

Snustad Practice Quiz

Chapter 01

1) Suppose you are studying hemophilia. Which of the following pieces of information would you expect to find in the National Center for Biotechnology (NCBI) database?

- a) The DNA sequence for the gene that causes hemophilia
- b) The protein sequence for the gene that causes hemophilia
- c) The mRNA sequence for the transcript of the gene that causes hemophilia
- d) Articles published about hemophilia
- e) all of the above

Answer: e

Feedback: The NCBI database is available free on the web and contains information about genes, proteins, genomes, publications, and other important data in the fields of genetics, biochemistry, and molecular biology. It contains the complete nucleotide sequences of all genomes that have been sequenced to date, in addition to many other useful search tools.

Section: 1.2 Three Great Milestones in Genetics

Difficulty Level: Easy

2) Recently, the genomes of Neanderthals and other early modern humans have been sequenced. How has the original human genome sequence provided by the Human Genome Project affected the ability to sequence subsequent genomes?

- a) Researchers can only sequence specific regions that they know will be different in earlier organisms.
- b) The genome of earlier humans should be identical to modern humans, so researchers can just look for slight individual variations.
- c) The HGP provided a sequence that can act as a reference genome, so comparing the older human genomes to the known genome can make the process significantly faster.
- d) Advances in DNA sequencing technology has made the process of genome sequencing more efficient and less expensive.
- e) Both C and D

Answer: E

Feedback: A reference genome allows researchers to have a scaffold, or a basic rough idea of the sequence they are expecting. They can run fewer sequencing reactions, since they have a reference to align their unknown sequence with. Many advances in sequencing technologies and computer software have made it significantly easier to collect and analyze the data, thanks in great part to the experience generated by the HGP.

Section: 1.2 Three Great Milestones in Genetics

Difficulty Level: Medium

3) Which of the following would you expect to observe during the process of DNA replication?

- a) hydrogen bonds forming between A-G and T-C
- b) covalent bonds forming between A-T and G-C
- c) hydrogen bonds breaking and reforming forming between A-G and T-C
- d) hydrogen bonds breaking and reforming forming between A-T and G-C
- e) breaking of the phosphate backbone of the parental strands

Answer: d

Feedback: Watson and Crick deduced that DNA molecules consisted of two chains of nucleotides. The two chains are held together by weak forces, known as hydrogen bonds that pair A with T and G with C. These base pairing specificities make the two chains of DNA complementary to each other.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Medium

4) DNA synthesis involves production of complementary strands. This means:

- a) Each progeny DNA molecule contains one new strand and one strand from the parent molecule; the nucleotide sequence of the new strand can be predicted from that of the parent strand
- b) Each replication of the DNA produces two completely new strands in the progeny molecules; the new nucleotide sequence cannot be predicted from the parent strand
- c) DNA synthesis involves production of one strand of DNA and one strand of RNA
- d) The process only takes place in bacterial cells
- e) None of these

Answer: a

Feedback: In DNA replication, the initial step involves strand separation of the parental DNA molecule. Those two strands serve as a template for the production of new complementary strands of DNA. This leaves two new progeny DNA molecules, each possessing one strand from the parent molecule and one newly produced strand.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Medium

5) Which of the following is not required for DNA within a genome of an organisms?

- a) It must be able to replicate
- b) It must encode for RNAs
- c) It must be able to change over time to adapt to different circumstances
- d) It must encode for proteins
- e) None of the above

Answer: d

Feedback: Not all DNA sequences encode for proteins. In order for DNA to be the genetic material contained in all living organisms, it must be able to transmit copies from cell to cell and from parents to offspring. It also must have information to direct activities, development, and behavior of the organisms. Finally, if DNA is the genetic material, it must be able to change over time to provide the genetic variability that allows organisms to adapt to changing circumstances.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Medium

6) How many potential different mRNA sequences can be transcribed for a given sequence of DNA, assuming a non-overlapping triplet codon?

5' -AAGTCGTACCTGGACACGGAA-3'
3' -TTCAGCATGGACCTGTGCCTT-5'

- a) 1
- b) 2
- c) 3
- d) 6
- e) None of the above

Answer: d

Feedback: In the human genome, a single gene can encode for several different mRNAs. The triplet codon means that you can start at the AAG, AGT, or GTC on the 5' strand, or the TTC, TCC, or CCG on the antisense strand. This means you have a total of six potential reading frame for any given region of double-stranded DNA.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Difficult

7) Reverse transcription is the process where:

- a) DNA is converted directly into polypeptides
- b) DNA is converted to RNA and then to polypeptides
- c) RNA is converted to DNA
- d) Polypeptides are converted to DNA

Answer: c

Feedback: Reverse transcription is the process where RNA is used as a template for the synthesis of DNA. This process is important in the life cycles of certain viruses, such as AIDS.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Easy

8) Viruses replicate by inserting their genomic information into the chromosome of their host organism. Based on what you know about the central dogma of molecular biology, which of the following would you expect for a virus with an RNA genome?

- a) A section of double-stranded RNA can be integrated directly into a chromosome since both are nucleic acids and share the same backbone.
- b) A section of RNA must be reverse-transcribed into DNA before it can be integrated into a chromosome.
- c) A virus with an RNA genome can replicate RNA directly without using DNA.
- d) A virus with an RNA genome cannot be integrated into a chromosome, but can translate proteins.
- e) None of the above

Answer: b

Feedback: Reverse transcription is the method by which RNA can be used as a template to direct DNA synthesis. If a virus needed to integrate into a chromosome, it must be first converted into DNA, since an RNA-DNA hybrid molecule would not be able to be properly transcribed and translated into viral proteins.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Hard

9) The changing of genetic information by means of duplication, insertion, deletion, or rearrangement is termed:

- a) mutation
- b) replication
- c) transcription
- d) translation

Answer: a

Feedback: Changes within the overall structure of the DNA molecule by deletion, insertion, duplication, or rearrangement are types of mutations. These changes can go unnoticed in an organism or they can cause a trait to change.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Easy

10) The sickle-cell mutation involves a codon changing from GAG to GTG. Suppose you instead have a mutation of the third base in the codon to a GAA. Would you expect this change to have the same effect, causing sickle-cell disease?

- a) Yes, because any change in one of the three bases in a codon will alter the amino acid that is encoded by that codon.
- b) Yes, because sickle-cell arises every time there is a change in the DNA sequence of this gene.
- c) No, because not every mutation in the DNA results in a change in the amino acid sequence.
- d) No, because the third base of a codon has no effect on the amino acid encoded by that codon.
- e) Both C and D

Answer: C

Feedback: The codon table shows that both GAG and GAA encode for Glutamic acid. Thus, a mutation in the third codon had no effect on the translated protein sequence. If you were to have mutated it to GAC or GAT, however, it would have changed the protein sequence to aspartic acid. Thus, the third base in a codon can sometimes affect the protein, but not always.

Section: 1.3 DNA as the Genetic Material

Difficulty Level: Hard

11) Suppose you are studying the PAX6 gene, a gene involved in eye formation in a wide variety of organisms ranging from flies to humans. You align a region of the gene and find the following homology:

Human	5' -ATGCCGTACGTGGTCACGGAA-3'
Mouse	5' -ATGCCGTACCTGGACACGGAA-3'
Rat	5' -ATGCCGTACCTGGACACGGAA-3'
Fly	5' -ATGTCGTTTCCTGCACGCGGAA-3'

Looking at differences in the sequences, what is the most likely relationship between humans, mice, rats, and flies?

- a) Mice and rats diverged most recently, since they have the fewest changes compared to the three other organisms.
- b) Humans diverged first, and then flies diverged from the two rodents.
- c) Rats and mice are more closely related because their sequences are the most similar.
- d) Humans are more closely related to mice than rats.
- e) None of the above

Answer: C

Feedback: Look at the total number of changes that occurred between each of the four organisms. Rats and mice have the same sequence, indicating they are closer relatives. Flies have quite a few mutations compared to the rodents and humans, indicating they diverged from the other three long ago. Humans share some similarity to the rodents, but have accumulated several changes that occurred after they branched off the last shared common ancestor between rodents and primates.

Section: 1.4 Genetics and Evolution

Difficulty Level: Hard

12) Using the phylogenetic tree in Figure 1.10, which vertebrate evolved the most recently?

- a) toads
- b) rats
- c) carp
- d) blue whales
- e) trout

Answer: d

Feedback: Branch points that occur farther to the right are the most recent. Thus, the purple branch between finback and blue whales was the most recent.

Section: 1.4 Genetics and Evolution

Difficulty Level: Medium

13) Using the phylogenetic tree in Figure 1.10, which pair of organisms shared a last common ancestor the most recently?

- a) cows and whales
- b) opossums and whales
- c) chickens and toads
- d) carp and loach
- e) toads and chickens

Answer: a

Feedback: The branch point between cows and whales occurred father to the right than any of these other relationships.

Section: 1.4 Genetics and Evolution

Difficulty Level: Medium

14) Using the phylogenetic tree in Figure 1.10, which pair of organisms would you expect to exhibit the most genetic variation between them?

- a) whales and carp
- b) whales and mice
- c) whales and opossums
- d) whales and chickens
- e) whales and toads

Answer: a

Feedback: Despite the fact that both are aquatic organisms, the last common ancestor shared between whales and carp was along the yellow line to the far left, indicating that those two organisms diverged longer ago than any other pair of organisms.

Section: 1.4 Genetics and Evolution

Difficulty Level: Hard

15) Transmission genetics:

- a) Analyzes DNA molecules and is rooted in the study of DNA sequences
- b) Uses genetic information to study infection rates and transmission of diseases
- c) Emphasizes the passing of genes and chromosomes from one generation to the next and the nature of genetic material
- d) Involves the use of DNA sequences to determine relationships between organisms

Answer: c

Feedback: Transmission genetics is the classical approach to genetic study that uses the structure and behavior of chromosomes to study the transmission of genes and chromosomes from parents to offspring.

Section: 1.5 Levels of Genetic Analysis

Difficulty Level: Easy

16) Recent studies have shown that blue eyes originated in humans living in Europe, as opposed to their African ancestors. Which of the major levels of genetics would focus on when and why this allele, leading to increased genetic variation?

- a) classical genetics
- b) transmission genetics
- c) molecular genetics
- d) population genetics
- e) none of the above

Answer: d

Feedback: Classical or transmission genetics is the area that focuses on the transmission of genes and chromosomes from one generation to the next, including how genes control traits and how they mutate. Molecular genetics focuses on the study of DNA sequences, and the chemical nature of the processes surrounding the DNA molecule. Population genetics studies a group of organisms and what makes them genetically unique from one another. It seeks to document this variability and to understand the significance.

Section: 1.5 Levels of Genetic Analysis

Difficulty Level: Medium

17) A group of researchers want to map the precise location of the gene for eye color and characterize which mutations result in the blue eye phenotype. Which of the major levels of genetics would focus on what changes occurred at the DNA level to create this allele?

- a) classical genetics
- b) transmission genetics
- c) molecular genetics
- d) population genetics
- e) none of the above

Answer: c

Feedback: Classical or transmission genetics is the area that focuses on the transmission of genes and chromosomes from one generation to the next, including how genes control traits and how they mutate. Population genetics studies a group of organisms and what makes them genetically unique from one another. Molecular genetics focuses on the study of DNA sequences, and the chemical nature of the processes surrounding the DNA molecule. Thus, studying the changes in the protein produced by this gene would require an emphasis in molecular genetics techniques.

Section: 1.5 Levels of Genetic Analysis

Difficulty Level: Medium

18) Eye color in humans is actually controlled by two different genes, each with two possible alleles. The various combinations of these two genes accounts explains why we see brown, blue, green, or hazel eyes. If you want to study the patterns of alleles that are inherited by individuals and how those combinations result in particular phenotypes, which of the major levels of genetics would you employ?

- a) classical genetics
- b) evolutionary genetics
- c) molecular genetics
- d) population genetics
- e) none of the above

Answer: a

Feedback: Population, or evolutionary, genetics studies a group of organisms and what makes them genetically unique from one another. Molecular genetics focuses on the study of DNA sequences, and the chemical nature of the processes surrounding the DNA molecule. Classical genetics is the area that focuses on the transmission of genes and chromosomes from one generation to the next, including how genes control traits and how they mutate.

Section: 1.5 Levels of Genetic Analysis

Difficulty Level: Medium

19) Genetic modification of food first appeared in human society:

- a) in the prehistoric days of the first civilizations
- b) in the 1800s with Mendel's pea breeding experiments
- c) in the 1980s with livestock supplements
- d) There are only genetically modified foods in laboratories and science fiction movies.

Answer: a

Feedback: By the time of the first human civilizations, humans had already cultivated plants and begun to raise livestock for food. They quickly learned to improve their food sources by selective breeding. Over many generations, this gave them plants and animals which were quite different from the original organisms.

Section: 1.6 Genetics in the World: Applications of Genetics to Human Endeavors

Difficulty Level: Easy

20) Many varieties of corn now grown in the United States contain a gene from the bacterium *Bacillus thuringiensis*. The purpose of this gene is:

- a) it allows the corn to produce a toxin to help keep insects from eating it
- b) it keeps the corn fresh so that processing times can be increased
- c) it provides the corn with nutrients for growth
- d) it allows photosynthesis to be increased in the plant

Answer: a

Feedback: The *Bacillus thuringiensis* gene that has been inserted into the genome of corn produces a toxic chemical, which is toxic to many insects. It allows the plant to produce its own insecticide.

Section: 1.6 Genetics in the World: Applications of Genetics to Human Endeavors

Difficulty Level: Medium