



Biology A - Unit 4 - GENETICS Unit Study Guide

*Welcome to your Unit 1 Genetics Answer Key! Answers to each question are in **red**, any additional explanations are provided in **blue***

1. Explain how mutations can be both harmful AND helpful. In your explanation provide 2 examples of disorders resulting from genetic mutations.

Some mutations have a positive effect on the organism in which they occur. They are called beneficial mutations. They lead to new versions of proteins that help organisms adapt to changes in their environment. Beneficial mutations are essential for evolution to occur. They increase an organism's chances of surviving or reproducing, so they are likely to become more common over time.

By the same token, any random change in a gene's DNA is likely to result in a protein that does not function normally or may not function at all. Such mutations are likely to be harmful. Harmful mutations may cause genetic disorders such as cystic fibrosis or sickle cell anemia.

2. Compare and contrast meiosis and mitosis.

Similarities:

- Both mitosis and meiosis are types of cell division.
- Both mitosis and meiosis produce daughter cells.
- Both mitosis and meiosis have the "PMAT" stages (which stand for Prophase, Metaphase, Anaphase, and Telophase).

Differences:

- Mitosis has only one round of cell division, while meiosis has two.
- Mitosis only occurs in somatic (body) cells, while meiosis occurs in sex cells.
- Mitosis produces daughter cells (diploid cells) that are identical to the parent cell, while meiosis produces haploid/monoploid cells that only have half of the normal number of chromosomes.

3. White spotting, or piebald trait, characterized by an absence of hair pigment in specific places, is caused by mutant copies of a **gene**.

(Explanation: A mutant copy of a **gene** is the cause of piebald trait. Traits are genetic and are caused by transmitting information (including mutations) during reproduction.)

4. An unpredicted change occurs in the genetic material of two chromosomes. What do we call this unexpected/unpredicted change in DNA?

Mutation

(Explanation: Mutations may happen spontaneously or as a response to changes in the environment of the chromosomes.)

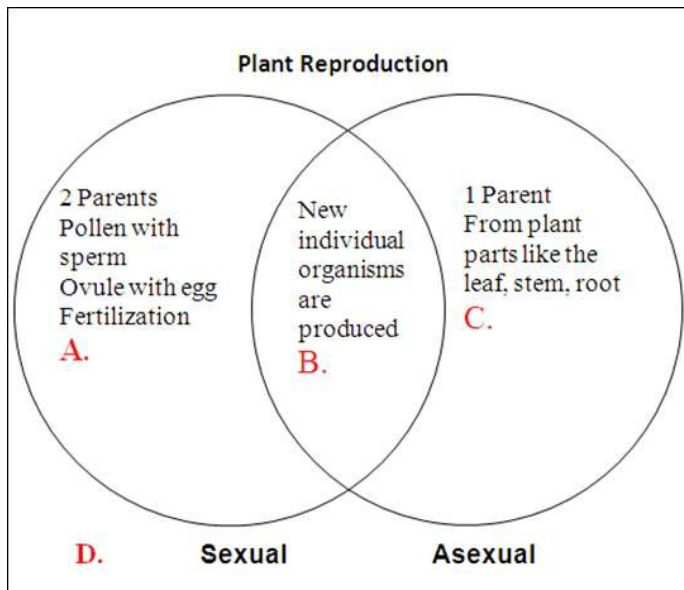
5. The codon chart shown below uses the three base sequence found on the mRNA molecule after the information is copied from DNA during transcription. If the mRNA message is AAC UAC UGC, what was the original DNA base sequence?

		Second Position										
		U		C		A		G				
First Position		code	Amino Acid	code	Amino Acid	code	Amino Acid	code	Amino Acid	Third Position		
		U	U	UUU	phe	UCU	ser	UAU	tyr		UGU	cys
UUC				UCC		UAC			UGC		C	
UUA	leu			UCA		UAA		STOP	UGA	STOP	A	
UUG				UCG		UAG		STOP	UGG	trp	G	
C	CUU		leu	CCU	pro	CAU	his	CGU	arg	U		
	CUC			CCC			CAC			CGC		C
	CUA			CCA			CAA	gln		CGA		A
	CUG			CCG			CAG			CGG		G
A	AUU		ile	ACU	thr	AAU	asn	AGU	ser	U		
	AUC			ACC			AAC		AGC		C	
	AUA			ACA			AAA	lys	AGA		A	
	AUG			ACG			AAG		AGG	arg	G	
G	GUU		val	GCU	ala	GAU	asp	GGU	gly	U		
	GUC			GCC			GAC			GGC		C
	GUA			GCA			GAA	glu		GGA		A
	GUG			GCG			GAG			GGG		G

TTG ATG ACG

6. What are the 3 principles of the Cell Theory?
1. All living organisms are composed of one or more cells.
 2. The cell is the basic unit of structure and organization in organisms.
 3. Cells arise from pre-existing cells.
7. *Palo Verde Tree a Witness for the Prosecution!*
 That could be the headline in a recent murder investigation. Detectives recently discovered pods from a Palo Verde tree in the truck of a suspect in an on-going murder investigation. Detectives on the scene of the crime also found similar trees with pods at the crime scene. How did detectives nab the suspect based on the pod evidence?
- B) Detectives used DNA markers to match the pods from the truck to pods on the scene.
8. What part of the cell contains the “blueprints” for proteins and polypeptide chains, such as insulin?
- DNA
 (Explanation: The blueprint for the polypeptide chain that is insulin is found in the DNA of specialized pancreatic cells. Beta cells in the pancreas produce insulin, but the original code for these proteins, like all proteins, comes from the DNA in the nucleus of the beta cells.)

9. Review the Venn diagram below of sexual reproduction and asexual reproduction in plants. Where in the diagram would you add offspring different from parents?



A) A

(Explanation: You would add offspring different from parents in the sexual reproduction circle. The purpose of sexual reproduction is genetic variation. Offspring receive a random mix of genes from both parents through meiosis.)

10. Scientists in North Carolina are developing a clone bank of disease and insect resistant Christmas trees. How would this be beneficial to Christmas tree growers?
Crop loss would be reduced because insect and disease problems would be reduced. The strongest, most resistant trees would be cloned. Any offspring would be identical to the parent trees. There would be fewer tree species but they would be healthier and stronger.
11. DNA is able to make exact copies of itself during replication because the nitrogen bases pair up in very specific ways. Explain how the nitrogen bases ALWAYS pair up.
The DNA bases ALWAYS pair as a-t and c-g. There is no other possible combination of the four bases. Remember, only RNA contains uracil.
12. During which stage of Meiosis does the production of four haploid gametes occur?
Telophase Meiosis II
(Explanation: The production of four haploid gametes from one mother cell is completed during telophase meiosis II. At the end of meiosis I, the mother cell has formed two daughter cells, but the chromosome number has not been reduced. When meiosis II begins, chromosomes are not replicated; the cells divide again, this time also dividing the chromosomes.)

13. How does radioactivity affect the rate and number of mutations in creatures that are exposed to it?

Radioactivity increases the rate and number of mutations in creatures that are exposed to it. When creatures are exposed to a higher than normal dose of radiation, they will show a **higher than average mutation rate**. The exact effect of these additional mutations cannot be predicted.

14. Describe/define fertilization.

Fertilization is the process that joins two haploid cells together to form a diploid. For example, the haploid number for a human gamete is 23. When you combine the sperm and egg (each has 23 chromosomes) through fertilization, a diploid cell with 46 chromosomes is formed.

15. Why is sexual reproduction important for the survival of a species?

1. It promotes genetic variability in offspring.
2. It causes new mutations to occur in the offspring.
3. It is more beneficial for the species than the individual.

(Explanation: Genetic variability is extremely important to the overall survival of a species, not an individual. It leads to organisms more "fit" to survive in their given environment.)

16. Mitosis is responsible for growth, repair, and maintenance in an organism because

C) exact duplicates of each mother cell are produced.

(Explanation: Mitosis produces exact duplicates of each mother cell are produced. Exact duplicates are required to make "more" of the cells and tissue required for growth and repair. Meiosis reduces the chromosome number by half to produce gametes.)

17. In tulips, tall stems (T) is a dominant trait while short stems (t) is a recessive trait. In a field of 1000 tulips, 820 are tall plants and 180 are short. What is the genotypic percentage of the tulips in the field?

In this case, about 25% will be homozygous dominant with tall stems, about 50% will be heterozygous for tall stems, and 25% will be homozygous recessive and have short stems. This ratio of offspring is typical of a cross between Tt and Tt.

	T	t
T	TT	Tt
t	Tt	tt

18. Transcribe the following DNA sequence into RNA: CGG TCG AGT GAT
 The answer is GCC AGC UCA CUA. In process of transcription, complementary bases are aligned with the DNA codons. However, in RNA, uracil pairs with adenine instead of thymine.
19. The central dogma of molecular biology is centered upon the process of _____, in which the information from DNA is transcribed and translated, resulting in amino acids being joined into polypeptides.
Protein Synthesis
 (Explanation: protein synthesis is the central idea in molecular biology in which the genetic information from DNA is transcribed by mRNA, then translated by tRNA, which leads to the assembly of proteins.)
20. A mutation in which type of cell can be passed along from parent to child?
B. sex cell
 (Explanation: Only mutations in sex cells can be passed from parent to offspring. Cells that make up organs in the body are called somatic cells. Mutations on these cells cannot be passed from parent to offspring.)
21. Information about traits is stored in the cell nucleus in a molecule called **DNA**.
22. The process of evolution involves changes in the genetic makeup of a population over a period of time. Sexual reproduction enhances variability among offspring. The random alteration of DNA from parent to offspring, called mutations, also produces variable characteristics in offspring. Some mutations can be helpful, while others can be harmful and hinder survival. In this experiment, students mimicked random mutations and the ability to collect and eat food. Each experimental group was timed for both collection and eating of the food, and data was collected to determine if the mutations were helpful or harmful when trying to collect and eat food. Of all the mutations, which one would MOST LIKELY contribute to a rapid rate of extinction?

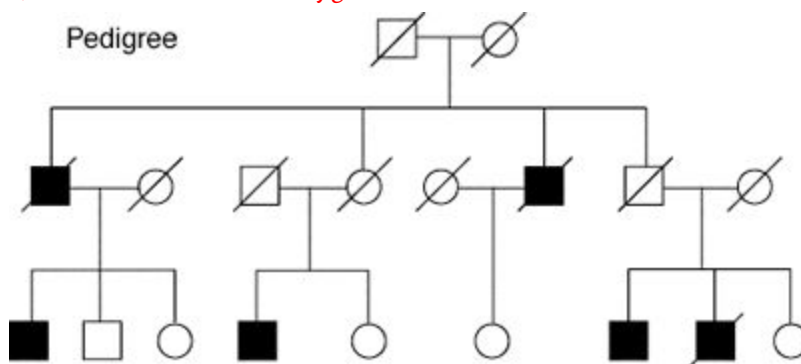
Group and Mutation	Time Taken to Collect Candy	Time Taken to Eat Candy
A Extra long nails	1 minute 3 seconds	8 minutes 12 seconds
B No digits; hands paddle-like	15 seconds	7 minutes 18 seconds
C Normal	22 seconds	2 minutes 44 seconds
D Hands fused in front of body; no range of motion	Did not collect 15 pieces. Collected 11 pieces	Ate 11 pieces; 4 minutes 12 seconds
E Webbing on hands and feet	11 minutes 45 seconds	17 minutes 12 seconds
F No peripheral	3 minutes 2 seconds	2 minutes 52 seconds

G Blind	Did not collect 15 pieces. Collected 4 pieces in 4 minutes	Ate only 4 pieces; 1 minute 16 seconds
H Short legs; normal number of digits on hands and feet	55 seconds	3 minutes 2 seconds

Of all the mutations, blindness would most likely lead to extinction. These organisms cannot see. They cannot find food and they cannot protect themselves from predators.

23. Colorblindness is a sex-linked trait. A mother with normal vision and a man who is colorblind have a colorblind daughter. What statement MUST be true about the parents?

A) The mother is a heterozygous carrier.



(Explanation: The mother is a heterozygous carrier. In order for the daughter to be colorblind, she must inherit the allele from both parents. The only possible choice from the father is X^c . In order to inherit the allele from her normal sighted mother, the mother must be a carrier.)

24. In pea plants, yellow seeds (Y) are dominant over green seeds (y), and rounded peas (R) are dominant over wrinkled peas (r). Cross a plant that is heterozygous for both traits with a plant that is homozygous recessive for both traits. Draw a Punnett square to show all possible offspring, and determine the genotypic and phenotypic ratios.

(This problem is worked out for you on the next page)

YyRr x yyrr

Step 1: DETERMINE THE GAMETES!!!

P1 Gametes: YR, Yr, yR, yr

P2 Gametes: yr, yr, yr, yr

	yr	yr	yr	yr
YR	YyRr	YyRr	YyRr	YyRr
Yr	Yyrr	Yyrr	Yyrr	Yyrr
yR	yyRr	yyRr	yyRr	yyRr
yr	yyrr	yyrr	yyrr	yyrr

Genotypes: YyRr, Yyrr, yyRr, yyrr

Phenotypes: Yellow Round, Yellow Wrinkled, Green Round, Green Wrinkled

Ratio: 1:1:1:1