

- Compare and contrast mitosis and meiosis. What are the advantages and disadvantages of each?*
 Mitosis makes identical copies of cells (1 cell → 2 daughter cells) and it used for growth, replacement of dead or damaged cells, and asexual reproduction. It does not require an opposite sex partner for organisms that reproduce this way, but does not increase genetic variation.
 Meiosis makes genetically different cells (1 cell → 4 gametes) and is used for sexual reproduction. Sexual reproduction requires an opposite sex partner, but increases the genetic variation of the population.
- Describe the process of crossing over. During which stage does it occur?*
 Crossing-over involves swapping a portion of homologous chromosomes, resulting in increased genetic variation of gamete cells. It occurs only during prophase I of meiosis.
- What are the two types of cell cycle regulators? Explain their function in cell division.*
 Two types of cell cycle regulators are internal and external regulators. Internal regulators respond to signals inside the cell, for example, ensuring that DNA replication is complete before initiating mitosis. External regulators respond to signals from outside the cell, for example, contact with other cells, which would slow the cell cycle.
- What is cancer? How does it relate to cell division?*
 Cancer is uncontrolled cell division. Cancerous cells either don't have, or fail to respond to, regulators which keep the cell cycle proceeding normally.
- Why do cells divide? What prompts them to do so? What purpose does it serve?*
 If cells become too large, it is impossible for their DNA to maintain control, and because the cell membrane cannot allow enough material exchange. Cell cycle regulators prompt cells to initiate cell division. Cell division occurs to allow growth, replace damaged cells, or for reproduction.

6. *Using the following information, create Punnett Squares designed to find the required probabilities:*

Brown Hair: H Brown eyes: E
Blond Hair: h Blue eyes: e

a) *What is the probability of having blue eyes if your mother is homozygous dominant and your father is homozygous recessive?*

	E	E
e	Ee	Ee
e	Ee	Ee

0 % probability of blue eyes (all offspring are heterozygous)

b) *What is the probability of having blond hair if your father is heterozygous and your mother is homozygous recessive?*

	h	h
H	Hh	Hh
h	hh	hh

50% probability of blond hair

c) *OMIT*

7. *How do sex-linked chromosomes affect inheritance patterns? Can a daughter inherit a sex-linked chromosomal disorder (such as colour-blindness) from her father?*
Sex-linked chromosomes affect males and females differently; males are more likely to be affected by x-linked disorders than females because males only have one x chromosome. A daughter would need to inherit a disorder like colour-blindness from both her mother and father (recessive disorders require that both x chromosomes are affected in females.)
8. *What is non-disjunction? Is Down syndrome an example of non-disjunction? How about Turner and Klinefelter's? Which chromosomes do these syndromes affect?*
Non-disjunction occurs when chromosomes fail to separate during meiosis. Down syndrome is an example of non-disjunction of chromosome 21. Turner's syndrome occurs when a biological female receives only one x chromosome (X), and Klinefelter's occurs when biological males receive an extra x chromosome (XXY).
9. *What is base-pairing? How is base-pairing involved in DNA replication?*
Base-pairing means that A (adenine) pairs with T (thymine), and C (cytosine) pairs with G (guanine). During DNA replication, each half the DNA double helix unwinds and a new complementary strand is synthesized following the rules of base-pairing.
10. *For the following DNA strand, create a complementary mRNA strand. Then, translate the mRNA into amino acids.*
 T A C C G T A G T C A G T A C G A T A G C T A G C A T A T T
 A U G/G C A/U C A/G U C/A U G/C U A/U C G/A U C/G U A/U A A
 methionine-alanine- serine – valine – methionine -leucine - serine - isoleucine – valine - Stop
11. *Describe the relationship between DNA, chromatin, histones, and nucleosomes.*
DNA and histone proteins form chromatin. DNA strands are wound around histone proteins to form nucleosomes.
12. *What is an anticodon? How does it function?*
An anticodon is the complementary sequence found on tRNA. Each anticodon is three bases long, and complements (corresponds to) the codon sequence found on mRNA. This allows the mRNA to be translated into protein.
13. *Describe the conclusions that Griffith, Avery, and Hershey and Chase drew from their experiments.*
Griffith concluded that some factor could be passed on from cells allowing them to be transformed from R-type to S-type.
Avery and colleagues determined that DNA was required in order for transformation to occur.
Hershey and Chase proved that DNA is the molecule of the gene that allows traits to be passed on from one generation to the next.
14. *If the code for the amino acid asparagine is found in a mRNA sequence, does that mean that asparagine will definitely be part of the complete protein that is produced? Explain.*
No, some sequences are part of introns that are spliced out of the mRNA before translation. Also, proteins undergo modification after translation, so asparagine will not necessarily be part of the final protein product.

15. Compare and contrast **substitution** mutations and **frameshift** mutations. Is one worse? Is one more beneficial?

Substitution and frameshift mutations are both types of point mutations that only affect that one gene. Substitutions change the codon for one amino acid, and will most likely result in less change than frameshifts.

Frameshift mutations involve insertion or deletion of a single nucleotide, resulting in greater changes because the entire sequence can be altered from that point onward.

Whether or not a mutation is beneficial or harmful depends on the protein product that results and how it affects the cell; drastic changes are usually not beneficial.

16. Explain the process that was used to clone Dolly the sheep. What are some ethical issues surrounding cloning?

To make a clone, a donor egg must be harvested from an adult sheep, and then have the nucleus removed. A cell from the animal that is to be cloned is also harvested, and the cell is fused with the donor enucleated egg. The egg now has a complete set of DNA, and it is allowed to go through several cell divisions in the lab, resulting in an embryo. The embryo is then transferred to the uterus of the surrogate mother and grows into a baby (Dolly).

Cloning raises some ethical concerns because animal clones don't tend to be as healthy as non-cloned animals, and have shorter lifespans. There are concerns about the long-term effects, as well as ownership (patents) of cloned organisms.

17. What role does gel electrophoresis play in the study of DNA?

Gel electrophoresis is used to separate DNA strands based on size. DNA strands that are shorter/smaller are able to move through the gel faster and farther, while large molecules do not travel as far. The result is a series of bands arranged by size. DNA samples can then be compared; two samples from the same source would result in identical patterns of bands.

18. What is polyploidy? When is this condition useful?

Polyploidy is the result of having extra sets of chromosomes. This condition can be useful to plants because they grow larger than their diploid counterparts, but it does not occur in most animals.

Describe the process of extracting DNA from a cell.

To extract DNA from cells, the cells must be broken up (usually in a blender), then have a lysis buffer (detergent) added to help bind the lipid components. The mixture is then filtered. Protease and heat are added to help break down the proteins. Finally, to visualize the DNA, cold isopropyl alcohol is added causing the DNA to precipitate in the solution.

19. What is the relationship between a hormone and a target cell?

A hormone acts only on cells that have the proper receptors, i.e. target cells. Cells without the right receptor are not affected by hormones.

20. What happens if blood glucose levels are not kept stable?

If blood glucose levels are not kept stable (not in homeostasis), the result is either hypoglycemia (low blood-sugar) or hyperglycemia (high blood-sugar). In either case, the person's cells are not getting the proper amount of glucose for energy, and they can become very sick or even go into a coma if levels are too high or too low.

21. *Compare and contrast steroid and non-steroid hormones.*

Steroid hormones are able to pass directly through the cell membrane and enter the nucleus, thereby affecting gene activity. Non-steroid hormones do not cross the cell membrane, but bind to a surface receptor and activate a second messenger to alter cell activity, but do not affect genes.

22. *Trace the path of a sperm cell from development in the testis until it leaves the body.*

After a sperm cell forms in the testis, it enters the epididymis portion of the testis to further develop and mature. Sperm are stored in the epididymis until ejaculation. During ejaculation, sperm cells move up via the vas deferens, which eventually merges with the urethra. Sperm cells along with seminal fluid pass through the urethra in the penis as they leave the body.

23. *Trace the path of an unfertilized egg from a follicle until it leaves the body.*

Egg cells are nourished by follicle cells in the ovary. During ovulation, the mature egg cell is released and is pulled into the Fallopian tube. If it is not fertilized, it will eventually disintegrate. If fertilization occurs, the zygote will move from the Fallopian tube to the uterus where it will implant and grow into a baby (if all goes well).

24. *Both the nervous and endocrine system help the body respond to particular situations. How are their roles different?*

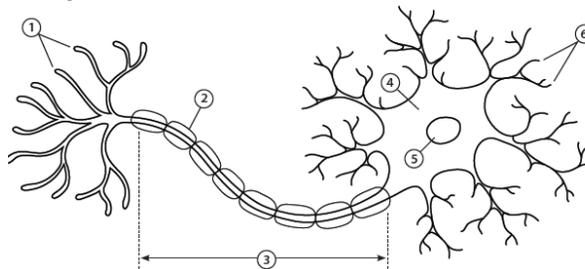
The nervous system is able to respond rapidly to changes and usually exerts its effects immediately for a short period of time. The endocrine system has a slower, but more prolonged effect.

25. *What are voluntary and involuntary actions? Which parts of the brain control them?*

Voluntary actions are those which we consciously choose to do, and are controlled by the cerebrum. Involuntary actions are actions which occur without conscious thought (e.g. heart beating, reflexes, etc.) and are controlled by the lower regions of the brain (cerebellum, brain stem) and spinal cord.

26. *Sketch and label the basic structure of a neuron.*

- 1) axon terminals
- 2) myelin sheath
- 3) axon
- 4) cell body
- 5) nucleus
- 6) dendrites



27. *Describe the 5 types of sensory receptors and their location.*

Pain receptors – response to everywhere but the brain

Chemoreceptors – respond to chemicals; nose and mouth

Mechanoreceptors – sense motion, pressure; in skin, inner ear

Photoreceptors – respond to light; retina of the eye

Thermoreceptors – respond to temperature; skin

28. *Describe the advantage of a reflex in the survival of an organism.*

A reflex allows an organism to respond to danger quickly, which is an advantage for survival. Many reflexes are controlled by the spinal cord, bypassing the brain, so the response is faster.

29. *What was the purpose of Darwin's voyage on the HMS Beagle? What did he gain from it?*

Darwin's purpose during the voyage of the HMS Beagle was to help him learn more about the natural world. During the trip, he realized the diversity of species was far greater than he previously realized,

and was able to gain many important insights from the fossils and living species he studied. Eventually, this allowed him to develop his theory of evolution by natural selection.

30. *How could horse breeders use artificial selection to increase the life span of the individuals in their herds?*

Horse breeders can choose to breed horses that had the longest life spans in the herd. By only choosing the long-lived horses for breeding, after several generations, it would be expected that the life spans of the new horses would be increased.

31. *What is fitness (in evolutionary terms)? How does it relate to adaptation?*

“Fitness” in evolutionary terms refers to an organism’s ability to survive and reproduce in its environment. Adaptations are traits that increase the fitness of an organism.

32. *How does the fossil record support the conclusions drawn by Darwin?*

The fossil record supports Darwin’s conclusions because we can compare fossils from older rock layers with newer rock layers and document the fact that life on Earth has changed over time. Many transitional fossils show the various intermediate stages of evolution of modern species from organisms that are now extinct.

33. *Why did it take so long for Darwin to publish his work?*

Darwin was hesitant to publish his work because his ideas conflicted with long-held, popular beliefs that the Earth was only a few thousand years old, made by a creator, and that species had not changed over time. He anticipated the public uproar that his theory could cause.

34. *How is artificial selection dependent on variation in nature?*

Artificial selection involves choosing organisms with desirable traits to breed. The variation that naturally exists, such as some plants bearing larger fruit, allows this selection to occur.

35. *In a population in genetic equilibrium, 3% of individuals are homozygous recessive for a certain trait, what percentage of the population are expected to be heterozygous?*

If 3% are homozygous recessive, this means that $q^2 = 0.03$.

Find q:

$$q = \sqrt{0.03}$$
$$q = 0.173$$

Find p:

$$p = 1 - q$$
$$p = 1 - 0.173$$
$$p = 0.827$$

Heterozygous individuals are represented by $2pq$:

$$2pq = 2(0.827)(0.173)$$
$$2pq = 0.286$$

Multiply by 100 to find the percentage: $0.286 \times 100 = 28.6\%$ are expected to be heterozygous