

Released Items

Biology 30



Diploma Examinations Program 2019

Alberta

This document was written primarily for:

Students	✓
Teachers	✓ of Biology 30
Administrators	✓
Parents	
General Audience	
Others	

Alberta Education, Government of Alberta

2019–2020

Biology 30 Released Items

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Please note that if you cannot access one of the direct website links referred to in this document, you can find diploma examination-related materials on the [Alberta Education website](#).

Introduction

The questions in this document are from the *Biology 30 November 2018 Diploma Examination*. This material, along with the Biology 30 Program of Studies, *Biology 30 Information Bulletin*, *Biology 30 Archived Bulletin*, *Biology 30 Student-based Performance Standards*, *Biology 30 Assessment Exemplars*, 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 can be found in the 2019-2020 *Biology 30 Information Bulletin*. The percentage reported in the *Difficulty* column indicates the proportion of students who answered the question **correctly**.

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To call toll-free from outside Edmonton, dial 310-0000.

Additional Documents

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, course clarifications, information about standards, 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*](#) contain questions from some previous diploma examinations and some practice questions that have been released.

Biology 30 November 2018 Diploma Examination: Blueprint Summary

Key: MC—Multiple Choice; NR—Numerical Response
 RU—Remembering/Understanding; A—Applying; HMA—Higher Mental Activities

Question	Keyed Answer(s)	Outcome	Cognitive Level	Difficulty (%)
NR1	5431	A1.1K, A1.2S	RU	75.9
MC1	D	A1.1K	A	51.3
MC2	A	A1.1K, A1.6K, A1.3STS	A	53.2
MC3	C	A1.2K, A1.3K	A	74.7
MC4	A	A1.3K, A1.2K	A	45.7
NR2	1324	A1.2K, A1.2S	RU	66.4
MC5	B	A1.4K, A1.2S, A1.3STS	RU	69.3
MC6	C	A1.5K, A1.2S	RU	77.1
MC7	D	A2.3K	A	57.5
MC8	C	A2.2K, A2.1K	HMA	54.5
MC9	A	A2.1K, A2.2K	A	53.8
MC10	C	A2.6K, A2.3K, A2.4K	A	54.0
MC11	D	A2.6K, A2.2K, A2.3K, A2.4K	A	51.8
MC12	D	A2.3K, A2.2K	RU	59.5
MC13	A	A2.2K	A	61.4
NR3	2314, 3214, 2341, 3241	B1.2K	RU	78.9
MC14	A	B1.2K, B1.3K, B2.3K, B1.2S	A	52.0
MC15	A	B2.3K, B2.3S	A	67.4
NR4	4578 (any order)	B1.1K, B1.2K, B1.5K, B1.2S, B1.1STS	RU	78.2

Key: MC—Multiple Choice; NR—Numerical Response
 RU—Remembering/Understanding; A—Applying; HMA—Higher Mental Activities

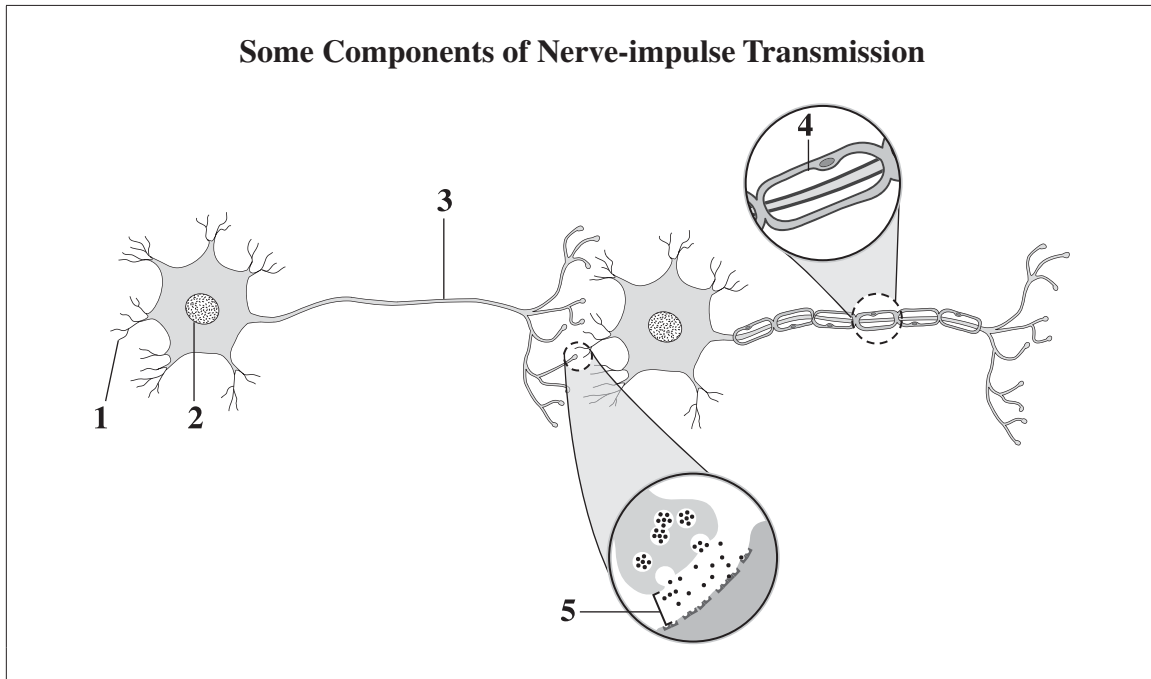
Question	Keyed Answer(s)	Outcome	Cognitive Level	Difficulty (%)
MC16	B	B1.2K, B1.1K	A	75.1
MC17	A	B1.4K, B1.1K, B1.2K, B2.1K	A	64.3
MC18	B	B3.5K, B2.1K, B3.1STS	RU	70.6
MC19	C	B2.2K, B2.2S	HMA	51.6
MC20	D	B2.2K	A	62.8
MC21	B	B3.1K, B3.3S	RU	56.4
NR5	3241	B3.3K, B3.1K	RU	52.5
MC22	C	B3.2K, B3.4K, B3.2S, B3.2STS	HMA	70.2
MC23	D	C1.1K, C1.1STS	A	37.6
MC24	C	C1.1K, C2.1K	HMA	55.9
MC25	D	C1.2K, C1.1K	A	63.9
MC26	B	C1.2K, C1.2S	RU	73.5
MC27	B	C1.2K, C1.2S	HMA	57.9
NR6	1432	C1.3K	RU	36.9
MC28	A	C1.5K, C1.3K, C1.3S	HMA	66.9
MC29	D	C1.7K, C1.4K, C1.2S	A	63.3
MC30	B	C1.7K, C1.2S	A	66.6
MC31	C	C2.2K, C2.3S	A	71.3
MC32	A	C2.2K, C2.3S	A	73.2
MC33	C	C2.2K, C2.3S	A	49.5
MC34	A	D1.3K, D1.3S	A	52.9

Key: MC—Multiple Choice; NR—Numerical Response
 RU—Remembering/Understanding; A—Applying; HMA—Higher Mental Activities

Question	Keyed Answer(s)	Outcome	Cognitive Level	Difficulty (%)
MC35	B	C2.2K, C2.3S	A	73.3
NR7	1010, 2020, 4040, 8080	C2.2K, C2.3S	A	61.5
MC36	B	C2.5K, C2.3S	A	64.8
MC37	C	C2.2K, C2.3S	A	62.0
MC38	D	C2.5K, C2.3S	A	63.5
NR8	0.25	C2.2K, C2.3S	HMA	59.0
NR9	38.7	C2.3K, C2.3S	A	46.7
NR10	2413	C3.1K, C2.1K, C2.5K	RU	56.1
MC39	C	C3.3K, C3.2K, C3.2S	RU	67.6
MC40	D	C3.3K, C3.2S	A	86.4
MC41	A	C3.6K, C3.3K, C3.2S	A	70.5
MC42	D	C3.7K, C1.3K	A	49.5
MC43	B	D1.1K, D1.2K, D1.4K	A	70.8
NR11	0.02	D1.3K, D1.3S	HMA	51.3
NR12	1342	D3.2K, D2.1K, D2.3K, D2.3S	A	66.9
MC44	B	D2.1K, D2.3S	A	65.1
MC45	A	D3.1K, D2.1K	A	68.6
MC46	C	D3.2K, D3.2S	A	51.5
MC47	A	D3.3K, D3.1K, D3.2K, D3.3S	A	60.6
MC48	B	D3.4K, D3.2K	A	59.1

Biology 30 November 2018 Diploma Examination: Released Items

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



Numerical Response

1. Match four of the components of nerve-impulse transmission numbered above with the descriptions given below.

Number:	_____	_____	_____	_____
Description:	Area into which neurotransmitter is released	Increases speed of transmission	Carries nerve impulses away from the cell body	Receives information from other neurons

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

Use the following information to answer question 1.

Some neurons have one or more types of potassium channels known as Kir2.1 in their membranes. The presence of these channels causes a greater-than-normal number of potassium ions to diffuse out of the neuron.

Ottersen, Ole Petter. 2005. Neurobiology: Sculpted by competition. *Nature* 434, no. 7036 (April 21): 969. doi:10.1038/434969a.

1. The effect of Kir2.1 channels on a neuron is to
- A. initiate depolarization of the neuron
 - B. initiate an action potential in the neuron
 - C. cause the inside of the neuron to become more positive
 - D. cause the inside of the neuron to become more negative

Use the following information to answer question 2.

Researchers have found flavour-modulating chemicals that increase the likelihood that sugar molecules will bind to taste receptors. Small amounts of sugar taste slightly sweet. However, the combination of the same amount of sugar and the flavour modulators intensifies the perception of sweetness.

2. Which of the following rows identifies two processes in neurons that could account for the intensifying of sweetness when sugar is combined with flavour modulators?

Row	Process 1	Process 2
A.	A larger number of neurons is stimulated.	Impulses occur with greater frequency.
B.	A larger number of neurons is stimulated.	The response threshold of the neurons is increased.
C.	Stimulated neurons produce a stronger impulse.	Impulses occur with greater frequency.
D.	Stimulated neurons produce a stronger impulse.	The response threshold of the neurons is increased.

Use the following information to answer question 3.

The enteric nervous system (ENS) plays an important role in the control of the involuntary muscles of the digestive system, which are responsible for the mechanical mixing of food.

3. Which of the following rows identifies the division of the nervous system in which the neurons of the ENS are classified and identifies the type of neuron that **directly** stimulates the muscles of the digestive system?

Row	Division of Nervous System	Type of Neuron
A.	Somatic	Motor
B.	Somatic	Sensory
C.	Autonomic	Motor
D.	Autonomic	Sensory

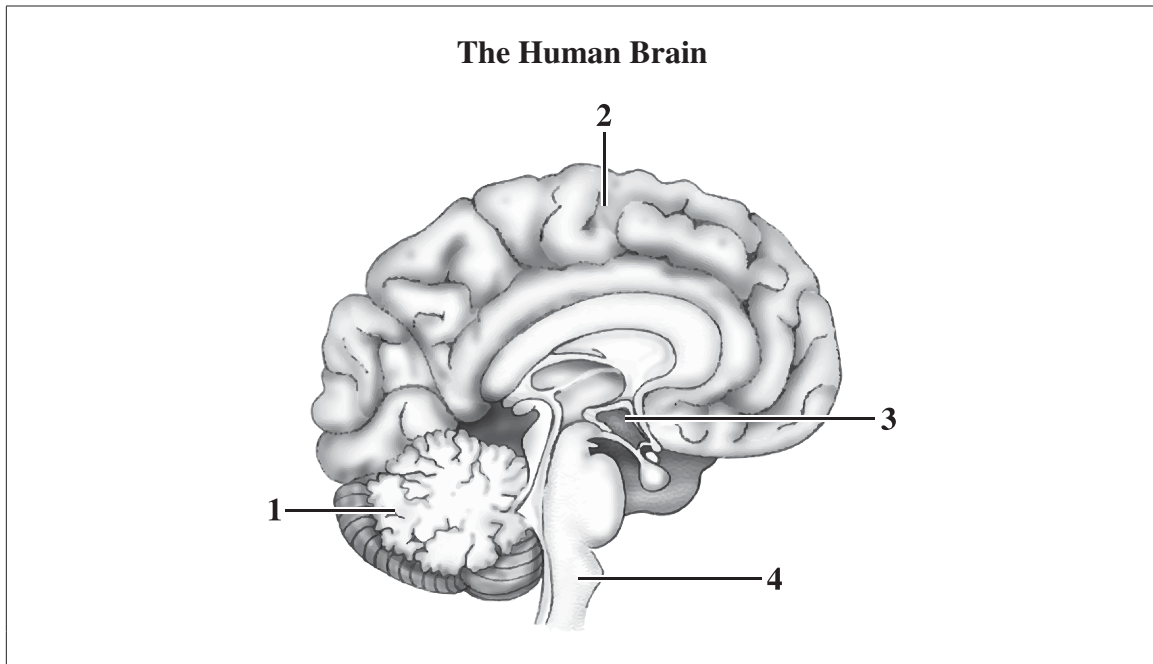
Use the following information to answer question 4.

Guillain–Barré syndrome is an autoimmune disorder in which the immune system damages the nerves of the peripheral nervous system. The most common type of Guillain–Barré syndrome is acute inflammatory demyelinating polyneuropathy (AIDP), a condition in which the immune system attacks the myelin sheath.

One symptom of AIDP is a loss of the knee-jerk reflex.

4. A person with AIDP is expected to have a change in the transmission of motor nerve impulses
- A. exiting the spinal cord and entering the PNS
 - B. exiting the spinal cord and entering the CNS
 - C. travelling through the PNS and then entering the spinal cord
 - D. travelling through the CNS and then entering the spinal cord

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



Numerical Response

2. Match each of the areas of the brain numbered in the diagram above with its function, as given below.

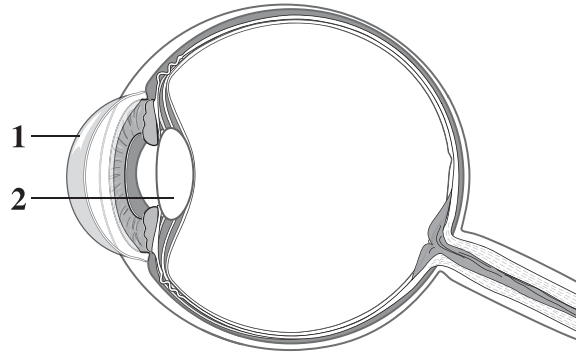
Number:	_____	_____	_____	_____
Function:	Control of muscle coordination	Control of pituitary secretion	Control of voluntary activity	Control of autonomic nervous activity

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

Use the following information to answer question 5.

Laser eye surgery involves the use of a laser to remove small amounts of eye tissue. In one type of laser eye surgery, vision is improved by reshaping the cornea.

The Human Eye



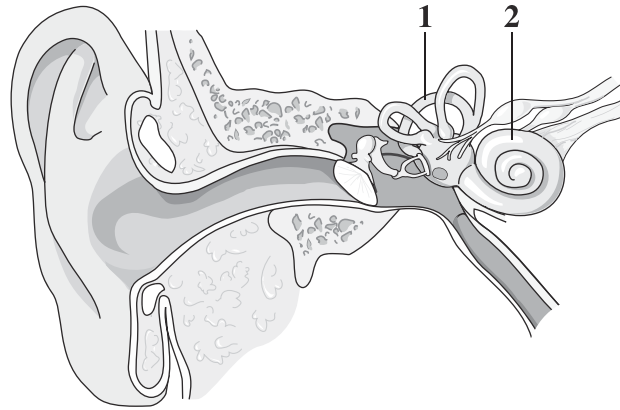
5. Which of the following rows identifies the structure that is reshaped during the type of laser eye surgery described above and **best** describes the function of the structure identified?

Row	Structure	Function
A.	1	Focuses images on the retina
B.	1	Bends light toward the pupil
C.	2	Focuses images on the retina
D.	2	Bends light toward the pupil

Use the following information to answer question 6.

Pendred syndrome is a genetic disorder that can result from the development of an abnormal cochlea.

The Human Ear



6. The structure of the human ear that develops abnormally in a person with Pendred syndrome is numbered
- A. 1, and it is responsible for hearing
 - B. 1, and it is responsible for balance
 - C. 2, and it is responsible for hearing
 - D. 2, and it is responsible for balance

Use the following information to answer question 7.

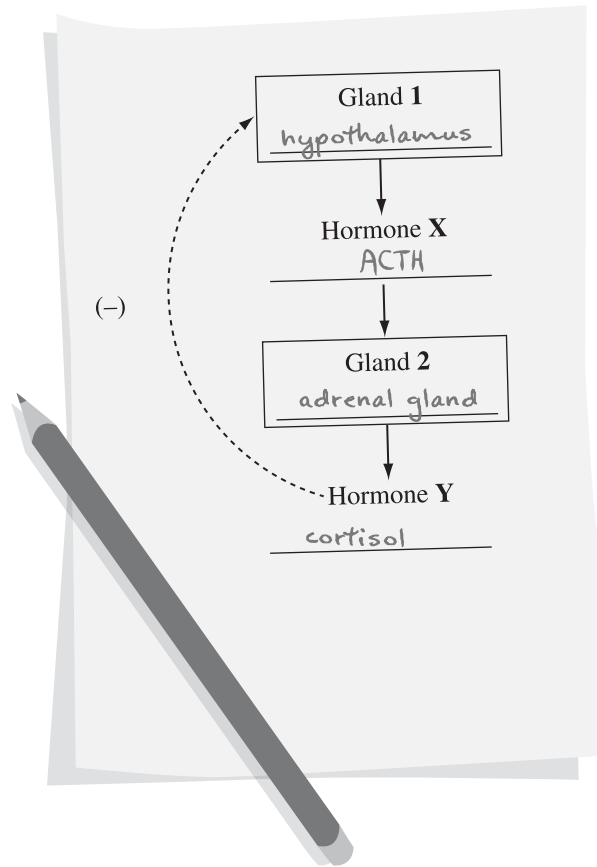
Babies are typically born between the 37th and the 42nd weeks of pregnancy. Babies born before the 37th week are considered pre-term. Researchers studied whether or not long-term stress in the mother was associated with pre-term births of their babies. Women with the highest amount of stress in the forms of negative life impacts and pregnancy-related anxiety throughout their pregnancies were found to have the greatest risk of pre-term birth.

Dole, N., D. A. Savitz, I. Hertz-Picciotto, A. M. Siega-Riz, M. J. McMahon, and P. Buekens. 2003. Maternal stress and preterm birth. *American Journal of Epidemiology* 157 (1): 14–24. doi:10.1093/aje/kwf176.

7. A woman who is at the greatest risk of pre-term birth would be expected to have
- A. lower-than-normal levels of epinephrine, and her blood-glucose levels would be higher than normal
 - B. lower-than-normal levels of cortisol, and her blood-glucose levels would be lower than normal
 - C. higher-than-normal levels of epinephrine, and her blood-glucose levels would be lower than normal
 - D. higher-than-normal levels of cortisol, and her blood-glucose levels would be higher than normal

Use the following information to answer question 8.

A student was asked to label the glands and hormones on a diagram representing the hormonal control of cortisol release.

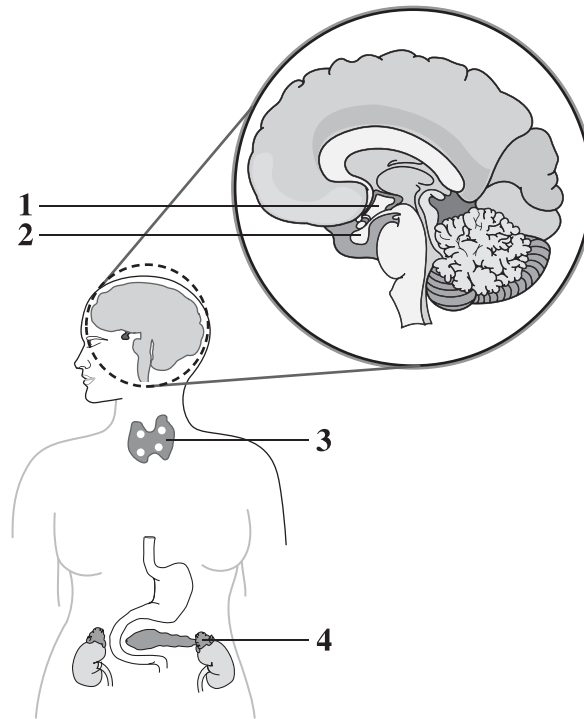


8. Which of the following statements **most appropriately** evaluates the diagram labelled by the student?
- A. Correct, because high levels of cortisol cause negative-feedback messages to be sent to Gland 1
 - B. Correct, because low levels of cortisol cause negative-feedback messages to be sent to Gland 1
 - C. Incorrect, because Gland 1 should be the pituitary gland
 - D. Incorrect, because Gland 2 should be the pituitary gland

Use the following information to answer question 9.

A tropic hormone stimulates the release of another hormone.

Some Endocrine Structures



9. The structures that secrete tropic hormones are numbered

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

Use the following information to answer question 10.

Synthesis of the hormone thyroxine is regulated by levels of TSH and requires sufficient amounts of iodine in the diet.

10. Which of the following rows describes the expected change in the level of thyroxine and the resulting change in the level of TSH in a person whose diet is deficient in iodine?

Row	Level of Thyroxine	Level of TSH
A.	Increases	Increases
B.	Increases	Decreases
C.	Decreases	Increases
D.	Decreases	Decreases

Use the following information to answer question 11.

Hashimoto disease is a disorder of the thyroid gland that is caused by an autoimmune destruction of thyroid cells. Symptoms include swelling of the thyroid gland and a deficiency of hormones secreted by the thyroid gland.

11. Which of the following rows identifies a hormone in which a person with Hashimoto disease is expected to be deficient and describes the function of the hormone?

Row	Hormone	Function
A.	ADH	Increases permeability of kidney tubules to water
B.	ADH	Decreases permeability of kidney tubules to water
C.	Calcitonin	Increases blood-calcium level
D.	Calcitonin	Decreases blood-calcium level

12. The **first** effect of aldosterone in the maintenance of homeostasis is
- A. decreased reabsorption of water from the bloodstream
 - B. increased reabsorption of water from the bloodstream
 - C. decreased reabsorption of sodium ions into the bloodstream
 - D. increased reabsorption of sodium ions into the bloodstream
-

Use the following information to answer question 13.

In an experiment, a group of mice received injections of a fatty acid known as palmitoleate in their muscle cells. A separate group of mice did not receive injections of palmitoleate. The muscle cells of mice that received palmitoleate absorbed higher levels of glucose than the muscle cells of mice that did not receive palmitoleate. Glucose metabolism is similar in humans and in mice.

Cao, Haiming, Kristin Gerhold, Jared R. Mayers, Michelle M. Wiest, Steven M. Watkins, and Gökhan S. Hotamisligil. 2008. Identification of a lipokine, a lipid hormone linking adipose tissue to systemic metabolism. *Cell* 134, no. 6 (September 19): 933–44. doi:10.1016/j.cell.2008.07.048.

13. A hormone that has a similar function to palmitoleate is
- A. insulin
 - B. cortisol
 - C. glucagon
 - D. epinephrine

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

Some Descriptions of Sperm and Seminal Fluid

- 1 Provides fructose
- 2 Provides genetic material
- 3 Contains digestive enzymes
- 4 Contains an alkaline substance

Numerical Response

- 3.** Match each description of sperm and seminal fluid numbered above with the name of the structure or substance associated with it given below. (There is more than one correct answer.)

Number: _____
Name: Sperm Sperm Seminal fluid Seminal fluid

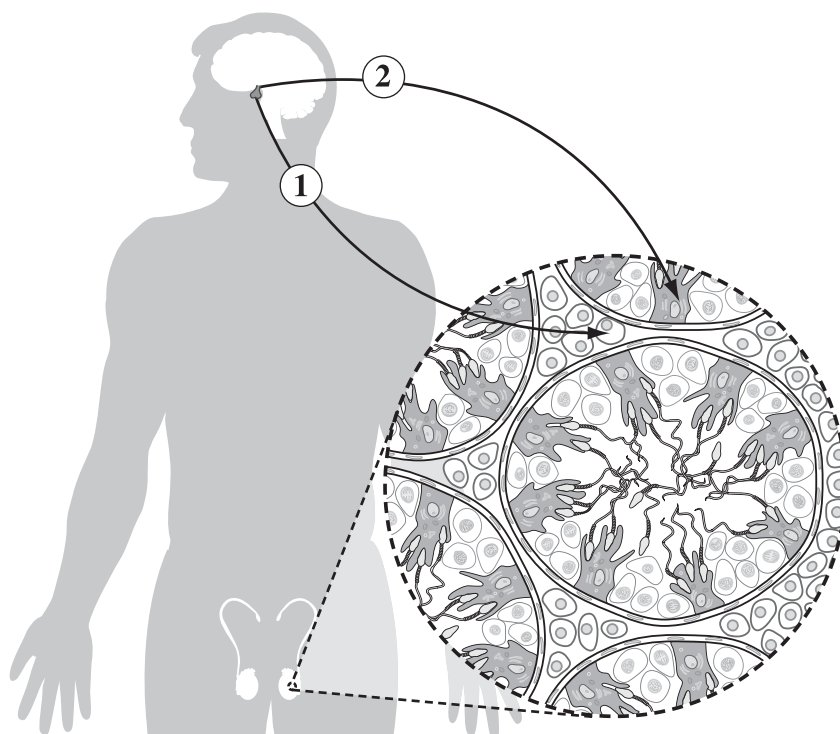
(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following information to answer question 14.

Tumour necrosis factor alpha (TNF-alpha) is a molecule that increases in a person's body as he or she ages. One effect of TNF-alpha is to inhibit testosterone production.

Maggio, M., S. Basaria, G. P. Ceda, A. Ble, S. M. Ling, S. Bandinelli, G. Valenti, and L. Ferrucci. 2005. The relationship between testosterone and molecular markers of inflammation in older men. *Journal of Endocrinological Investigation* 28 (S11): 116–19.

Two Hormonal Pathways in the Human Reproductive System



14. Which of the following rows identifies the hormonal pathway, numbered in the diagram above, that is **directly** affected by TNF-alpha and the type of cell stimulated by the hormonal pathway?

Row	Hormonal Pathway	Type of Cell
A.	1	Interstitial
B.	1	Sertoli
C.	2	Interstitial
D.	2	Sertoli

Use the following information to answer question 15.

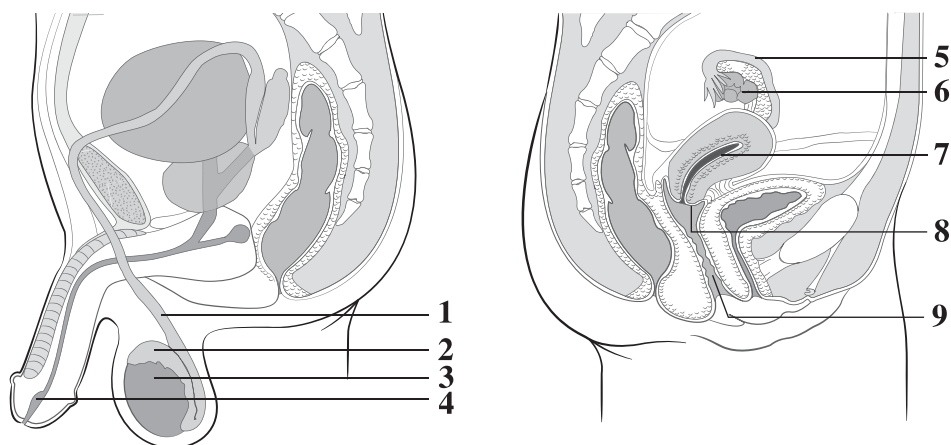
Inhibin is a hormone that has a negative-feedback effect on the secretion of FSH in males.

15. The effect of increased secretion of inhibin on a person's reproductive system is
- A. decreased spermatogenesis
 - B. decreased secretion of testosterone
 - C. increased activity of the Sertoli cells
 - D. increased activity of the interstitial cells

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

Gonorrhea is a sexually transmitted infection caused by the *Neisseria gonorrhoeae* bacterium that grows in warm, moist areas of the body. *N. gonorrhoeae* can grow in the urethra in men and in the Fallopian tubes, uterus, and cervix in women.

Human Reproductive Structures



Numerical Response

4. In the diagrams above, the four areas where *N. gonorrhoeae* can grow are numbered _____, _____, _____, and _____.

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

16. A structure in a man that has a similar function to a Fallopian tube in a woman is the
- A. epididymis
 - B. vas deferens
 - C. seminal vesicle
 - D. seminiferous tubule

Use the following information to answer question 17.

Intersexual fish are genetically male when hatched, but as adults they contain both ovarian and testicular tissue. Intersexual fish have been found in some British waterways, and researchers hypothesize that the development of these fish results from the presence of a reproductive hormone in the waterways.

Jobling, Susan, Richard Williams, Andrew Johnson, Ayesha Taylor, Melanie Gross-Sorokin, Monique Nolan, Charles R. Tyler, Ronny van Aerle, Eduarda Santos, and Geoff Brighty. 2006. Predicted exposures to steroid estrogens in U.K. rivers correlate with widespread sexual disruption in wild fish populations. *Environmental Health Perspectives* 114 (S1): 32–39. doi:10.1289/ehp.8050.

17. Which of the following rows identifies the hormone that is **most likely** responsible for the development of intersexual fish between hatching and adulthood, and the gland that normally produces the hormone identified?

Row	Hormone	Gland
A.	Estrogen	Ovary
B.	Estrogen	Pituitary gland
C.	Testosterone	Testes
D.	Testosterone	Pituitary gland

Use the following information to answer question 18.

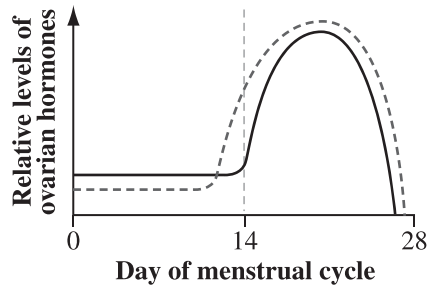
During in vitro fertilization (IVF), a particular hormone is administered to women to stimulate the development of multiple ova.

18. The hormone that is **most likely** administered to women undergoing IVF as described above is

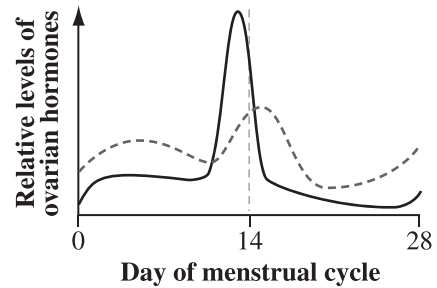
- A. LH
- B. FSH
- C. estrogen
- D. progesterone

19. Which of the following graphs represents the levels of estrogen and progesterone during a typical menstrual cycle, if ovulation occurs on day 14 of the cycle?

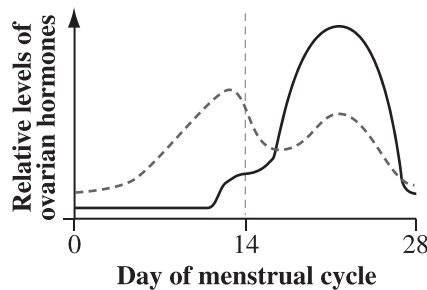
A.



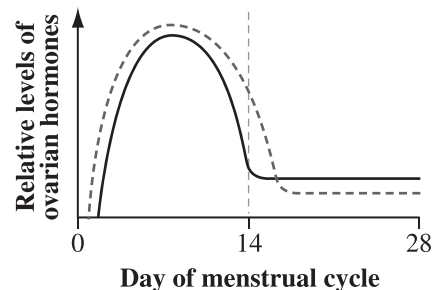
B.



C.



D.



Use the following information to answer question 20.

Scientists hypothesize that stress decreases both the production and release of progesterone.

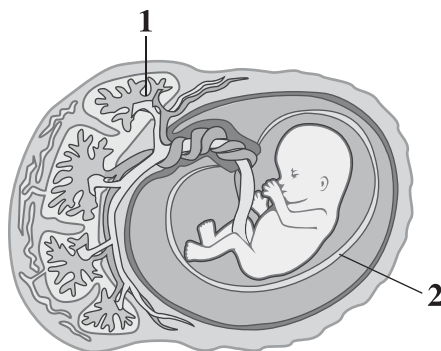
Wang, L., X. Wang, W. Wang, C. Chen, A. G. Ronnenberg, W. Guang, A. Huang, Z. Fang, T. Zang, L. Wang, and X. Xu. 2004. Stress and dysmenorrhoea: A population based prospective study. *Occupational & Environmental Medicine* 61, no. 12 (December): 1021–26. doi:10.1136/oem.2003.012302.

20. A woman who experiences stress during her menstrual cycle is expected to
- A. have increased endometrial development
 - B. have increased follicular development
 - C. ovulate more frequently than normal
 - D. menstruate earlier than normal

Use the following information to answer question 21.

Beckwith–Wiedemann syndrome (BWS) is a genetic disorder associated with abnormal growth in children. Mothers of children with BWS often had enlarged placentas during pregnancy.

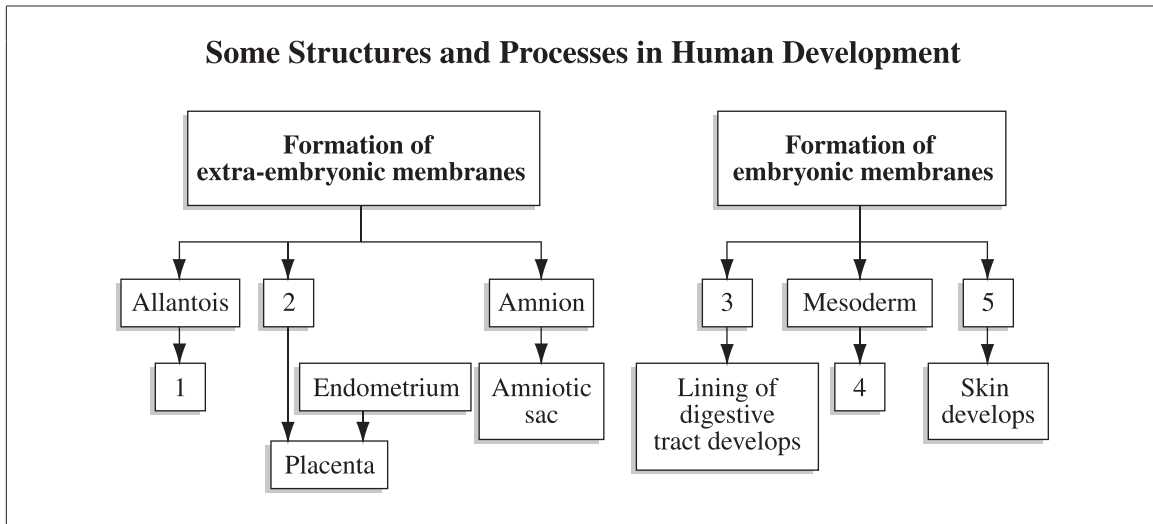
Some Structures Associated with Fetal Development



21. Which of the following rows identifies the structure that is often enlarged in pregnant women who have children with BWS and a hormone produced by the structure?

Row	Structure	Hormone
A.	1	LH
B.	1	Progesterone
C.	2	LH
D.	2	Progesterone

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



Numerical Response

- 5.** Match four of the boxes numbered in the diagram above with their descriptions below.

Number: _____
Description: Endoderm Chorion Skeletal muscle development Umbilical cord development

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

Use the following information to answer question 22.

Danazol, a drug that mimics a particular human reproductive hormone, is taken by both men and women to treat a number of different medical conditions. When taken by pregnant women, danazol can cause the genitals of a female embryo to become masculine.

22. If a pregnant woman takes danazol, the time of pregnancy during which her female embryo is **most likely** to be affected by the drug is
- A. during the first two weeks because the reproductive system differentiates during this time
 - B. during the first two weeks because a high rate of cell division occurs during this time
 - C. between the fifth and eighth weeks because the reproductive system differentiates during this time
 - D. between the fifth and eighth weeks because a high rate of cell division occurs during this time

Use the following information to answer question 23.

To produce large rainbow trout for the sport-fishing industry, fish farmers subject fertilized rainbow trout eggs to high pressure. The pressure causes a fertilized egg to fuse with the chromosomes in a polar body. The resulting structure develops into a larger-than-normal rainbow trout that is sterile.

Rainbow trout have a chromosome number of $2n = 58$ and normally produce gametes by meiosis.

23. In a rainbow trout that is produced by subjecting a fertilized egg to high pressure, the chromosome number of a somatic cell is
- A. $n = 29$
 - B. $n = 58$
 - C. $2n = 58$
 - D. $3n = 87$

Use the following information to answer question 24.

In honey bees, female bees develop from fertilized eggs, and male bees develop from unfertilized eggs.

More than 30 mutations have been described in honey bees, including alterations in eye colour and wing size. Most of these mutations are recessive.

Harbo, J. R., and T. E. Rinderer. 1980. Breeding and genetics of honey bees. *Agriculture Handbook*, no. 335: 49–57.

24. The honey bees expected to have a higher proportion of recessive phenotypes are
- A. females, because they are haploid
 - B. females, because they are diploid
 - C. males, because they are haploid
 - D. males, because they are diploid

Use the following information to answer question 25.

Chlamydia pneumoniae is a bacterium that attacks cells by inserting its DNA into a host cell and causing the production of proteins that alter the normal reproduction of the host cell. One of these proteins is called CopN. In mammalian cells in which CopN is present, the cell cycle stops in interphase after DNA has replicated.

Huang, Jin, Cammie F. Lesser, and Stephen Lory. 2008. The essential role of the CopN protein in *Chlamydia pneumoniae* intracellular growth. *Nature* 456, no. 7218 (November 6): 112–15. doi:10.1038/nature07355.

25. Compared to mammalian cells in which CopN is not present, mammalian cells in which CopN is present have
- A. half the genetic material, and cytokinesis has occurred
 - B. half the genetic material, and cytokinesis has not occurred
 - C. twice the genetic material, and cytokinesis has occurred
 - D. twice the genetic material, and cytokinesis has not occurred

Use the following information to answer question 26.

The following micrograph shows mitosis in some cells in an onion root tip.



26. The phase of mitosis that has **just finished** in the cell labelled 1 in the micrograph is
- A. prophase
 - B. anaphase
 - C. telophase
 - D. metaphase

Use the following information to answer question 27.

A student viewed an onion root tip under a microscope and counted the number of cells in each phase of the cell cycle. The student collected data while looking at three different sites of the onion root tip and recorded it in the table below.

Phase of Cell Cycle	Number of Cells			
	Site I	Site II	Site III	Total
Interphase	171	167	173	511
Prophase	13	17	5	35
Metaphase	8	6	8	22
Anaphase	5	7	7	19
Telophase	3	9	8	20

27. A conclusion supported by the data collected is that in the majority of onion root tip cells
- A. a cell plate is forming
 - B. individual chromosomes are not visible
 - C. chromosomes are lined up in the middle
 - D. spindle fibres are pulling chromosomes apart

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

Some Events in a Cell Cycle

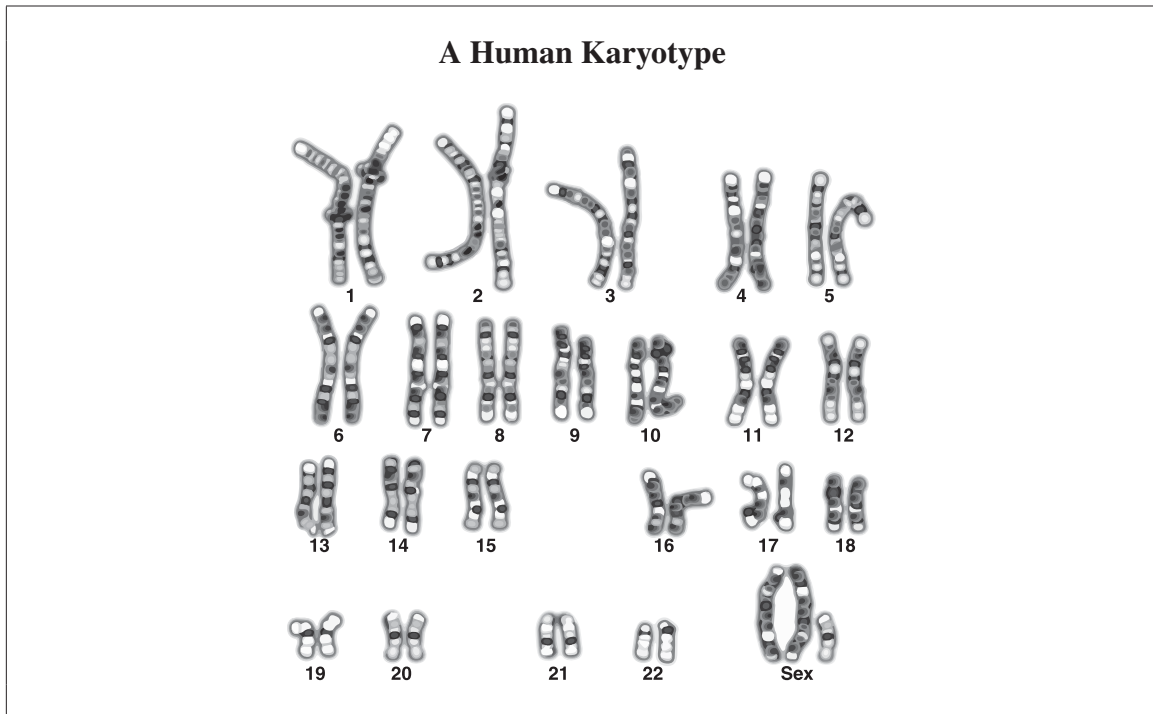
- 1 DNA replicates.
- 2 Sister chromatids separate.
- 3 Homologous chromosomes separate.
- 4 Crossing over between non-sister chromatids occurs.

Numerical Response

6. The order in which the events in the cell cycle numbered 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 question 28.



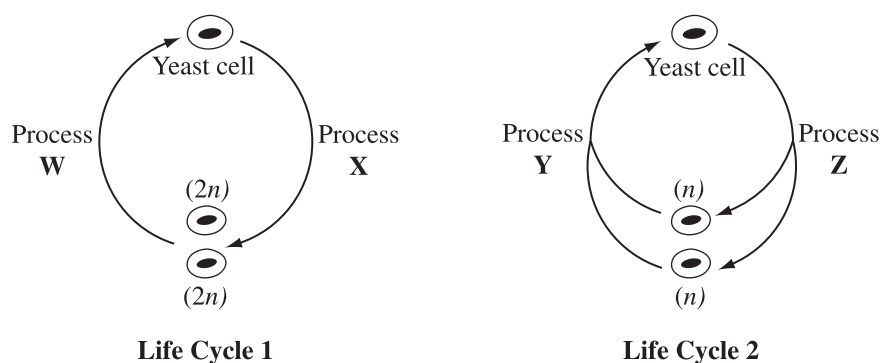
28. Based on the karyotype above, nondisjunction occurred in the parent during either
- A. anaphase I of oogenesis or anaphase I of spermatogenesis
 - B. anaphase I of oogenesis or metaphase I of spermatogenesis
 - C. metaphase I of oogenesis or anaphase I of spermatogenesis
 - D. metaphase I of oogenesis or metaphase I of spermatogenesis

Use the following information to answer question 29.

Saccharomyces cerevisiae is a yeast that reproduces asexually in favourable environmental conditions and sexually in unfavourable environmental conditions.

Goddard, Matthew R., H. Charles, J. Godfray, and Austin Burt. 2005. Sex increases the efficacy of natural selection in experimental yeast populations. *Nature* 434, no. 7033 (March 31): 636–40. doi:10.1038/nature03405.

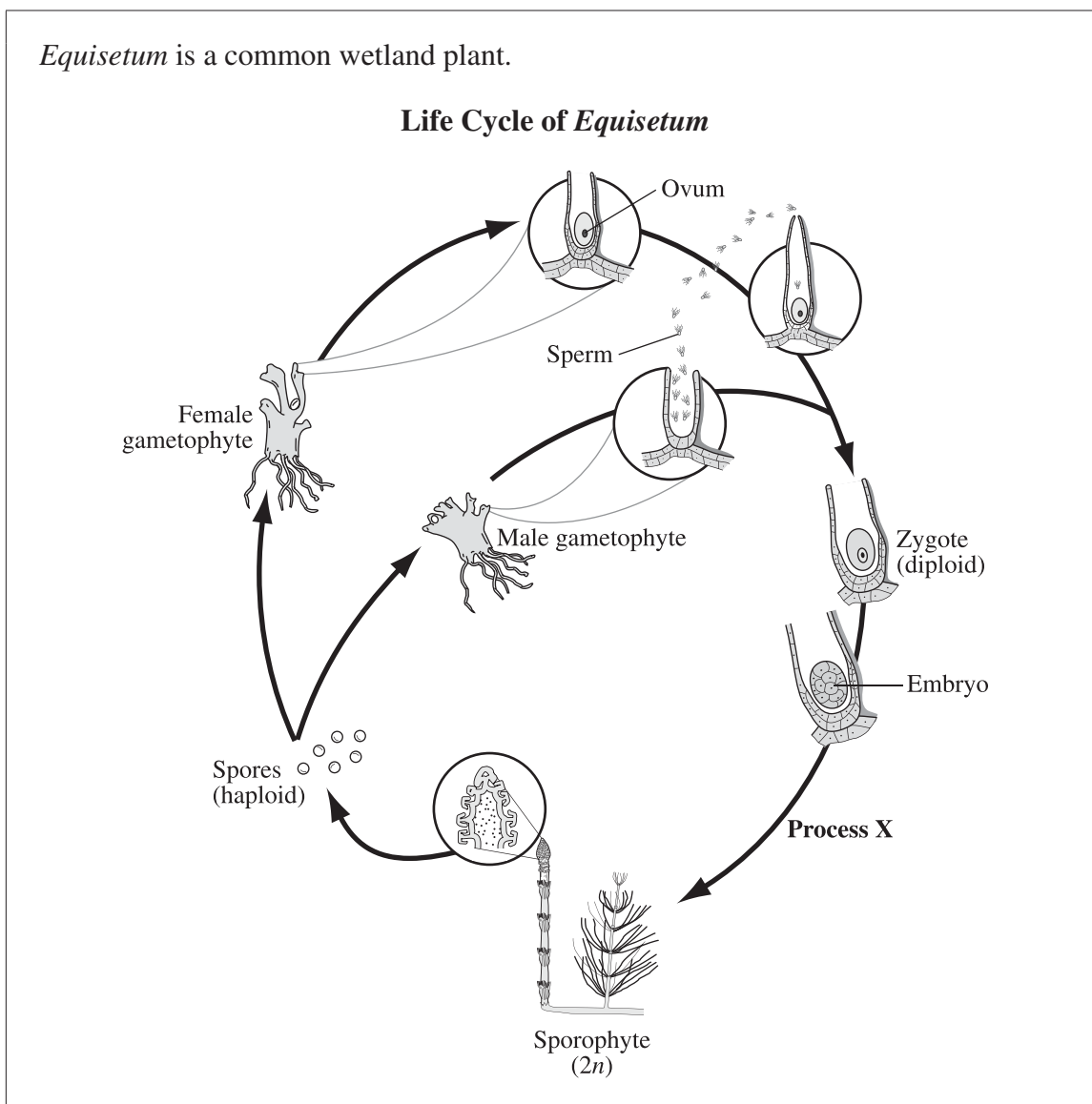
Two Life Cycles of *S. cerevisiae*



29. Which of the following rows identifies processes Y and Z as shown in Life Cycle 2?

Row	Process Y	Process Z
A.	Mitosis	Mitosis
B.	Fertilization	Mitosis
C.	Meiosis	Fertilization
D.	Fertilization	Meiosis

Use the following information to answer question 30.



30. The type of cell division represented by Process X in the life cycle of *Equisetum* is
- A. mitosis, and the cells of the sporophyte are genetically different from the cells of the embryo
 - B. mitosis, and the cells of the sporophyte and the embryo are genetically identical
 - C. meiosis, and the cells of the sporophyte are genetically different from the cells of the embryo
 - D. meiosis, and the cells of the sporophyte and the embryo are genetically identical

Use the following information to answer question 31.

Hyperelastosis cutis (HC) is an autosomal recessive disorder in horses that causes the skin to tear easily.

31. A female horse is known to be a carrier of HC if she is mated with a
- A. heterozygous male horse, and 50% of their offspring have HC
 - B. heterozygous male horse, and 75% of their offspring have HC
 - C. homozygous recessive male horse, and 50% of their offspring have HC
 - D. homozygous dominant male horse, and 75% of their offspring have HC

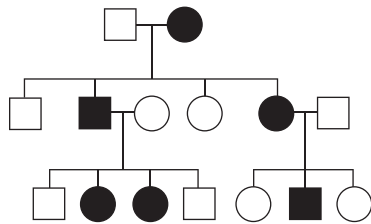
Use the following information to answer questions 32 to 34.

Type 1 neurofibromatosis (NF1) is a genetic disorder that has many different phenotypes. Symptoms include patches of skin pigmentation, tumours of the nervous system, learning disabilities, and hypertension. NF1 is an autosomal dominant disorder that occurs in one in 3 000 births in the U.S.

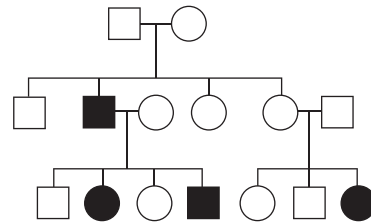
Rasmussen, Sonja A., and J. M. Friedman. 2000. *NF1* gene and neurofibromatosis 1. *American Journal of Epidemiology* 151 (1): 33–40.

32. Which of the following pedigrees **best** represents the inheritance pattern of NF1?

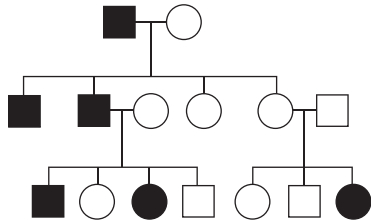
A.



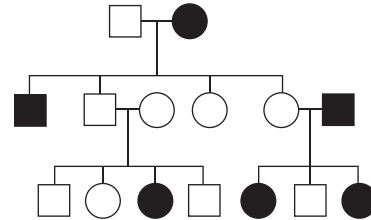
B.



C.



D.



33. A man who is heterozygous for NF1 and a woman who does not have the disorder have a child. What is the probability that this child is a son who has NF1?
- A. 0.00
 B. 0.13
 C. 0.25
 D. 0.50
34. Which of the following expressions represents the frequency of the allele that causes NF1?
- A. $p = 0.000\ 2$
 B. $q = 0.999\ 8$
 C. $q^2 = 0.999\ 7$
 D. $p^2 + 2pq = 0.000\ 3$

Use the following information to answer question 35.

The coats of Labrador retrievers are black, chocolate, or yellow in colour. Two genes control coat colour in these dogs. Their genotypes and phenotypes are shown below.

Genotype	Phenotype
$D_B_$	Black
D_bb	Chocolate
$dd_ _$	Yellow

35. The crossing of a black Labrador retriever with a chocolate Labrador retriever produces a litter of five black puppies and one yellow puppy. The possible genotypes of the parents are
- A. $DdBb$ and $DdBb$
 B. $DdBB$ and $Ddbb$
 C. $DDBb$ and $Ddbb$
 D. $DdBB$ and $DDbb$

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

Coat pattern and colour in the domestic cat are determined by the interaction of two genes. The presence of the dominant agouti allele (*A*) causes more than one colour along a strand of hair, which is necessary to produce a tabby pattern. The presence of two recessive agouti alleles (*a*) causes a solid coat.

The black gene determines coat colour, as shown below.

Genotype	Phenotype
<i>A_B_</i>	Black tabby
<i>A_bb</i>	Chocolate tabby
<i>aaB_</i>	Solid black
<i>aabb</i>	Solid chocolate

Numerical Response

7. What is the expected phenotypic ratio in the offspring that are produced by a cross between a homozygous solid black cat and a heterozygous black tabby cat?

Ratio: _____ : _____ : _____ : _____
Phenotype: **Black tabby** **Chocolate tabby** **Solid black** **Solid chocolate**

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

Use the following information to answer question 36.

The genome of *Drosophila melanogaster*, or fruit fly, has been fully sequenced. One gene that is located on the X chromosome is the gene for crossveinless wings.

D. melanogaster have three pairs of homologous chromosomes and two sex chromosomes. Female flies carry two X chromosomes, whereas male flies have one X chromosome and one Y chromosome. The crossveinless trait is recessive.

Campbell, Neil A. 1987. *Biology*. Menlo Park: The Benjamin/Cummings Publishing Company, Inc.

36. A female fly that is a carrier for crossveinless wings mates with a male fly that has crossveinless wings. What is the probability that this mating produces female flies with crossveinless wings?
- A. 0.13
 - B. 0.25
 - C. 0.50
 - D. 0.75

Use the following information to answer question 37.

Mutations in the *MSTN* gene are associated with abnormal muscle development in whippets, dogs that were developed for racing.

Whippets with two copies of the mutated *MSTN* allele are more muscular than normal and are known as bully whippets.

Whippets with two unmutated *MSTN* alleles have normal muscle development.

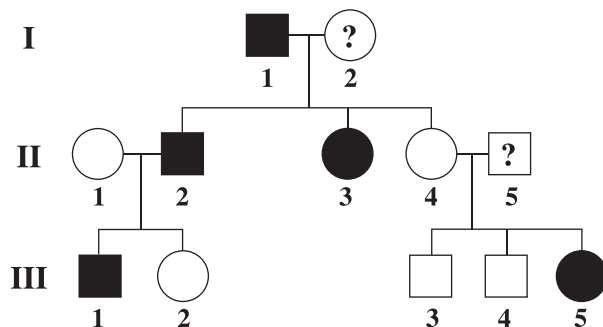
Whippets with one unmutated and one mutated *MSTN* allele are more muscular than normal whippets but not as muscular as bully whippets. The *MSTN* gene is located on chromosome 37.

Mosher, Dana S., Pascale Quignon, Carlos D. Bustamante, Nathan B. Sutter, Cathryn S. Mellersh, Heidi G. Parker, and Elaine A. Ostrander. 2007. A mutation in the myostatin gene increases muscle mass and enhances racing performance in heterozygote dogs. *PLoS Genetics* 3 (5): 779–86. doi:10.1371/journal.pgen.0030079.

37. The mode of inheritance of the *MSTN* gene that controls muscle development in whippets is an example of
- A. multiple alleles
 - B. a sex-linked condition
 - C. incomplete dominance
 - D. an autosomal recessive condition

Use the following information to answer question 38.

The following pedigree illustrates the inheritance of an X-linked recessive condition.



38. Which of the following rows describes individuals **I-2** and **II-5**?

Row	Individual I-2	Individual II-5
A.	Affected	Unaffected
B.	Affected	Affected
C.	Carrier	Unaffected
D.	Carrier	Affected

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

Inheritance of ABO blood types is controlled by three alleles. The alleles for type A blood (I^A) and type B blood (I^B) are co-dominant, and the allele for type O blood (i) is recessive.

Some Descriptions of Blood Type in a Family

Generation I: The father has type A blood and the mother has type AB blood.

Generation II: The oldest child is a son with type A blood; the second-oldest child is a daughter with type B blood; and the youngest child is a son whose blood type is unknown.

Numerical Response

8. If the two parents in Generation I have another child, what is the probability that this child will be a daughter with type A blood?

Answer: _____

(Record your answer as a value between 0 and 1 rounded to two decimal places in the numerical-response section on the answer sheet.)

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

Cross-over Frequencies of Some Genes on Human Chromosome 22

Genes	Cross-over Frequency
1 and 4	25.9%
1 and 3	18.8%
2 and 3	19.9%
2 and 4	12.8%
3 and 4	7.1%

Numerical Response

9. What is the cross-over frequency between genes 1 and 2?

Answer: _____%

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

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

Major Contributions of Some Scientists to Genetics

- 1 Made images of DNA using X-rays
- 2 Used pea plants to formulate laws of inheritance
- 3 Built a model that accurately depicted the structure of DNA
- 4 Compared inheritance patterns for autosomes and sex chromosomes

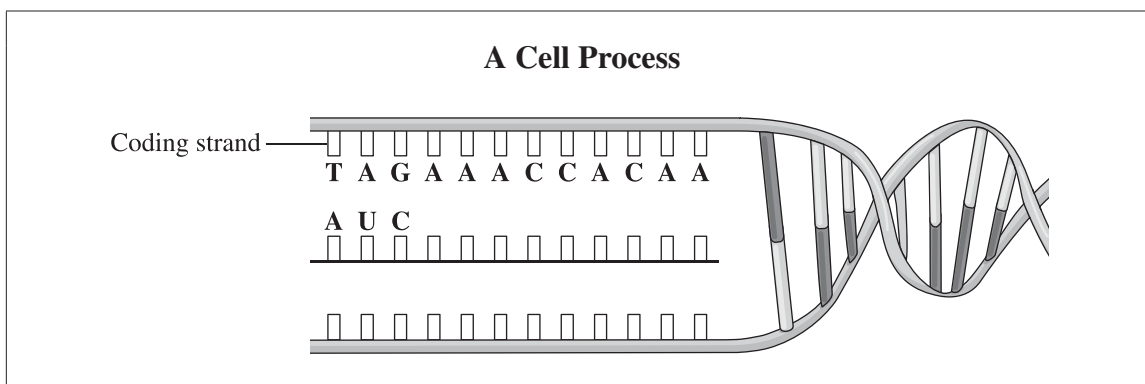
Numerical Response

10. Match each of the contributions listed above with the names of scientists given below who are **most closely** associated with that contribution.

Number: _____
Scientist: Mendel Morgan Franklin Watson and Crick

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

Use the following information to answer question 39.



39. The process illustrated in the diagram above is
- A. replication, and it takes place in the nucleus
 - B. replication, and it takes place in the cytoplasm
 - C. transcription, and it takes place in the nucleus
 - D. transcription, and it takes place in the cytoplasm

Use the following information to answer question 40.

Thalassemia is an autosomal recessive disorder that causes a decrease in hemoglobin in red blood cells.

A Segment of the Gene Associated with Thalassemia

AAC CTC AGT

Beldjord, Cherif, Claudine Lapoumeroulie, Josee Pagnier, M. Benabadi, Rajagopal Krishnamoorthy, Dominique Labie, and Arthur Bank. 1988. A novel β thalassemia gene with a single base mutation in the conserved polypyrimidine sequence at the 3' end of IVS 2. *Nucleic Acids Research* 16, no. 11 (June 10): 4927–35. doi:10.1093/nar/16.11.4927.

40. The amino acid sequence coded by the segment of the gene associated with thalassemia shown above is
- A. asparagine—aspartate—arginine
 - B. asparagine—glutamate—serine
 - C. leucine—histidine—threonine
 - D. leucine—glutamate—serine

Use the following information to answer question 41.

In some horses, a particular gene mutation results in the production of a silver mane and tail. The protein coded by the mutated gene contains the amino acid cysteine instead of the normal amino acid, arginine.

Brunberg, Emma, Leif Andersson, Gus Cothran, Kaj Sandberg, Sofia Mikko, and Gabriella Lindgren. 2006. A missense mutation in *PMEL17* is associated with the Silver coat color in the horse. *BMC Genetics* 7 (October 9): 46. doi:10.1186/1471-2156-7-46.

41. A change in DNA that could lead to the production of a silver mane and tail in a horse is the change from
- A. TCT to ACA
 - B. TCC to TCT
 - C. AGA to ACA
 - D. AGG to ACG
-

Use the following information to answer question 42.

Leigh syndrome is a serious neurological disorder that is caused by mutations in more than 30 different genes. While most of these mutations are found in nuclear DNA, a few of these mutations are located in mitochondrial DNA.

42. Which of the following statements describes the gametes in which the mutations that cause Leigh syndrome are carried?
- A. All of the genes are carried only by ova.
 - B. All of the genes are carried by both ova and sperm.
 - C. Most of the genes are carried only by ova while a few are carried by both ova and sperm.
 - D. Most of the genes are carried by both ova and sperm while a few are carried only by ova.

Use the following information to answer question 43.

Male birds of the species *Parus major* express one of two different shades of yellow in their breast feathers. Some males have bright yellow breast feathers, and other males have pale yellow breast feathers. Males with pale breast feathers produce sperm that are less mobile than sperm produced by males with bright breast feathers. Females prefer to mate with males that have bright yellow breast feathers.

Helfenstein, Fabrice, Sylvain Losdat, Anders Pape Møller, Jonathan D. Blount, and Heinz Richner. 2010. Sperm of colourful males are better protected against oxidative stress. *Ecology Letters* 13, no. 2 (February): 213–22. doi:10.1111/j.1461-0248.2009.01419.x.

43. Which of the following rows identifies a factor influenced by the expression of two types of breast feathers of male birds and describes the potential effect of the factor on the population's gene pool?

Row	Factor	Effect of Factor
A.	Non-random mating	Maintains genetic equilibrium
B.	Non-random mating	Disrupts genetic equilibrium
C.	The bottleneck effect	Maintains genetic equilibrium
D.	The bottleneck effect	Disrupts genetic equilibrium

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

Congenital nephrotic syndrome of the Finnish type (CNF) is a genetic disorder. A person must inherit two alleles in order to develop CNF. In Finland, one in 8 000 people is known to have CNF.

Kestilä, M., M. Männikkö, C. Holmberg, G. Gyapay, J. Weissenbach, E. R. Savolainen, L. Peltonen, and K. Tryggvason. 1994. Congenital nephrotic syndrome of the Finnish type maps to the long arm of chromosome 19. *American Journal of Human Genetics* 54, no. 5 (May): 757–64.

Numerical Response

11. What is the frequency of the heterozygous genotype in the Finnish population described above?

Answer: _____

(Record your answer as a value between 0 and 1 rounded to two decimal places in the numerical-response section on the answer sheet.)

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

Boswellia papyrifera is a species of tree found in mature forests in northern Ethiopia.

Some Statements About *Boswellia papyrifera*

- 1 About 80% of the vegetation in a forest is composed of *B. papyrifera* trees.
- 2 The long-horned beetle, *Idactus spinipennis*, infects *B. papyrifera* trees.
- 3 *B. papyrifera* trees are harvested for their resin, a product that is used to make incense and perfume.
- 4 Fires occasionally occur in the forests that contain *B. papyrifera* trees, but the population is eventually re-established after the fire.

Groenendijk, Peter, Abeje Eshete, Frank J. Sterck, Pieter A. Zuidema, and Frans Bongers. 2012. Limitations to sustainable frankincense production: Blocked regeneration, high adult mortality and declining populations. *Journal of Applied Ecology* 49, no. 1 (February): 164–73. doi:10.1111/j.1365-2664.2011.02078.x.

Numerical Response

- 12.** Match each of the statements about *B. papyrifera* trees numbered above with the term that **best** describes the statement given below. (Use each number only once.)

Number: _____
Term:
 Climax **Environmental** **Secondary** **Parasitism**
 community **resistance** **succession**

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

Use the following information to answer question 44.

Grass can store varying amounts of silica. Rodents called voles use grass as a food source, and the amount of silica present in the grass affects the growth of the vole population. High silica content makes grass difficult for a vole to digest, which leads to decreased growth and reproduction rates in the vole population. Fewer voles consume grass when the silica content is high.

Massey, Fergus P., and Sue E. Hartley. 2006. Experimental demonstration of the antiherbivore effects of silica in grasses: Impacts on foliage digestibility and vole growth rates. *Proceedings of the Royal Society B: Biological Sciences* 273, no. 1599 (September 22): 2299–304. doi:10.1098/rspb.2006.3586.

44. The relationship between the grass and vole populations is **best** described as
- A. symbiotic
 - B. producer–consumer
 - C. interspecific competition
 - D. intraspecific competition

Use the following information to answer question 45.

Wild boars were introduced to Alberta farms in the 1990s and then raised in captivity. Some of the boars escaped from the farms. Despite the harsh climate in Alberta, the non-captive wild boar population increased rapidly.

Non-captive wild boars compete with other wildlife populations for resources. Government officials are concerned about the increasing non-captive wild boar population and its effect on wildlife populations native to Alberta.

Municipal District of Big Lakes. 2010. Wild Boar Program. Accessed October 19. www.mdbiglakes.ca/services/agricultural/asb-programs/wild-boar-program

45. Which of the following rows identifies an expected effect of the non-captive wild boar population on wildlife populations native to Alberta and the reason for the effect?

Row	Effect on Wildlife Populations Native to Alberta	Reason
A.	Decreased growth	Increased interspecific competition
B.	Decreased growth	Increased intraspecific competition
C.	Increased growth	Increased interspecific competition
D.	Increased growth	Increased intraspecific competition

Use the following information to answer question 46.

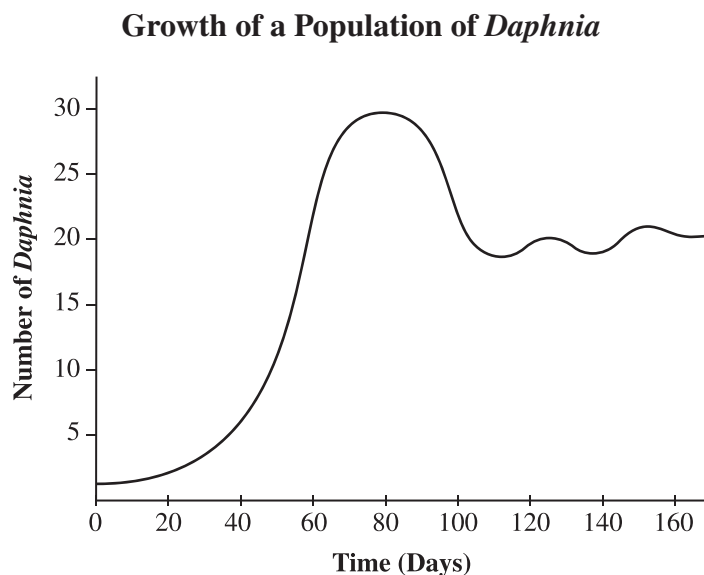
The greater sage grouse is a large bird that lives in the Canadian prairies and is considered to be a species at risk. In 2001, 108 male greater sage grouse were counted at breeding sites in Alberta. In 2012, 13 male greater sage grouse were counted at the breeding sites.

Alberta Wilderness Association. 2016. *Issues: Wildlife, Sage-Grouse, History*. www.albertawilderness.ca/issues/wildlife/sage-grouse/#parentHorizontalTab4.

46. The per capita growth rate of the population of male greater sage grouse in Alberta between 2001 and 2012 was
- A. 0.9
 - B. 7.3
 - C. -0.9
 - D. -7.3

Use the following information to answer question 47.

The graph below represents growth of a population of *Daphnia*, which are small aquatic organisms.



47. Based on the graph, the growth pattern of *Daphnia* over the 160 days is **best** described as
- A. logistic, because population growth is limited
 - B. exponential, because population growth is limited
 - C. logistic, because mortality is always higher than natality
 - D. exponential, because natality is always higher than mortality

Use the following information to answer question 48.

Female caribou reach sexual maturity at three years of age and will typically give birth to one calf per year after that.

48. The reproductive strategy of caribou is **best** described as
- A. *K*-selected, because caribou have a high biotic potential
 - B. *K*-selected, because caribou have a low biotic potential
 - C. *r*-selected, because caribou have a high biotic potential
 - D. *r*-selected, because caribou have a low biotic potential