immersed in 0.3% d-phenothrin lotion for 3 min
  - Group 3—not immersed in a lotion
- At time = 0 h, adults and nits from all three groups were counted, washed with water, dried, and incubated at 27°C.
- At time = 24 h, the number of surviving adult lice were counted. The number of lice hatched from nits and capable of sucking blood were also counted.

**Results**

**Number of Surviving Lice and Lice Hatched from Nits at 0 h and 24 h**

	Group 1 (malathion)		Group 2 (d-phenothrin)		Group 3 (untreated)	
	0 h	24 h	0 h	24 h	0 h	24 h
Nits	142	0	157	0	136	105
Adults	100	0	100	0	100	100

**Experiment II**

**Procedure**

- Lotions were tested on three groups of head lice *Pediculus humanus capitis* that were taken from the heads of elementary-school students from Paris.
- At time = 0 h, the lice were counted and treated as follows:
  - Group 4—immersed in 0.5% malathion lotion for 3 min
  - Group 5—immersed in 0.3% d-phenothrin lotion for 3 min
  - Group 6—not immersed in a lotion
- Survivors in each group were counted at time = 1 h, time = 2 h, and time = 24 h.

**Results**

**Number of Surviving Lice at Specific Times**

Time (h)	Group 4 (malathion)	Group 5 (d-phenothrin)	Group 6 (untreated)
0	357	416	320
1	0	376	298
2	0	364	289
24	0	82	44

**Written Response – 15% (12 marks)**

- 1.** a. Identify one fixed variable, one responding variable, and the manipulated variable in **experiment I**.

**(3 marks)**

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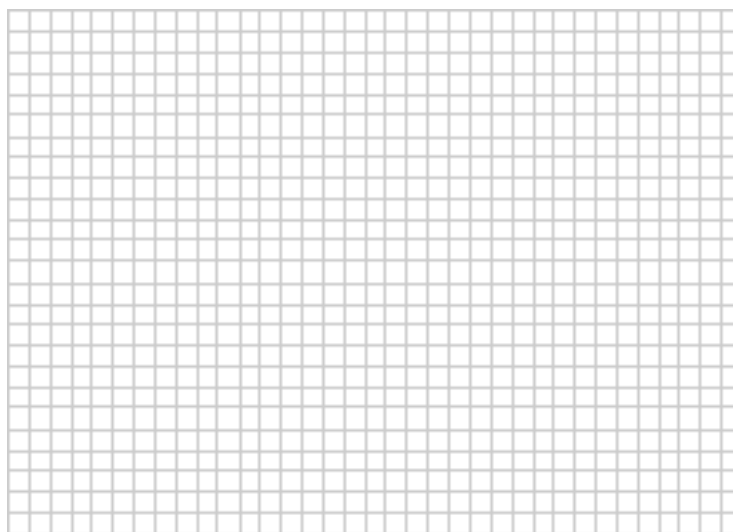
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- b. Prepare a line graph to illustrate the data collected in **experiment II**.

**(3 marks)**



(1 mark)

- c. Malathion is an effective insecticide because it can inhibit cholinesterase. Predict one physiological effect that malathion would have on neural transmission in treated lice.

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(1 mark)

- d. Identify the relationship that exists between lice and rabbits. Provide one explanation to support the relationship that you identify.

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(2 marks)

- e. The experimenters concluded that lice collected from school children have more resistance to insecticides than do lice raised in controlled laboratory conditions.

- i. What data, from the study, do you believe the experimenters used to conclude that the population of lice collected from school children was resistant to insecticides.

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- ii. Describe one possible cause of this increased resistance.

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(2 marks)

- f. Identify and explain two problems that make this a poor experiment.

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Use the following information to answer the next question.

The islets of Langerhans are small clusters of cells in the pancreas. They monitor and regulate blood glucose levels. In patients with type I *diabetes mellitus*, the islet cells no longer produce one of the major hormones necessary to control blood glucose levels. Until about 75 years ago, these patients died within months of the onset of the disease. Today, these patients are treated to control blood glucose levels, and they are able to live relatively normal lives. However, many of these patients eventually do suffer from diabetes-related disorders caused by abnormal fluctuations in blood glucose levels. These fluctuations can damage blood vessels and may result in blindness, kidney failure, and blood circulation problems in the feet and hands.

Recent research has focused on transplanting islet cells from a donor pancreas into a diabetic patient. The islet cell clusters are separated from other pancreatic cells and injected into the large vein that leads into the patient's liver. The clusters lodge in small blood vessels in the patient's liver and begin to produce hormones in response to changing blood glucose levels.

**Written Response – 15% (12 marks)**

2. • Identify the hormone lacking in a person with type I *diabetes mellitus*, and explain two physiological mechanisms by which this hormone regulates blood glucose levels. Draw a feedback loop that illustrates this regulation.
- Explain why successful islet cell transplants may prevent some of the physiological problems experienced by many patients with *diabetes mellitus*.
  - Describe two technological issues and one societal issue that researchers might have faced during the development of the islet cell transplant procedure.

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

## BIOLOGY DATA

## Symbols

Symbol	Description	Symbol	Description
$A$	area	$>$	greater than, dominant over
$B$	births during time interval	$<$	less than, recessive to
$b$	per capita births $(\frac{B}{N})$	$=$	equal to, codominant with, incompletely dominant with
$D$	deaths during time interval	$/$	divided by, "out of"
$d$	per capita deaths $(\frac{D}{N})$	$\times$	multiplied by, times, crossed with, mated with
$D_p$	population density		change
$K$	carrying capacity	$\sigma^{\text{♂}}$	male
$N$	population size	$\sigma^{\text{♀}}$	female
$\Delta N$	change in population size	$n$	chromosome number
$PG\%$	population growth (percent)	$I^A, I^B, i$	alleles (human blood type) ABO system ( $I^A = I^B, I^A > i, I^B > i$ )
$r$	per capita population growth rate ( $b - d$ )	$t$	time
$V$	volume	$\Delta t$	change in time

Fold and tear along perforation.

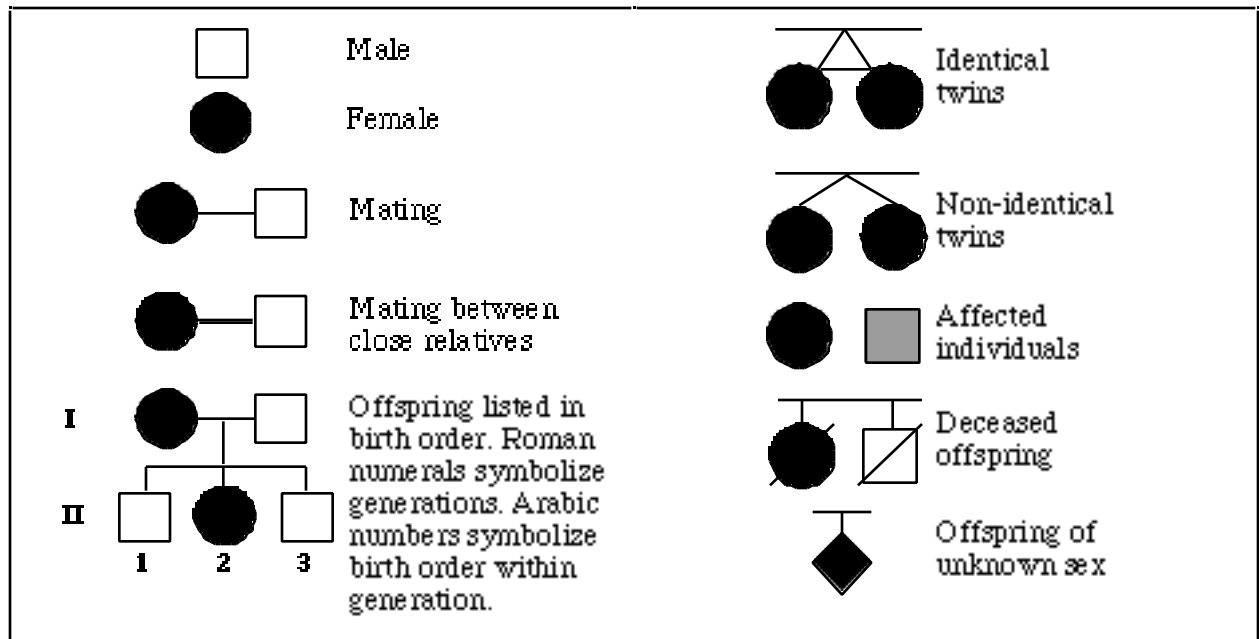
## Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{V}$ or $D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Population growth (%)	$PG\% = \frac{\Delta N \times 100\%}{N}$

### 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





**Messenger RNA Codons and Their Corresponding Amino Acids**

		S	E	C	O	N	D	B	A	S	E		
		U		C		A		G					
<b>F</b>	<b>U</b>	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	<b>U</b>	<b>T</b>		
		UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	<b>C</b>			
<b>I</b>		UUA	Leu	UCA	Ser	UAA	STOP**	UGA	STOP**	<b>A</b>	<b>H</b>		
		UUG	Leu	UCG	Ser	UAG	STOP**	UGG	Trp	<b>G</b>			
<b>R</b>											<b>I</b>		
<b>S</b>	<b>C</b>	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	<b>U</b>	<b>R</b>		
		CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	<b>C</b>			
<b>T</b>		CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	<b>A</b>	<b>D</b>		
		CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	<b>G</b>			
<b>B</b>											<b>A</b>		
<b>A</b>	<b>A</b>	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	<b>U</b>	<b>B</b>		
		AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	<b>C</b>			
		AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	<b>A</b>			
		AUG	Met or START*	ACG	Thr	AAG	Lys	AGG	Arg	<b>G</b>			
<b>A</b>											<b>A</b>		
<b>S</b>	<b>G</b>	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	<b>U</b>	<b>S</b>		
		GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	<b>C</b>			
<b>E</b>		GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	<b>A</b>	<b>E</b>		
		GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	<b>G</b>			

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

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

**Abbreviations for Amino Acids**

Amino Acid	Abbreviation
Alanine	Ala
Arginine	Arg
Asparagine	Asn
Aspartate	Asp
Cysteine	Cys
Glutamate	Glu
Glutamine	Gln
Glycine	Gly
Histidine	His
Isoleucine	Ile
Leucine	Leu
Lysine	Lys
Methionine	Met
Phenylalanine	Phe
Proline	Pro
Serine	Ser
Threonine	Thr
Tryptophan	Trp
Tyrosine	Tyr
Valine	Val

**Information About Nitrogen Bases**

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

Fold and tear along perforation.

Biology 30  
Diploma Examination  
June 1996

Multiple–Choice Key,  
Numerical–Response Key  
and  
Sample Answers to  
Written–Response Questions



**Biology 30 June 1996 Diploma Examination  
Multiple Choice and Numerical Response Keys**

**Multiple Choice**

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

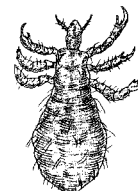
**Numerical Response**

- |           |      |
|-----------|------|
| <b>1.</b> | 8123 |
| <b>2.</b> | 50   |
| <b>3.</b> | 0.25 |
| <b>4.</b> | 3311 |
| <b>5.</b> | 0.50 |
| <b>6.</b> | 75   |
| <b>7.</b> | 5    |
| <b>8.</b> | 123  |

Use the following information to answer the next question.

Millions of children from around the world are infested with lice and nits, the eggs of lice. Lice are tiny blood-sucking insects that live in the hair on the head or body. Different species of lice prefer different locations. Recently, the incidence of infestation by lice has increased dramatically among children in France and the United States.

To treat an infestation of lice, lotions that contain the insecticides **malathion** or **d-phenothrin** are applied to the head or body. Either insecticide can inhibit the action of cholinesterase in lice. Although factors such as the frequency, duration, or dosage of the application can influence the effectiveness of a treatment, it is suspected that lice have developed resistance to the insecticides in the lotions.



A Louse

Some researchers in France conducted two experiments to compare the effectiveness of lotions that contain either **malathion** or **d-phenothrin**.

### Experiment I

- Procedure**
- Lotions were tested on three groups of body lice *Pediculus humanus humanus* that were raised under laboratory conditions using rabbits as hosts and treated as follows:
    - Group 1—immersed in 0.5% malathion lotion for 3 min
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### Results

#### Number of Surviving Lice and Lice Hatched from Nits at 0 h and 24 h

	Group 1 (malathion)		Group 2 (d-phenothrin)		Group 3 (untreated)	
	0 h	24 h	0 h	24 h	0 h	24 h
Nits	142	0	157	0	136	105
Adults	100	0	100	0	100	100

### Experiment II

- Procedure**
- Lotions were tested on three groups of head lice *Pediculus humanus capitis* that were taken from the heads of elementary-school students from Paris.
  - At time = 0 h, the lice were counted and treated as follows:
    - Group 4—immersed in 0.5% malathion lotion for 3 min
    - Group 5—immersed in 0.3% d-phenothrin lotion for 3 min
    - Group 6—not immersed in a lotion
  - Survivors in each group were counted at time = 1 h, time = 2 h, and time = 24 h.

### Results

#### Number of Surviving Lice at Specific Times

Time (h)	Group 4 (malathion)	Group 5 (d-phenothrin)	Group 6 (untreated)
0	357	416	320
1	0	376	298
2	0	364	289
24	0	82	44

## SAMPLE ANSWERS TO THE WRITTEN-RESPONSE SECTION

**Note:** The responses that follow represent **one** approach to each of the problems. During the diploma examination marking session, provision is made for considering the various approaches students may have used.

### Sample Answers for Question 1

#### Written Response – 15% (12 marks)

(3 marks)

**1.** a. Identify one fixed variable, one responding variable, and the manipulated variable in **experiment I**.

- Fixed variables

*Award 1 mark for any one of the following:*

- Source of lice and nits (rabbits)      Type of lice
- Location of testing (laboratory)      Duration of treatment
- Washing with water      Drying
- Times at which lice were counted      Incubating at 27°C

- Responding variables

*Award one mark for any one of the following:*

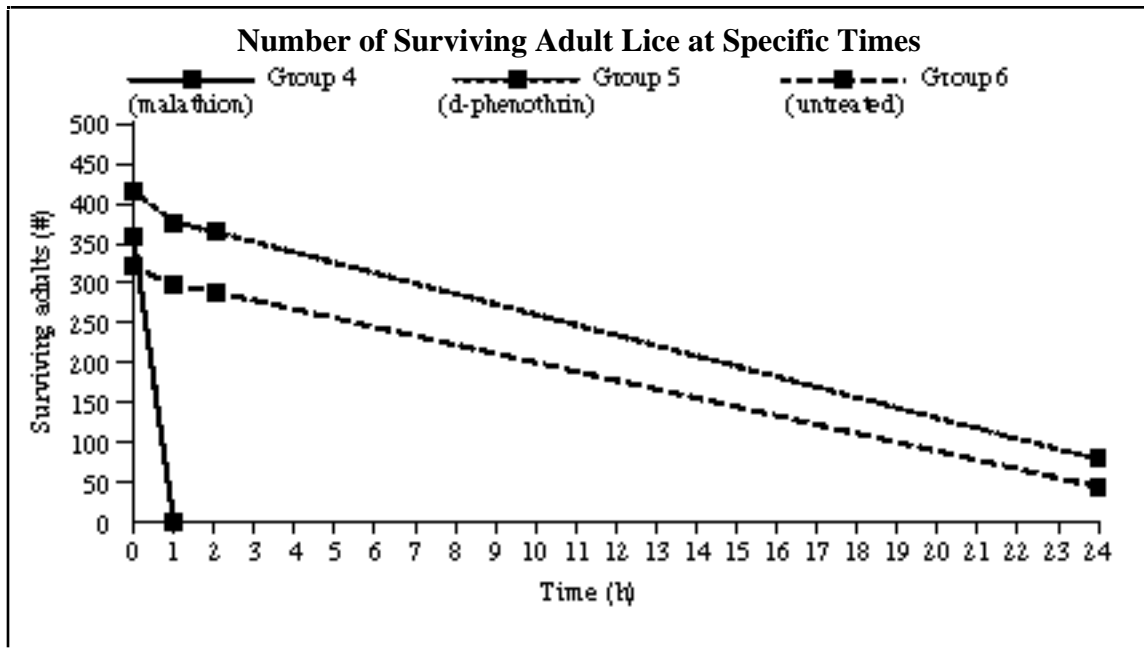
- Number of surviving adult lice / mortality of adults
- Number of surviving lice hatched from nits / mortality of nits

- Manipulated variable – 1 mark

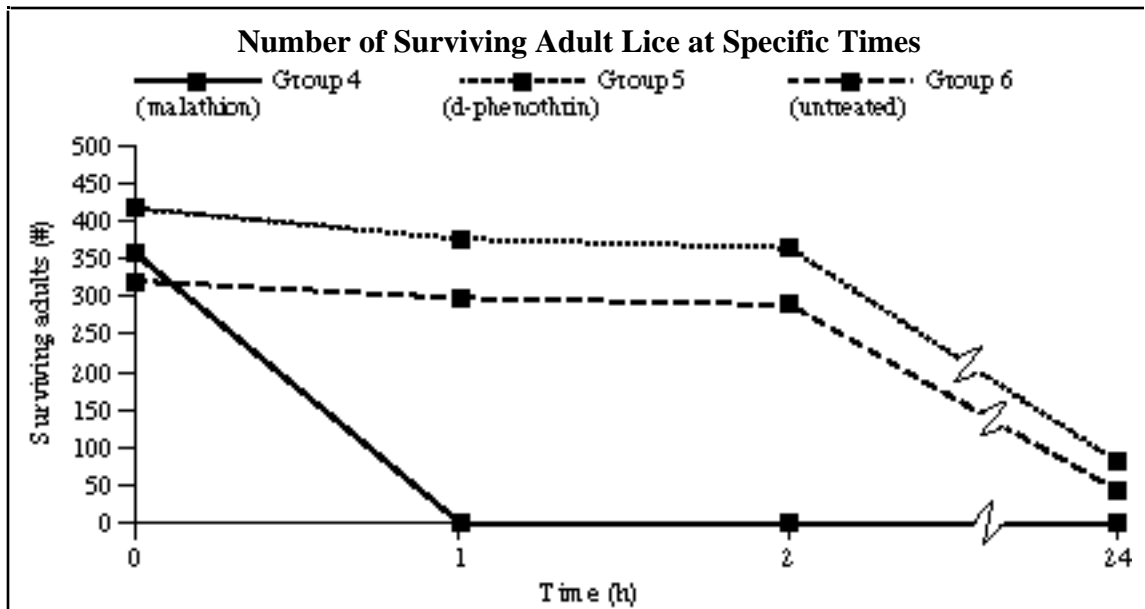
- Type/use of insecticide

(3 marks)

b. Prepare a line graph to illustrate the data collected in **experiment II**.



—OR—



	Ticks	Conversions	
Title	1	<u>Ticks</u>	<u>Marks</u>
Legend	1	6	3
X-axis units and labels	1	4-5	2
Y-axis units and labels	1	2-3	1
Correctly plotted data	2	0-1	0

**(1 mark)**

- c. Malathion is an effective insecticide because it can inhibit cholinesterase. Predict one physiological effect that malathion would have on neural transmission in treated lice.

*Award 1 mark for both parts of the following:*

Without cholinesterase:

- acetylcholine will continually stimulate the neuron.

OR

- the neuron will be unable, eventually, to repolarize.

**(1 mark)**

- d. Identify the relationship that exists between lice and rabbits. Provide one explanation to support the relationship that you identify.

*Award 1 mark for both parts of the following:*

- Parasitism
- Sucking blood from rabbits would be harmful to the rabbits and helpful to the lice.

(2 marks)

- e. The experimenters concluded that lice collected from school children have more resistance to insecticides than do lice raised in controlled laboratory conditions.
- i. What data, from the study, do you believe the experimenters used to conclude that the population of lice collected from school children was resistant to insecticides?

*Award 1 mark for the following:*

- Data obtained from Experiment **II**, Group 5, indicate that *d-phenothrin* is ineffective on head lice of children.

- ii. Describe one possible cause of this increased resistance.

*Award 1 mark for both parts of the following:*

- Either:
  - existence of a resistant variant,
- OR
- mutation to form resistant variant in ‘wild’ population,  
AND THEN (*must have*)
- Exposure to insecticides increases frequency of resistant variants.

(2 marks)

- f. Identify and explain two problems that make this a poor experiment.

*Award 1 mark each for any two of the following:*

- Different species, body versus head lice compared.
- The stage of the life cycle of the lice is not identified (other than ‘nit’). ‘Old’ lice may die more readily than ‘young’ lice.
- Different hosts, rabbits versus children, are compared.
- In Experiment **II**, the lice that were untreated died off. The reason is unclear. Did the lice die because they were removed from the host?
- etc.



## Sample Answers for Question 2

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

The islets of Langerhans are small clusters of cells in the pancreas. They monitor and regulate blood glucose levels. In patients with type I *diabetes mellitus*, the islet cells no longer produce one of the major hormones necessary to control blood glucose levels. Until about 75 years ago, these patients died within months of the onset of the disease. Today, these patients are treated to control blood glucose levels, and they are able to live relatively normal lives. However, many of these patients eventually do suffer from diabetes-related disorders caused by abnormal fluctuations in blood glucose levels. These fluctuations can damage blood vessels and may result in blindness, kidney failure, and blood circulation problems in the feet and hands.

Recent research has focused on transplanting islet cells from a donor pancreas into a diabetic patient. The islet cell clusters are separated from other pancreatic cells and injected into the large vein that leads into the patient's liver. The clusters lodge in small blood vessels in the patient's liver and begin to produce hormones in response to changing blood glucose levels.

### **Written Response – 15% (12 marks)**

- 2.**
- Identify the hormone lacking in a person with type I *diabetes mellitus*, and explain two physiological mechanisms by which this hormone regulates blood glucose levels. Draw a feedback loop that illustrates this regulation.
  - Explain why successful islet cell transplants may prevent some of the physiological problems experienced by many patients with *diabetes mellitus*.
  - Describe two technological issues and one societal issue that researchers might have faced during the development of the islet cell transplant procedure.

## Sample Answers for Question 2

Students' responses may include some of the following information.

Insulin is lacking in people with type I *diabetes mellitus*. Insulin regulates blood sugar levels by

- making membranes more permeable to glucose. Glucose leaves the blood and enters cells where it can be used as an energy source.
- promoting the conversion of glucose to glycogen in the liver/muscles. This prevents glucose from entering the blood.



Transplanted islet cells should respond with the speed and accuracy of a normal pancreas. This would eliminate the blood glucose level fluctuations that cause the problems associated with diabetes.

Possible technological problems include:

- transplant rejection
- identification of islet cells
- isolation of islet cells
- determination of number of cells to be transplanted
- determination of the method of introducing the islet cells into the body

*Many others may be appropriate.*

Possible societal issues include:

- determination of who receives transplants
- cost of transplants/research
- finding donors

*Many others may be appropriate.*

## Holistic Key for the Written-Response Question 2

Score	Scoring Description		
	Science	Technology/Society	Presentation
<p style="text-align: center;"><b>4</b></p> <p><b>Standard of Excellence</b></p> <p>The response addresses all of the major points of the question.</p>	<ul style="list-style-type: none"> <li>• The response identifies insulin, explains two mechanisms by which it regulates blood sugar levels, and diagrams the feedback loop.</li> <li>• The response explains why islet cell transplants could prevent problems associated with fluctuating glucose levels.</li> </ul>	<ul style="list-style-type: none"> <li>• Two technological problems are described.</li> <li>• One societal issue is described.</li> </ul>	<ul style="list-style-type: none"> <li>• Explanations of concepts are clear, concise, and logical.</li> <li>• Complete, grammatically correct sentences are used.</li> <li>• Appropriate scientific vocabulary is used effectively.</li> <li>• Consistency of thought is demonstrated.</li> <li>• The response is well organized.</li> </ul>
<p style="text-align: center;"><b>3</b></p> <p>The response addresses most of the major points of the question.</p>	<ul style="list-style-type: none"> <li>• The response identifies insulin, describes two mechanisms by which it regulates blood sugar levels and sketches the feedback loop.</li> <li>• The response explains why islet cell transplants could prevent symptoms associated with diabetes.</li> </ul>	<ul style="list-style-type: none"> <li>• One technological problem is described.</li> <li>• One societal issue is described.</li> </ul>	<ul style="list-style-type: none"> <li>• Explanations of concepts are clear.</li> <li>• Complete sentences are used.</li> <li>• Some appropriate scientific vocabulary is used.</li> <li>• Consistency of thought is demonstrated.</li> <li>• The response is organized.</li> </ul>
<p style="text-align: center;"><b>2</b></p> <p><b>Acceptable Standard</b></p> <p>The response addresses some of the major points of the question.</p>	<ul style="list-style-type: none"> <li>• The response identifies insulin and identifies one mechanism by which it regulates blood sugar levels.</li> <li>• The response indicates that insulin will alleviate some symptoms of diabetes.</li> </ul>	<ul style="list-style-type: none"> <li>• One technological problem is identified.</li> <li>• One societal issue is identified.</li> </ul>	<ul style="list-style-type: none"> <li>• Most explanations of concepts are clear.</li> <li>• Some appropriate scientific vocabulary is used.</li> <li>• Some organizational skills are evident.</li> </ul>
<p style="text-align: center;"><b>1</b></p> <p>The response addresses few of the major points of the question.</p>	<ul style="list-style-type: none"> <li>• The response identifies insulin.</li> </ul>	<ul style="list-style-type: none"> <li>• One technological problem or societal issue is identified.</li> </ul>	<ul style="list-style-type: none"> <li>• Little appropriate scientific vocabulary is used.</li> <li>• Organizational skills are not evident.</li> </ul>
<p style="text-align: center;"><b>0</b></p> <p>The response does not address the major points of the question.</p>	<ul style="list-style-type: none"> <li>• Not attempted.</li> </ul>	<ul style="list-style-type: none"> <li>• Technologies or issues not identified.</li> </ul>	