

Biology 30

Released Items

2017 Released Diploma Examination Items



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Introduction

The questions in this document are from the Biology 30 January 2017 Form 2 Diploma Examination. This material, along with the Biology 30 Program of Studies, *Biology 30 Information Bulletin*, student-based performance standards, and school authority or school reports, can provide insight for teachers to assist them with instructional programming.

The blueprint summary on the following pages shows the keyed response, outcome classification according to the program of studies, classification of cognitive level, and difficulty for each question. An explanation of the cognitive levels (including minor revisions made in 2017) can be found in the 2017-2018 *Biology 30 Information Bulletin*. The percentage reported in the *Difficulty* column indicates the proportion of students who got the question **correct**.

Additional Documents and Online Resources

Provincial Assessment supports the instruction of Biology 30 with the following documents and online resources.

These documents contain information about administrations of the diploma examinations for the upcoming school year, sample questions, and assessment samples for classroom use.

- [*Biology 30 Information Bulletin*](#)
- [*Biology 30 Archived Information Bulletin*](#)
- [*Biology 30 Assessment Exemplars*](#)
- [*Biology 30 Student-based Performance Standards*](#)

The [Biology 30 Practice Tests](#) contains previous diploma examinations and some practice questions that have been released.

Biology 30 Diploma Examination January 2017: Blueprint Summary

Key: MC—Multiple Choice; NR—Numerical Response

R/U—Remembering/Understanding; A—Application; HMA—Higher Mental Activities

Question	Key	Outcome	Cognitive Level	Difficulty (%)
MC1	C	A1.1K, A1.2S	R/U	86.5
MC2	A	A1.1K, A.13STS	A	76.1
MC3	D	A1.3K, A1.2S	A	81.6
NR1	4312	A1.2K	R/U	84.3
MC4	D	A1.2K	R/U	53.1
NR2	457 (any order)	A1.4K, A1.2S	R/U	66.3
MC5	C	A1.5K, A1.3S	A	72.4
MC6	C	A2.1K, A2.2K	R/U	46.9
MC7	D	A2.3K, A2.2K, A2.6K	HMA	42.6
MC8	A	A2.6K	A	73.6
MC9	C	A2.3K, A2.6K, A2.3S	A	49.3
NR3	3421	A2.2K, A2.4K	A	65.9
MC10	C	A2.2K, A2.1K	A	63.4
MC11	B	A2.4K	A	65.5
NR4	6231	B1.2K, B1.2S	R/U	55.4
MC12	D	B1.3K, B1.2S	HMA	67.3
MC13	C	B1.2K, B2.3K	A	68.7
MC14	B	B2.3K, B2.3S	HMA	75.8
MC15	A	B1.5K, B1.1K, B1.2K, B1.1STS	A	66.0
MC16	C	B2.1K, B2.2STS	R/U	72.7
MC17	D	B2.2K, B2.1STS	A	62.6
MC18	A	B2.2K, B2.3S	HMA	53.0
MC19	C	B3.5K, B2.2K	HMA	43.3
MC20	D	B3.2K, B1.1K, B3.1K, B3.3S	A	82.5
MC21	A	B3.3K	R/U	43.0
MC22	C	C1.6K, B3.1K, B3.2K	R/U	80.4
NR5	234	B3.1K, B3.2STS, B1.2S	A	62.4

Key: MC—Multiple Choice; NR—Numerical Response
 R/U—Remembering/Understanding; A—Application; HMA—Higher Mental Activities

Question	Key	Outcome	Cognitive Level	Difficulty (%)
MC23	C	C1.4K	A	58.3
MC24	B	C1.1K, C1.3S	HMA	48.0
MC25	A	C1.2K	R/U	51.5
NR6	1324	C1.4K, C1.2S	HMA	55.3
MC26	A	C1.5K, C1.2S	A	50.7
MC27	D	C1.7K, C1.1K, C1.2S	A	74.0
MC28	D	C1.7K, C1.3K, C1.4K, C1.1K, C1.2S	A	55.6
MC29	B	C2.2K, C2.3S	A	69.5
MC30	B	C2.2K, C2.3S	A	69.0
MC31	B	C2.4K, C2.2K, C2.3S	HMA	51.6
MC32	A	C2.5K, C2.3S	HMA	66.5
MC33	D	C2.2K, C2.5K, C2.3S	A	76.6
NR7	121 or 242 or 484	C2.2K, C2.3S	A	79.7
NR8	0.13	C2.2K, C2.3S	HMA	31.6
MC34	A	C2.3K, C2.3S	A	86.6
MC35	A	C3.3K, C3.2S	A	73.8
MC36	B	C3.2K, C3.3K	A	74.0
MC37	D	C3.7K	R/U	65.0
NR9	3412	C3.3K, C3.2K, C3.2S	A	59.4
MC38	B	C3.6K, C3.2K, C3.3K, C3.2S	A	68.7
MC39	D	C3.4K, C3.2K, C3.2S, C3.2STS	A	46.0
MC40	B	D1.2K, D1.4K	A	57.5
NR10	0.30	D1.3K, D1.3S	A	60.6
MC41	B	D1.3K, D1.3S	A	54.5
MC42	A	D2.3K	A	71.8
MC43	A	D2.1K	A	70.5
MC44	B	D1.2K, D1.3K, D3.1K	A	45.4
MC45	D	D3.2K, D2.1STS	A	46.6

Key: MC—Multiple Choice; NR—Numerical Response
R/U—Remembering/Understanding; A—Application; HMA—Higher Mental Activities

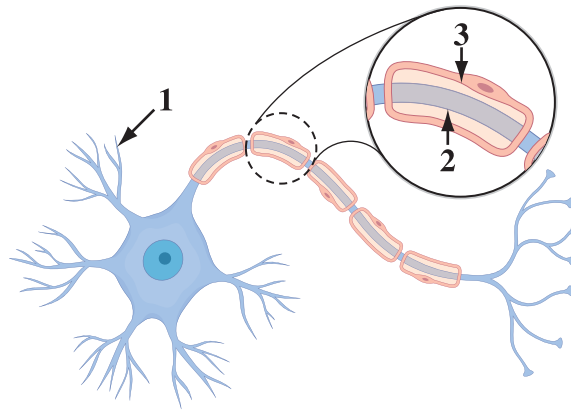
Question	Key	Outcome	Cognitive Level	Difficulty (%)
NR11	31.6	D3.2K, D3.3S	A	76.4
MC46	B	D3.3K, D3.3S	A	82.9
NR12	2211	D3.4K	A	75.9

Biology 30 Diploma Examination January 2017: Released Items

Use the following information to answer question 1.

Charcot–Marie–Tooth disease (CMT) is a neurological disorder characterized by nerve damage that causes muscle weakness and loss of sensation. The two most common forms of this disorder are CMT1 and CMT2. CMT1 is caused by a genetic mutation that results in abnormal structure and function of the myelin sheath, and CMT2 is caused by a genetic mutation that leads to the abnormal functioning of the axon.

A Neuron



1. Which of the following rows identifies the structures of a neuron affected by CMT1 and CMT2?

Row	CMT1	CMT2
A.	1	2
B.	2	3
C.	3	2
D.	3	1

Use the following information to answer question 2.

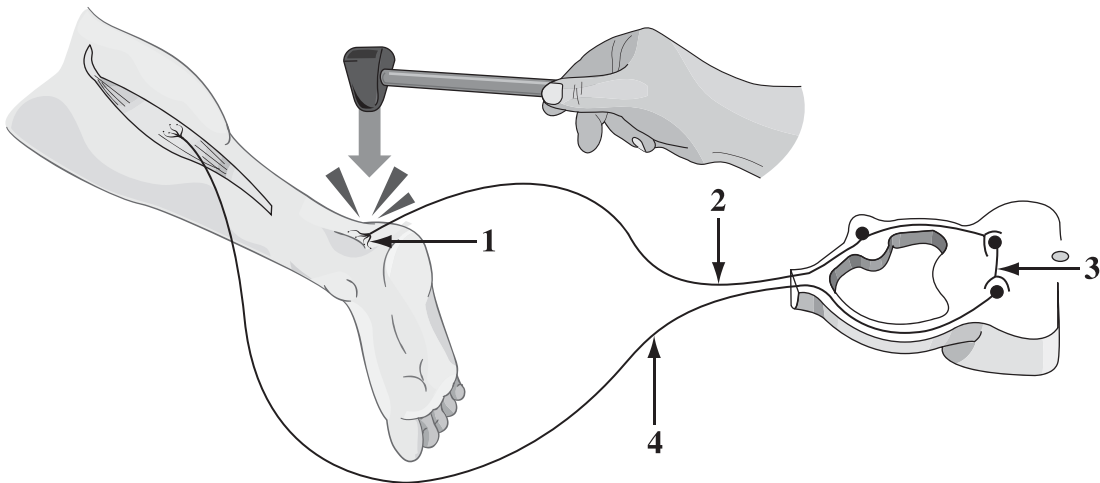
Lignocaine is an anesthetic used to block pain during dental procedures. Lignocaine diffuses into neurons and works by blocking sodium channels.

2. The blocking of sodium channels by lignocaine prevents the diffusion of sodium ions
- A. into the neuron, thus inhibiting an action potential
 - B. into the neuron, which decreases the threshold potential of the neuron
 - C. out of the neuron, thus inhibiting an action potential
 - D. out of the neuron, which decreases the threshold potential of the neuron

Use the following information to answer question 3.

The Achilles tendon reflex is observed when the Achilles tendon of a person is tapped with a patellar hammer and the calf muscle contracts. A doctor tapped the Achilles tendon of a man and did not observe a contraction of the man's calf muscle. The man reported that he felt the hammer strike his tendon.

The Achilles Tendon Reflex Pathway



3. The two structures numbered above that are **most likely** damaged in the Achilles tendon reflex pathway are
- A. 1 and 2
 - B. 1 and 3
 - C. 2 and 3
 - D. 3 and 4

Use the following information to answer numerical-response question 1.

Adrenoleukodystrophy (ALD) is a genetic disorder that causes damage to the myelin sheaths of neurons in the brain.

Some Symptoms of ALD

- 1 Decreased vision
- 2 Decreased hearing
- 3 Decreased learning ability
- 4 Decreased muscular coordination

Numerical Response

1. Match each of the symptoms of ALD listed above with the region of the brain associated with it given below.

Symptom of ALD: _____
Region of the brain: Cerebellum Frontal lobe Occipital lobe Temporal lobe

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

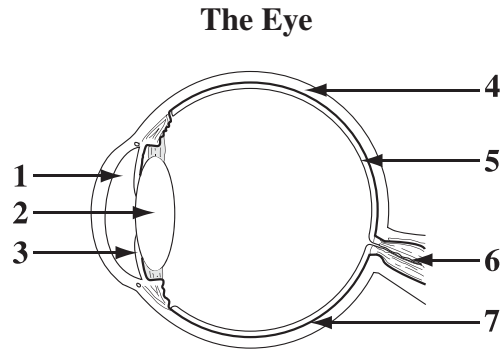
Use the following information to answer question 4.

Exposure to certain foods or environmental agents can cause a severe allergic reaction known as anaphylaxis. Common symptoms of anaphylaxis include a decrease in blood pressure and constriction of bronchioles in the lungs.

4. The division of the nervous system that produces effects **most** similar to those of anaphylaxis is the
- A. sympathetic nervous system, which is part of the somatic nervous system
 - B. sympathetic nervous system, which is part of the autonomic nervous system
 - C. parasympathetic nervous system, which is part of the somatic nervous system
 - D. parasympathetic nervous system, which is part of the autonomic nervous system

Use the following information to answer numerical-response question 2.

Collie eye anomaly (CEA) is a genetic disorder that affects a number of eye structures in dogs of various collie breeds. CEA results in thinning of the sclera, reduced development of the choroid, and detachment of the retina. The structures and functions of the parts of the eye are similar in dogs and in humans.



Numerical Response

2. In the diagram above, the three eye structures that are affected in a dog with CEA are numbered _____, _____, and _____.

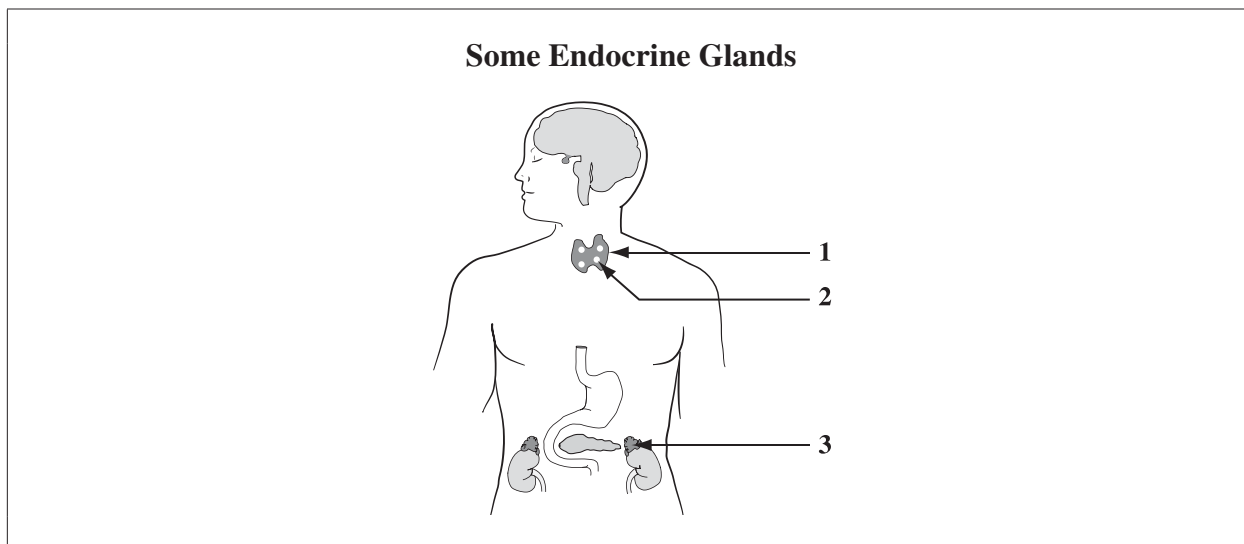
(Record all **three digits** of your answer **in any order** in the numerical-response section on the answer sheet.)

Use the following information to answer question 5.

Barotrauma is a condition that results from pressure differences on the two sides of the tympanic membrane. Sometimes, extreme differences in pressure can damage the tympanic membrane. Swallowing or yawning helps to equalize air pressure on both sides of the tympanic membrane.

5. A symptom of barotrauma is expected to be
- A. dizziness resulting from damage to hair cells
 - B. hearing loss resulting from damage to hair cells
 - C. hearing loss resulting from decreased amplification of sound
 - D. dizziness resulting from decreased transmission of nerve impulses

Use the following information to answer question 6.



6. Which of the following rows identifies the gland that secretes PTH and the gland that secretes calcitonin?

Row	Gland That Secretes PTH	Gland That Secretes Calcitonin
A.	1	2
B.	1	3
C.	2	1
D.	2	3

Use the following information to answer question 7.

Sheehan syndrome is a rare condition in women that results from severe blood loss during or after childbirth. Because of the blood loss, the pituitary gland receives insufficient oxygen and nutrients, which causes the death of cells and a permanent deficiency of hormones from the pituitary gland. Sheehan syndrome can be treated with lifelong hormone replacement therapy.

7. An endocrine function that is **not likely** to be affected by Sheehan syndrome is the
- A. regulation of metabolism
 - B. regulation of the menstrual cycle
 - C. ability to respond to long-term stress
 - D. release of calcium into the bloodstream

Use the following information to answer questions 8 and 9.

Wolfram syndrome is a rare genetic disorder characterized by large amounts of dilute urine, symptoms of type 1 diabetes mellitus, and reduced hearing and vision.

8. Which of the following rows identifies the expected blood-glucose level and the expected blood-insulin level in a person with Wolfram syndrome?

Row	Blood-glucose Level	Blood-insulin Level
A.	Higher than normal	Lower than normal
B.	Higher than normal	Higher than normal
C.	Lower than normal	Lower than normal
D.	Lower than normal	Higher than normal

9. In a person with Wolfram syndrome, the amount and concentration of urine produced could result from
- A. lower-than-normal secretion of ADH from the adrenal gland
 - B. higher-than-normal secretion of ADH from the adrenal gland
 - C. lower-than-normal secretion of ADH from the pituitary gland
 - D. higher-than-normal secretion of ADH from the pituitary gland

Use the following information to answer numerical-response question 3.

Some Events in the Endocrine System

- 1 Metabolic rate increases.
- 2 Thyroxine secretion increases.
- 3 The hypothalamus secretes a releasing hormone.
- 4 TSH travels through the bloodstream to the target cells.

Numerical Response

3. In order to restore homeostasis when thyroxine levels in the blood are lower than normal, the sequence in which the events listed above occur is _____, _____, _____, and _____.

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

Use the following information to answer questions 10 and 11.

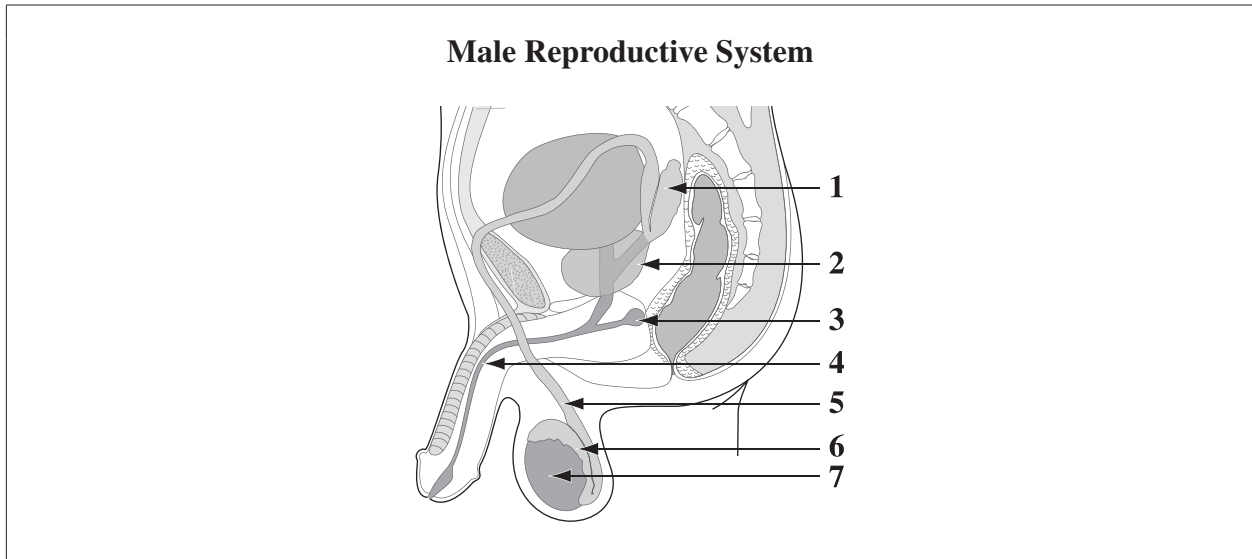
Corticotropin-releasing hormone (CRH) stimulates the release of ACTH.

10. Which of the following rows identifies the gland that is **directly** stimulated by CRH and the gland that is stimulated by ACTH?

Row	Gland Directly Stimulated by CRH	Gland Stimulated by ACTH
A.	Hypothalamus	Adrenal gland
B.	Hypothalamus	Pituitary gland
C.	Pituitary gland	Adrenal gland
D.	Pituitary gland	Hypothalamus

11. Which of the following statements describes the negative feedback control of CRH?
- A. Low levels of cortisol will inhibit the release of CRH.
 - B. High levels of cortisol will inhibit the release of CRH.
 - C. Low levels of epinephrine will inhibit the release of CRH.
 - D. High levels of epinephrine will inhibit the release of CRH.

Use the following information to answer numerical-response question 4.



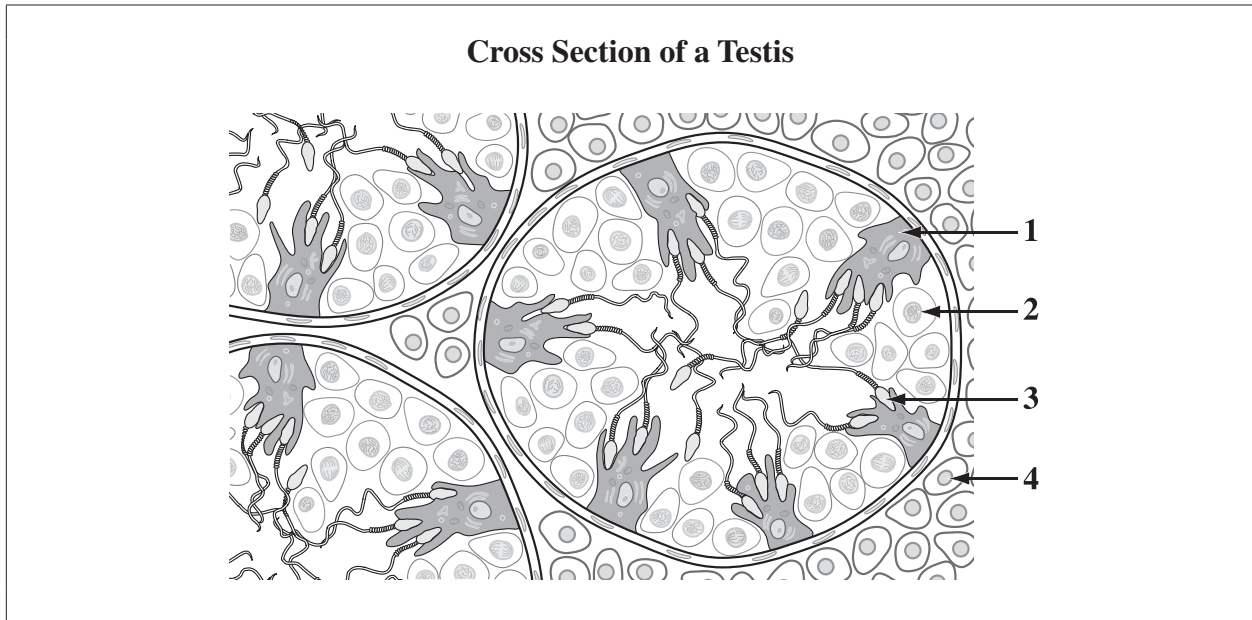
Numerical Response

4. Match the numbers on the diagram above with the structures of the male reproductive system indicated below.

Number: _____
Structure: Epididymis Prostate gland Cowper's gland Seminal vesicle

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

Use the following information to answer question 12.



12. In the diagram above, the cells numbered 1, 2, and 3 are located within
- A. an epididymis
 - B. a vas deferens
 - C. a seminal vesicle
 - D. a seminiferous tubule

Use the following information to answer question 13.

Some men naturally produce more testosterone than other men. Men who have naturally high levels of testosterone in their blood have a significantly increased risk of developing prostate cancer compared with men who have normal concentrations of testosterone in their blood.

—based on Parsons et al., 2005

Parsons, J. Kellogg, H. Ballentine Carter, Elizabeth A. Platz, E. James Wright, Patricia Landis, and E. Jeffrey Metter. 2005. Serum testosterone and the risk of prostate cancer: Potential implications for testosterone therapy. *Cancer Epidemiology Biomarkers & Prevention*, no. 14 (September): 2257. doi:10.1158/1055-9965.EPI-04-0715.

13. Which of the following rows describes the relative activity in the interstitial cells that could account for an increased risk of prostate cancer in a man with a naturally high level of testosterone and the expected relative activity in the seminiferous tubules?

Row	Relative Activity in Interstitial Cells	Relative Activity in Seminiferous Tubules
A.	Lower than normal	Higher than normal
B.	Lower than normal	Lower than normal
C.	Higher than normal	Higher than normal
D.	Higher than normal	Lower than normal

Use the following information to answer question 14.

Researchers studied the effect of a plant known as tulsi on the reproductive ability of male rabbits. They fed one group of male rabbits a diet of rabbit food along with 2 g of tulsi leaves. A separate group of male rabbits were fed a diet that consisted only of rabbit food. The rabbits were fed for 30 days. Blood samples were then taken from both groups of rabbits to measure their levels of FSH. Rabbits and humans have similar reproductive hormones.

Blood FSH Levels of Two Groups of Male Rabbits

Group	Levels of FSH (mIU/mL)
Rabbits fed rabbit food along with tulsi	0.13
Rabbits fed rabbit food only	0.64

—based on Sethi et al., 2010

Sethi, Jyoti, Mridul Yadav, Sushma Sood, Kiran Dahiya, and Veena Singh. 2010. Effect of Tulsi (*Ocimum Sanctum* Linn.) on sperm count and reproductive hormones in male albino rabbits. *International Journal of Ayurveda Research* 1, no. 4 (October–December): 208–210. doi:10.4103/0974-7788.76782.

14. Based on the experimental results, the researchers would **most likely** expect that
- A. sperm count will be lower in the group of rabbits that were fed rabbit food only
 - B. sperm count will be lower in the group of rabbits that were fed rabbit food with tulsi
 - C. testosterone levels will be lower in the group of rabbits that were fed rabbit food only
 - D. testosterone levels will be lower in the group of rabbits that were fed rabbit food with tulsi

Use the following information to answer question 15.

In men, untreated sexually transmitted infections (STIs) caused by bacteria may cause inflammation of the epididymides, a condition known as epididymitis. In women, untreated STIs may cause inflammation and scarring within the Fallopian tubes, a condition known as pelvic inflammatory disease (PID). Both conditions can cause infertility.

15. Which of the following rows describes possible causes of infertility in men with epididymitis and in women with PID?

Row	Cause of Infertility in Men with Epididymitis	Cause of Infertility in Women with PID
A.	Fewer sperm present in semen	Sperm are less likely to reach an ovum
B.	Fewer sperm present in semen	Ovulation is less likely to occur
C.	Less semen is produced	Sperm are less likely to reach an ovum
D.	Less semen is produced	Ovulation is less likely to occur

Use the following information to answer question 16.

North American girls are reaching puberty at a much younger age than those of previous generations, some as young as eight years of age. Researchers are investigating the link between cosmetic products used by young girls and the early onset of puberty. Tests have shown that shampoos rich in hormone additives may be a cause of early sexual maturation in girls.

—based on Myers et al., 2015

Myers, Sharon L., Chun Z. Yang, George D. Bittner, Kristine L. Witt, Raymond R. Tice, and Donna D. Baird. 2015. Estrogenic and anti-estrogenic activity of off-the-shelf hair and skin care products. *Journal of Exposure Science and Environmental Epidemiology* 25, no. 3 (May/June): 271–77. doi:10.1038/jes.2014.32.

16. The hormone additive that could **directly** cause the early development of secondary sex characteristics in young girls is
- A. LH
 - B. FSH
 - C. estrogen
 - D. progesterone

Use the following information to answer question 17.

A radical hysterectomy is a surgical procedure that involves the removal of the uterus and cervix. Sometimes both ovaries and both Fallopian tubes are also removed, a procedure known as a hysterectomy with bilateral salpingo-oophorectomy (BSO).

17. Two hormones expected to be deficient in a woman who has had a radical hysterectomy with BSO are
- A. FSH and LH
 - B. FSH and estrogen
 - C. LH and progesterone
 - D. estrogen and progesterone

Use the following information to answer questions 18 and 19.

An experiment has shown that when women are in the most fertile stage of their menstrual cycle, they have higher-pitched voices than when they are in the least fertile stage.

—based on Bryant and Haselton, 2009

Bryant, Gregory A., and Martie G. Haselton. 2009. Vocal cues of ovulation in human females. *Biology Letters* 5, no. 1 (February 23): 12–15. doi:10.1098/rsbl.2008.0507.

18. Which of the following rows identifies the phase of the menstrual cycle and a hormonal event that **most closely** corresponds with higher-pitched voices in women?

Row	Phase of Menstrual Cycle	Hormonal Event
A.	Ovulation	High levels of LH
B.	Ovulation	High levels of progesterone
C.	Follicular phase	High levels of LH
D.	Follicular phase	High levels of progesterone

Use the following additional information to answer question 19.

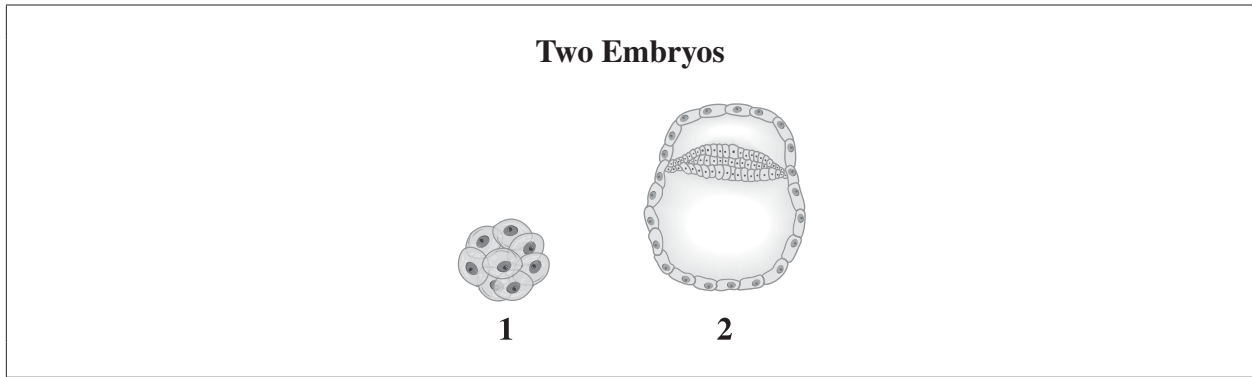
Women taking the birth-control pill do not show a variation in voice pitch during their menstrual cycles.

—based on Pipitone & Gallup, 2008

Pipitone, R. Nathan, and Gordon G. Gallup Jr. 2008. Women's voice attractiveness varies across the menstrual cycle. *Evolution & Human Behavior* 29, no. 4 (July): 268–74. doi:10.1016/j.evolhumbehav.2008.02.001.

19. Which of the following statements explains the observation described above?
- A. LH and FSH are at high levels.
 - B. Progesterone and estrogen are at low levels.
 - C. Progesterone and estrogen are at high levels.
 - D. LH is at a high level, but FSH is at a low level.

Use the following information to answer question 20.



20. Which of the following rows describes the typical locations of embryos 1 and 2 in a pregnant woman?

Row	Location of Embryo 1	Location of Embryo 2
A.	Uterus	Fallopian tube
B.	Uterus	Uterus
C.	Fallopian tube	Fallopian tube
D.	Fallopian tube	Uterus

21. Which of the following rows identifies an embryonic germ layer and an organ that develops from it?

Row	Embryonic Germ Layer	Organ
A.	Mesoderm	Heart
B.	Mesoderm	Skin
C.	Endoderm	Heart
D.	Endoderm	Skin

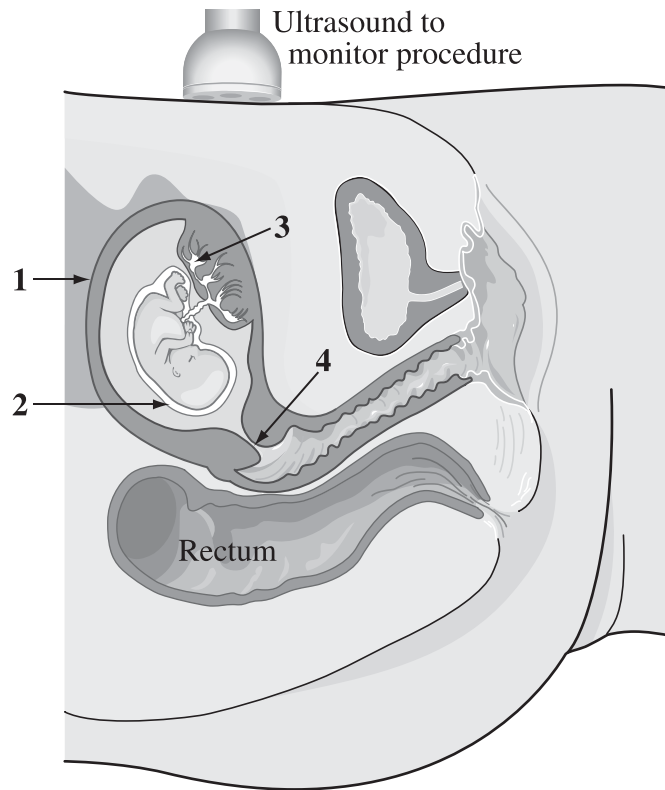
22. Which of the following events results in the production of identical twins?

- A.** Two ova combine with two sperm during fertilization.
- B.** One ovum and two sperm combine during fertilization.
- C.** A blastocyst divides into two embryos just before implantation.
- D.** A blastocyst divides into two embryos after organ development begins.

Use the following information to answer numerical-response question 5.

Chorionic villus sampling (CVS) is a procedure in which a sample of chorionic villus tissue is collected during early pregnancy so it can be analyzed for chromosomal disorders. One CVS technique is performed by inserting a thin plastic tube known as a catheter into the vagina and passing it through another opening to reach the chorionic villus tissue.

Structures Related to Pregnancy



Numerical Response

5. Match three of the structures related to pregnancy numbered in the diagram above with the descriptions given below.

Number:	_____	_____	_____
Description:	Amnion	Chorionic villi	Structure catheter passes through

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

Use the following information to answer question 23.

Many amphibians can regenerate limbs they lost due to injury. During regeneration, cells in the tissue layer next to the injured area lose their specialized characteristics and become similar to stem cells. These stem-like cells respond to growth factors and then specialize into bone, muscle, and skin cells.

23. The cell processes that allow for the regeneration of limbs in amphibians are
- A. meiosis and differentiation
 - B. meiosis and gastrulation
 - C. mitosis and differentiation
 - D. mitosis and gastrulation

Use the following information to answer question 24.

The western clawed frog has a diploid chromosome number of 20. In western clawed frogs, the sex chromosomes are ZZ in males and ZW in females.

—based on Hayes et al., 2010

Hayes, Tyrone B., Vicky Khoury, Anne Narayan, Mariam Nazir, Andrew Park, Travis Brown, Lillian Adame et al. 2010. Atrazine induces complete feminization and chemical castration in male African clawed frogs (*Xenopus laevis*). *Proceedings of the National Academy of Sciences of the United States of America* 107, no. 10 (March 9): 4612–17. doi:10.1073/pnas.0909519107.

24. A karyotype of a somatic cell from a female western clawed frog would show
- A. 9 pairs of homologous autosomes and 1 pair of homologous sex chromosomes
 - B. 9 pairs of homologous autosomes and 1 pair of non-homologous sex chromosomes
 - C. 19 pairs of homologous autosomes and 1 pair of homologous sex chromosomes
 - D. 19 pairs of homologous autosomes and 1 pair of non-homologous sex chromosomes

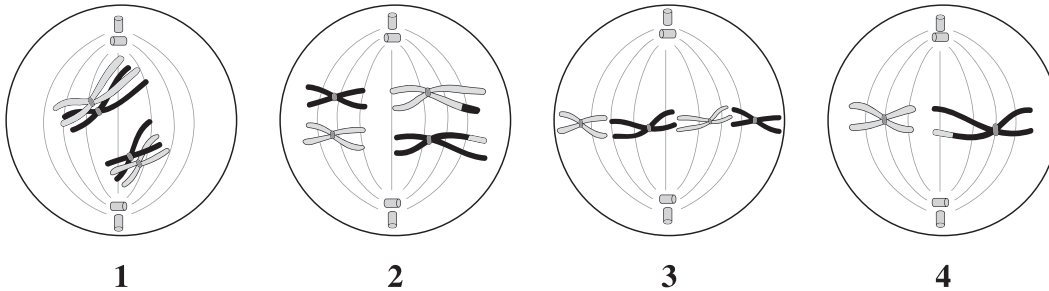
25. Which of the following rows matches a phase of the cell cycle of a human cell with a description of that phase?

Row	Phase	Description
A.	Prophase	Nuclear membrane would not be visible and DNA would be condensed.
B.	Metaphase	Nuclear membrane would be visible and DNA would not be condensed.
C.	Anaphase	Nuclear membrane would not be visible and DNA would not be condensed.
D.	Interphase	Nuclear membrane would be visible and DNA would be condensed.

Use the following information to answer numerical-response question 6 and question 26.

The following diagrams illustrate some phases of cell division in a hypothetical cell with a chromosome number of $2n = 4$.

Some Phases of Cell Division



Numerical Response

6. Match the phase of cell division numbered above with its name given below.

Phase:

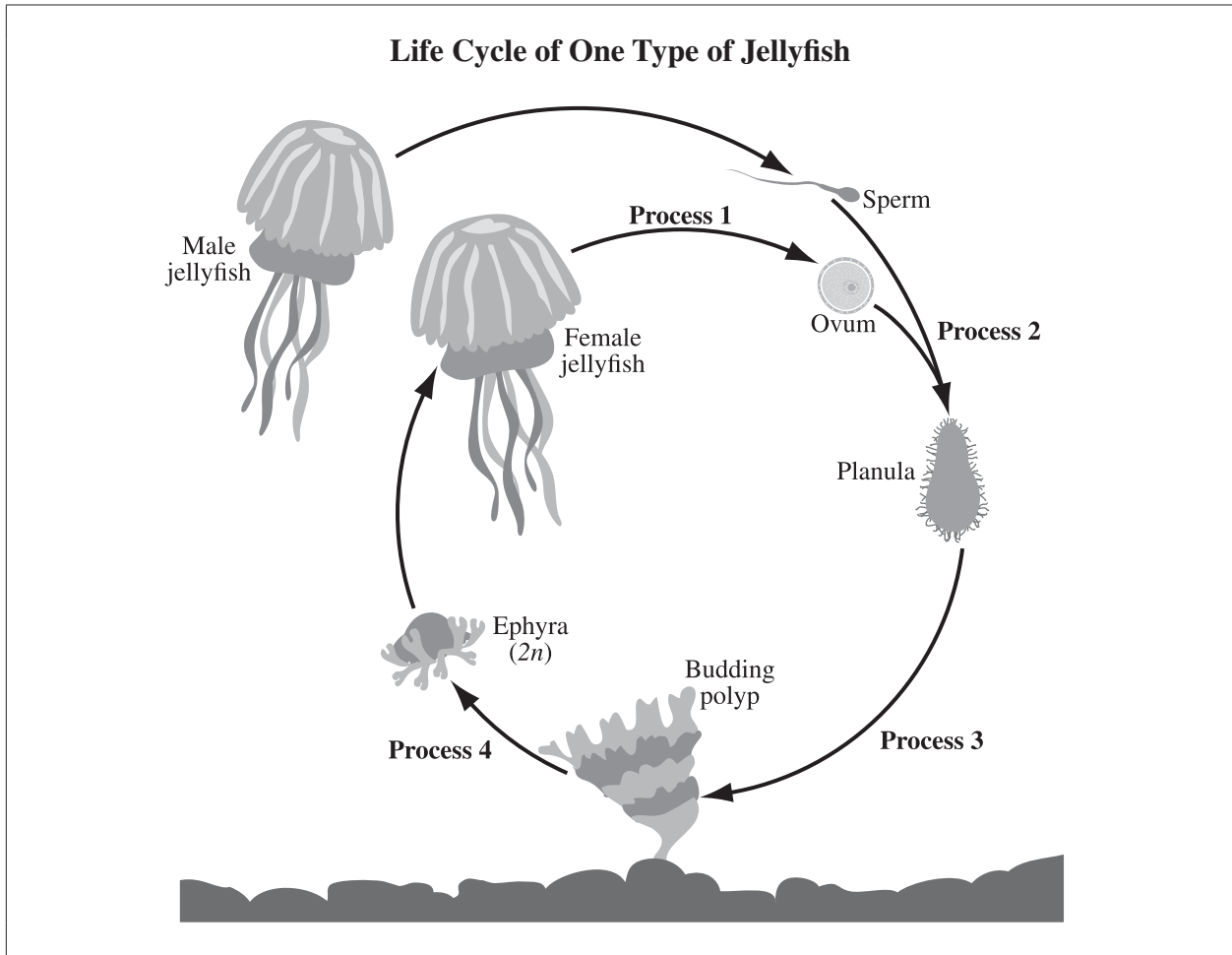
Name: Prophase I Metaphase Metaphase I Metaphase II

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

26. Which of the following rows identifies the event illustrated in phase 1 in the diagram above and the **most likely** effect of the event identified?

Row	Event	Effect
A.	Synapsis	Recombination of alleles
B.	Synapsis	Independent assortment of alleles
C.	Segregation	Recombination of alleles
D.	Segregation	Independent assortment of alleles

Use the following information to answer questions 27 and 28.



27. Which of the following rows identifies the ploidy of the planula, the budding polyp, and a gamete in the life cycle of a jellyfish?

Row	Planula	Budding Polyp	Gamete
A.	n	n	$2n$
B.	n	$2n$	n
C.	$2n$	$2n$	$2n$
D.	$2n$	$2n$	n

28. The two processes that result in the production of cells that are genetically identical to the parent cells are labelled in the diagram above as processes

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

Use the following information to answer question 29.

Gaucher disease is characterized by the accumulation of a fatty substance in the organs of affected individuals. Gaucher disease has an autosomal recessive pattern of inheritance.

29. A woman who is heterozygous for Gaucher disease has a child with a man who does not have the disorder, but whose mother had the disease. What is the probability that the child has Gaucher disease?
- A. 0.00
 - B. 0.25
 - C. 0.50
 - D. 0.75

Use the following information to answer question 30.

The Kermode bear, also called “spirit bear” by the Tsimshian people, is a subspecies of the black bear and is found on Princess Royal Island, British Columbia. Most Kermode bears have a black coat, but a small number have a white coat, which is caused by the presence of two autosomal recessive alleles.

30. A female Kermode bear with a black coat gives birth to twin cubs, one with a black coat and one with a white coat. Which of the following rows identifies the genotype of the female parent bear, and the genotype and phenotype of the male parent bear?

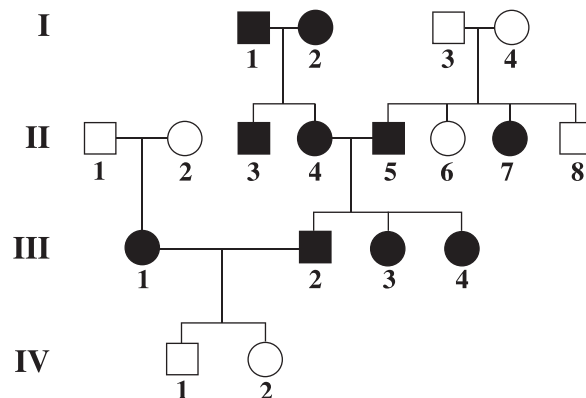
Row	Genotype of Female Parent Bear	Genotype of Male Parent Bear	Phenotype of Male Parent Bear
A.	BB	bb	White
B.	Bb	Bb	Black
C.	$X^B X^b$	$X^b Y$	White
D.	$X^B X^b$	$X^B Y$	Black

Use the following information to answer question 31.

A form of congenital deafness is inherited as a result of the interaction between two genes, *D* and *E*, which assort independently.

Genotype	Phenotype
<i>D</i> _ <i>E</i> _	Normal hearing
<i>dd</i> __	Deaf
__ <i>ee</i>	Deaf

Pedigree Illustrating the Inheritance of Congenital Deafness



31. The evidence displayed by the pedigree that the alleles for congenital deafness are recessive is that
- A. more female than male offspring are affected
 - B. individuals I-3 and I-4 produced affected offspring
 - C. individuals II-4 and II-5 produced affected offspring
 - D. individuals III-1 and III-2 produced unaffected offspring

Use the following information to answer question 32.

Hemophilia is an X-linked recessive disorder in which blood does not clot normally. The parents of a boy who has hemophilia both have normal blood clotting. The four grandparents of the boy also have normal blood clotting.

32. The probability that a sister of the boy will have hemophilia is
- A. 0.00
 - B. 0.13
 - C. 0.25
 - D. 0.50

Use the following information to answer question 33 and numerical-response question 7.

Some chicken breeds have three different phenotypes for feather colour: black, white, and blue. When a pure-breeding chicken with black feathers is crossed with a pure-breeding chicken with white feathers, all of the offspring have blue feathers.

33. The alleles that determine feather colour in chickens as described above are **most likely**
- A. linked alleles
 - B. multiple alleles
 - C. X-linked alleles
 - D. incompletely dominant alleles

Numerical Response

7. What is the expected phenotypic ratio for feather colour if two chickens with blue feathers are crossed?

Ratio: _____ : _____ : _____
Phenotype: **Black** **Blue** **White**

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

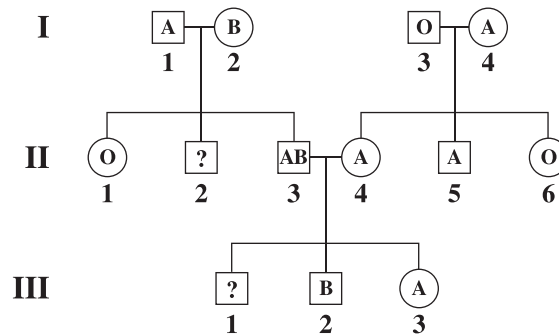
Use the following information to answer numerical-response question 8.

The genotypes and phenotypes associated with the inheritance of ABO blood type in humans are shown in the table below.

The Inheritance of ABO Blood Type in Humans

Phenotype	Genotype
Type A blood	$I^A I^A, I^A i$
Type B blood	$I^B I^B, I^B i$
Type AB blood	$I^A I^B$
Type O blood	ii

Pedigree Illustrating the Inheritance of ABO Blood Type



The letters shown in the pedigree symbols indicate the phenotypes of the individuals.

Numerical Response

8. Individuals I-1 and I-2 have a fourth child. What is the probability that their child is a daughter with type A blood?

Answer: _____

(Record your answer as a value rounded to two decimal places in the numerical-response section on the answer sheet.)

Use the following information to answer question 34.

In rice, the genes for grain weight (*GW*), root length (*RL*), panicle weight (*PNW*), and leaf angle (*LA*) are all found on chromosome 5. Map distances between the four genes are shown below.

Genes	Distance in Map Units
<i>GW</i> and <i>RL</i>	31
<i>RL</i> and <i>PNW</i>	95
<i>GW</i> and <i>LA</i>	50
<i>LA</i> and <i>RL</i>	81
<i>PNW</i> and <i>LA</i>	14

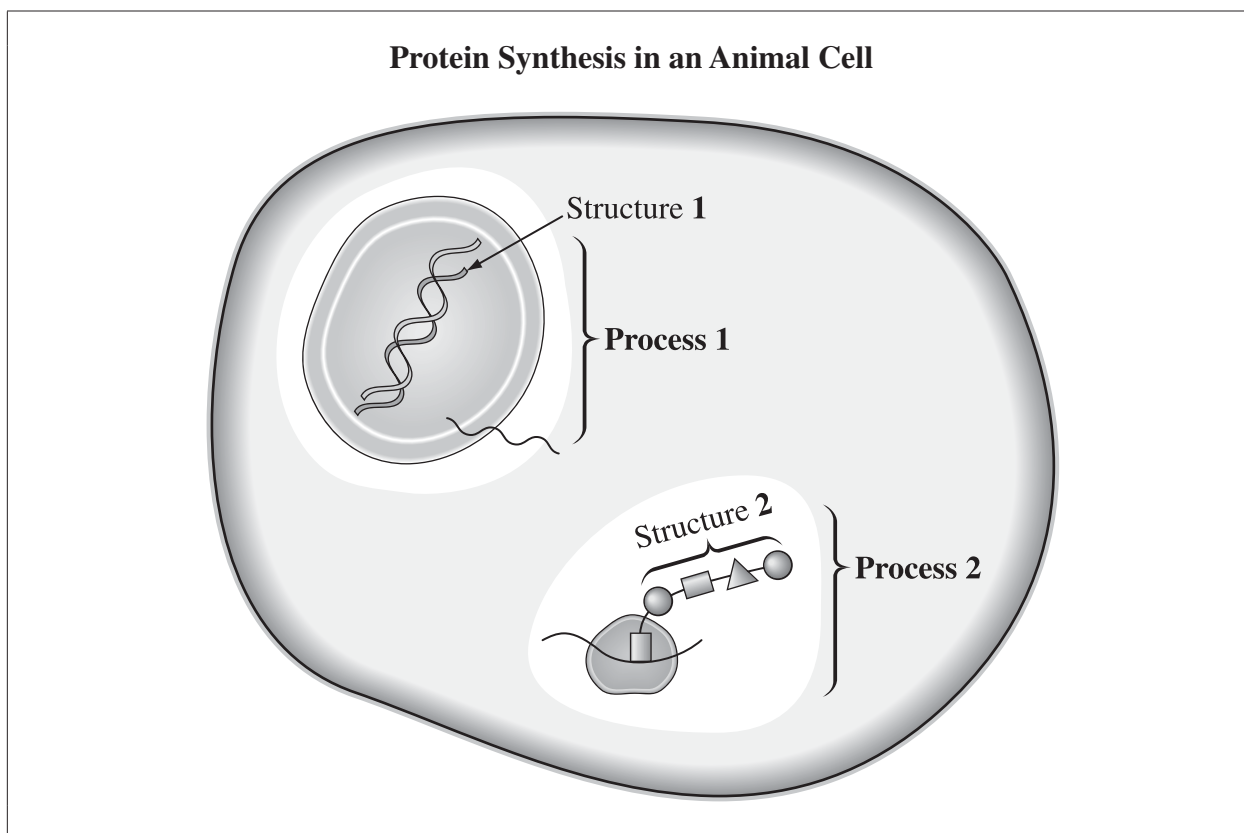
—based on USDA Agricultural Research Service, 2003

United States Department of Agriculture, Agricultural Research Service. 2003. *Rice Research Unit Genetic Characterization of Rice Traits and Mapping Populations Program*. Last modified March 4. usda-ars-beaumont.tamu.edu/bio.html. Accessed July 5, 2005.

34. The order of the four genes on chromosome 5 in rice is

- A. *PNW, LA, GW, RL*
- B. *PNW, GW, RL, LA*
- C. *RL, LA, GW, PNW*
- D. *RL, GW, PNW, LA*

Use the following information to answer question 35.



35. Which of the following rows identifies the structures and processes of protein synthesis, as shown in the diagram above?

Row	Structure 1	Process 1	Structure 2	Process 2
A.	Gene	Transcription	Protein	Translation
B.	Gene	Translation	Protein	Transcription
C.	Protein	Transcription	Gene	Translation
D.	Protein	Translation	Gene	Transcription

Use the following information to answer question 36.

Viruses are simple pathogens that can reproduce only within a host cell. The Picornaviridae family contains about 200 viruses that cause a wide variety of diseases, including the common cold, polio, and hepatitis A. A picornavirus contains RNA as its genetic material and is active only when it is in a host cell.

- 36.** Which of the following statements identifies a difference between the genetic material of a picornavirus and the genetic material of its host cell?
- A.** The genetic material of a picornavirus is a double helix, whereas the genetic material of its host cell is a single helix.
 - B.** The genetic material of a picornavirus is a single helix, whereas the genetic material of its host cell is a double helix.
 - C.** The genetic material of a picornavirus contains thymine, whereas the genetic material of its host cell contains uracil.
 - D.** The genetic material of a picornavirus contains cytosine, whereas the genetic material of its host cell contains guanine.

Use the following information to answer question 37.

Mutations in mitochondrial DNA can cause abnormalities in hair cells located in the organ of Corti and are linked to certain forms of hearing loss.

—based on Pandya, 2004

Pandya, Arti. 2004. Nonsyndromic hearing loss and deafness, mitochondrial. *GeneReviews*, October 22. Last updated July 3, 2014. www.ncbi.nlm.nih.gov/books/NBK1422/c.

37. Mutations in the hair cells in the organ of Corti are transmitted from a
- A. father to his daughters only
 - B. father to all of his children
 - C. mother to her sons only
 - D. mother to all of her children

Use the following information to answer numerical-response question 9.

An Amino Acid Sequence

serine—lysine—tyrosine—asparagine

Nucleotide Sequences

- 1 AGT TTT ATA TTG
- 2 GGT TTT GTA AAC
- 3 UCA AAA UAU AAC
- 4 AGU UUU AUA UUG

Numerical Response

9. Given the amino acid sequence above, match the number of each nucleotide sequence with the type of nucleic acid that it codes for.

Number:	_____	_____	_____	_____
Nucleic acid:	mRNA	tRNA	DNA that codes for the amino acid sequence	DNA that does not code for the amino acid sequence

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

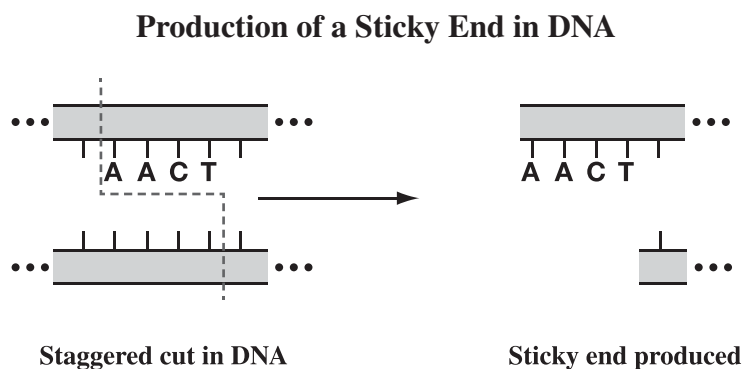
Use the following information to answer question 38.

A silent mutation occurs when a change to a single nucleotide in a gene sequence results in an altered DNA triplet but an unaltered amino acid.

38. A change in a gene sequence that is an example of a silent mutation is a change from
- A. TGT to AGT
 - B. ATA to ATG
 - C. CCC to GGG
 - D. AUC to AUG

Use the following information to answer question 39.

Certain enzymes produce staggered cuts in DNA known as sticky ends. A sticky end has a specific sequence of nitrogen bases.



39. Which of the following rows identifies the enzyme that produces a sticky end, as shown above, and the sequence of bases in DNA that are complementary to the sequence of bases of the sticky end?

Row	Enzyme	Sequence of Bases
A.	Ligase	UUGA
B.	Ligase	TTGA
C.	Restriction enzyme	UUGA
D.	Restriction enzyme	TTGA

Use the following information to answer question 40.

Biologists studied the migration patterns of grizzly bears from two populations that are separated by a major highway in Alberta. By analyzing DNA from fur caught in barbed wire, the biologists were able to differentiate one grizzly bear population from another.

The biologists made the following conclusions:

- Grizzly bear populations on different sides of the highway are genetically distinct.
- Very few grizzly bears migrate across the highway; those that do are usually male.
- Grizzly bear populations that are not separated by the highway are genetically diverse.

—based on Proctor and Paetkau, 2004

Proctor, Michael, and David Paetkau. 2004. *A Genetic-based Spatial Analysis of Grizzly Bears in Alberta*, March. Commissioned by: Alberta Sustainable Resource Development, Fish and Wildlife Division.

40. Grizzly bear populations on different sides of the highway are genetically distinct from one another because of
- A. decreased natural selection
 - B. a decreased rate of gene flow
 - C. a decreased rate of genetic drift
 - D. a decreased number of mutations

Use the following information to answer numerical-response question 10.

The Roma are a group of traditionally nomadic people who wandered in search of food, work, and places to camp. Genetic analysis indicates that the Roma people descended from populations in India and Pakistan. Three main groups of Roma presently live in Europe, each of which originated when a few individuals broke away from the parent population and formed new, isolated communities.

Congenital myasthenic syndrome (CMS) is an autosomal recessive disorder that is found in a higher-than-normal frequency in a Roma population in Europe. Researchers examined 43 people for CMS in the population and found that 13 of them had the disorder.

—based on Abicht et al., 1999

Abicht, A., R. Stucka, V. Karcagi, A. Herczegfalvi, R. Horváth, W. Mortier, U. Schara et al. 1999. A common mutation (ε1267delG) in congenital myasthenic patients of Gypsy ethnic origin. *Neurology* 53, no. 7 (October 22): 1564. doi:10.1212/WNL.53.7.1564.

Numerical Response

- 10.** What is the frequency of the CMS disorder in the Roma population examined by the researchers?

Answer: _____

(Record your answer **as a value rounded to two decimal places** in the numerical-response section on the answer sheet.)

Use the following information to answer question 41.

Niemann–Pick disease type C is an autosomal recessive disorder caused by mutations in either the *NPC1* or *NPC2* gene. Among the worldwide population, approximately 1 in 150 000 people have Niemann–Pick disease type C.

—based on U.S. National Library of Medicine, 2016

U.S. National Library of Medicine. 2016. Health conditions: Niemann-Pick disease. *Genetics Home Reference*. ghr.nlm.nih.gov/condition/niemann-pick-disease.

41. One step that must be performed in order to calculate the percentage of the worldwide population that is heterozygous for Niemann–Pick disease type C is
- A. $1 - p$
 - B. $1 - q$
 - C. $1 - q^2$
 - D. $1 - (p^2 + 2pq)$
-

Use the following information to answer question 42.

The glaciers in Glacier Bay, Alaska, have receded unusually quickly over the past 200 years. As a glacier recedes, the granite rock underneath it is exposed. The first organisms that grow in the newly exposed areas are lichens, followed by small plants, and then trees such as mountain alder, Sitka willow, and black cottonwood.

42. The development over time of a variety of communities in an area exposed by a receding glacier is an example of
- A. primary succession
 - B. secondary succession
 - C. a logistic growth pattern
 - D. an exponential growth pattern

Use the following information to answer question 43.

Giraffes and other hoofed animals, including impalas, steenboks, and kudus, feed on acacia trees on the African savannah. Giraffes feed on leaves at the top of the tree, whereas the other hoofed animals, which are smaller than giraffes, feed on the lower leaves.

A controlled study showed that when smaller hoofed animals are prevented from feeding on a tree, giraffes feed on the lower leaves.

—based on Cameron and du Toit, 2007

Cameron, Elissa Z., and Johan T. du Toit. 2007. Winning by a neck: Tall giraffes avoid competing with shorter browsers. *American Naturalist* 169, no. 1 (January): 130–35. doi:10.1086/509940.



43. The giraffe's preference for feeding on leaves at the top of a tree is likely a result of
- A. interspecific competition
 - B. intraspecific competition
 - C. environmental resistance
 - D. predator–prey interactions

Use the following information to answer question 44.

The island of Madagascar is located 400 km off the coast of Africa and 8 000 km off the coast of Indonesia. Genetic evidence suggests that Madagascar was originally settled approximately 1 200 years ago by a relatively small group of Indonesians that included about 30 women.

—based on Cox et al., 2012

Cox, Murray P., Michael G. Nelson, Meryanne K. Tumonggor, François-X. Ricaut, and Herawati Sudoyo. 2012. A small cohort of Island Southeast Asian women founded Madagascar. *Proceedings of the Royal Society B: Biological Sciences* 279, no. 1739 (July 22): 2761–68. doi:10.1098/rspb.2012.0012.

44. The genetic evidence suggests that the settlement of Madagascar **most closely** exemplified the
- A. founder effect, and immigration was the main factor contributing to early population growth
 - B. founder effect, and natality was the main factor contributing to early population growth
 - C. bottleneck effect, and immigration was the main factor contributing to early population growth
 - D. bottleneck effect, and natality was the main factor contributing to early population growth

Use the following information to answer question 45.

Tansy ragwort is a plant that was introduced to North America from Europe and Asia. In 1976, a large area of grassland in Oregon was infested with tansy ragwort.

To help control the infestation, the cinnabar moth and the ragwort flea beetle, two species not native to Oregon, were introduced to the infested area. Cinnabar moths and ragwort flea beetles use tansy ragwort as a food source.

By 1988, the area infested with tansy ragwort had been reduced by approximately 75 percent.

—based on McEvoy et al., 1991

McEvoy, Peter, Caroline Cox, and Eric Coombs. 1991. Successful biological control of ragwort, *Senecio jacobaea*, by introduced insects in Oregon. *Ecological Applications* 1, no. 4 (November): 430–42.

45. The **first** effect of introducing cinnabar moths and ragwort flea beetles on the population of tansy ragwort was
- A. a decrease in biotic potential
 - B. an increase in biotic potential
 - C. a decrease in environmental resistance
 - D. an increase in environmental resistance

Use the following information to answer numerical-response question 11.

Rocky Mountain bighorn sheep live along the border between Alberta and British Columbia in the southern half of both provinces.

Rocky Mountain Bighorn Sheep Population in 1989 and 2008

Sample Area	1989	2008
Area 1	5 215	5 815
Area 2	785	870
Area 3	4 000	4 500

—based on Jorgenson, 2008

Jorgenson, Jon T. 2008. Rocky Mountain bighorn sheep status report – Alberta. *Biennial Symposia Northern Wild Sheep and Goat Council* 16:30–36. media.nwsgc.org/proceedings/NWSGC-2008/AlbertaStatus_Report_NWSGC_Final_2008%20alberta.pdf.

Numerical Response

11. What was the growth rate of the Rocky Mountain bighorn sheep population in Area 1 between 1989 and 2008?

Answer: _____ bighorn sheep/year

(Record your answer as a value rounded to one decimal place in the numerical-response section on the answer sheet.)

Use the following information to answer question 46.

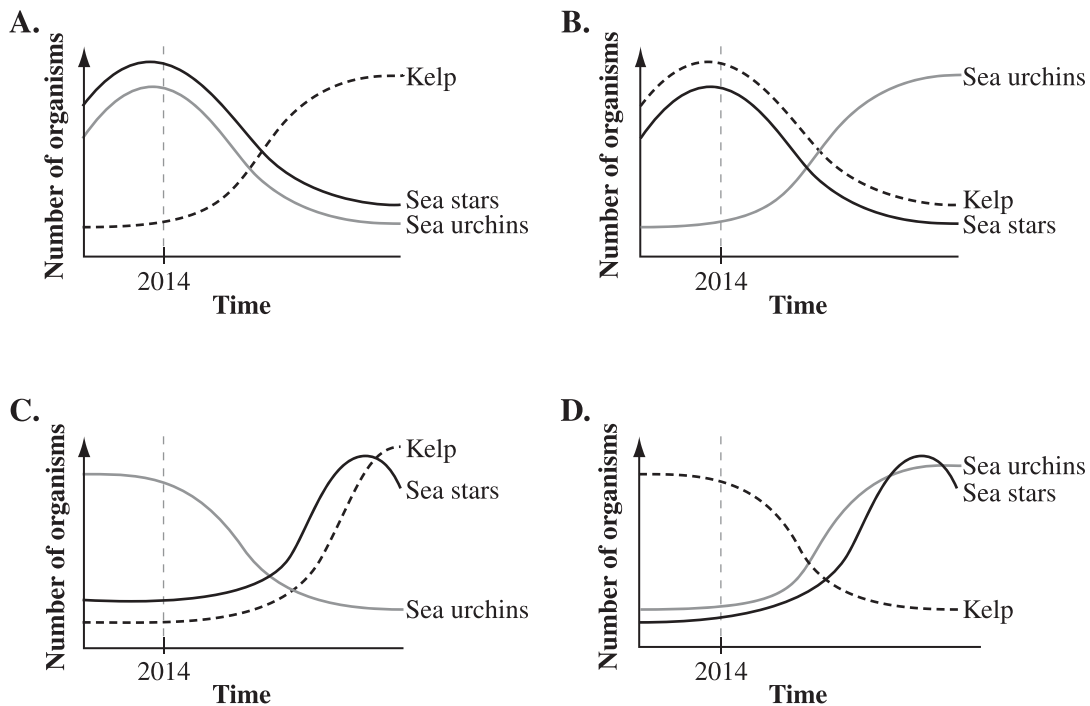
Sea stars are marine organisms. In 2013, the population of sea stars rapidly increased along the Pacific coast. In 2014, the spread of a disease called sea star wasting disease caused sea star populations to rapidly decline.

A main food source for sea stars is another marine organism called sea urchins. Sea urchins eat kelp, which is a marine plant.

—based on Hewson et al., 2014

Hewson, Ian, Jason B. Button, Brent M. Gudenkauf, Benjamin Miner, Alisa L. Newton, Joseph K. Gaydos, Janna Wynne et al. 2014. Densovirus associated with sea-star wasting disease and mass mortality. *Proceedings of the National Academy of Sciences of the United States of America* 111, no. 48 (December 2): 17278-83. doi:10.1073/pnas.1416625111.

46. The graph that **best** represents the population growth of sea stars, sea urchins, and kelp after 2014 is



Use the following information to answer numerical-response question 12.

The lake sturgeon is one of the longest-living species of fish that inhabits the North Saskatchewan and South Saskatchewan rivers of Alberta. Lake sturgeon can live to be older than 100 years. Females reach sexual maturity at approximately 25 years of age and reproduce every 4 or 5 years.

During reproduction, females release approximately 50 000 eggs into the water, and males release sperm into the water, where fertilization occurs. The fertilized eggs mature for approximately 1 week before hatching.

Reproductive Strategies

- 1 r -selected
- 2 K -selected

Numerical Response

12. Using the numbers above, match the reproductive strategy with the characteristic of lake sturgeon that **best** represents it given below. (A number may be used more than once.)

Number: _____
Characteristic: **Lifespan** **Age of sexual maturity** **Number of eggs released** **Fertilized egg maturation**

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