Test bank: Chapter 2

Type: multiple choice question
Title: Chapter 02 - Question 01
01) Which of the following is not a component of DNA?
***a.** Ribose
Feedback: DNA is composed of deoxyribose, nucleotide bases, and phosphate. Ribose is a component of RNA.
Page reference: p30
b. Deoxyribose
Feedback: DNA is composed of deoxyribose, nucleotide bases, and phosphate.
Page reference: p30
c. Nucleotide bases
Feedback: DNA is composed of deoxyribose, nucleotide bases, and phosphate.
Page reference: p30
d. Phosphate
Feedback: DNA is composed of deoxyribose, nucleotide bases, and phosphate.
Page reference: p30

Type: true-false
Title: Chapter 02 - Question 02
02) True or false? DNA is polar, with the 5' end referring to a carbon atom on a deoxyribose subunit that is attached to a hydroxyl group.
a. True
Feedback: 3' and 5' refer to specific carbon atoms in the deoxyribose molecule. The 5' carbon is attached to triphosphate at the end of the DNA strand. The 3' carbon is attached to a hydroxyl group.
Page reference: p30
***b.** False
Feedback: 3' and 5' refer to specific carbon atoms in the deoxyribose molecule. The 5' carbon is attached to triphosphate at the end of the DNA strand. The 3' carbon is attached to a hydroxyl group.
Page reference: p30

Type: multiple choice question
Title: Chapter 02 - Question 03
03) The four nitrogenous bases found in DNA are cytosine, thymine, adenine, and guanine. Which of the following statements regarding the bases is correct?
a. Adenine is a pyrimidine and pairs with cytosine in the DNA double helix.
Feedback: Adenine is a purine, has a double ring structure, and pairs with thymine, which is a pyrimidine with a single ring structure. Pyrimidines always pair with purines in the DNA double helix. (A pairs with T and C pairs with G.) **Page reference:** p37
***b.** Cytosine has a single ring structure and pairs with guanine in the DNA double helix.
Feedback: Cytosine is a pyrimidine (single ring structure) and pairs with guanine, which is a purine (double ring structure). Pyrimidines always pair with purines in the DNA double helix. (A pairs with T and C pairs with G.) **Page reference:** p37
c. Thymine is a purine and pairs with adenine in the DNA double helix.
Feedback: Thymine is a pyrimidine (single ring structure) and pairs with adenine, which is a purine (double ring structure). Pyrimidines always pair with purines in the DNA double helix. (A pairs with T and C pairs with G.) **Page reference:** p37
d. Guanine has a double ring structure and pairs with thymine in the DNA double helix.
Feedback: Guanine does have a double ring structure (and is therefore a purine), but is pairs with cytosine, which is a pyrimidine with a single ring structure. Pyrimidines always pair with purines in the DNA double helix. (A pairs with T and C pairs with G.) **Page reference:** p37

Type: matching question
Title: Chapter 02 - Question 04

04) Rank the DNA sequences according to the order in which they would denature as temperature is increased. i.e., the sequence that would be denatured at the lowest temperature would be ranked 1. For simplicity, only a single strand of each double helix is shown.
Feedback: Adenine (A) pairs with thymine (T) and cytosine (C) pairs with guanine (G) in the DNA double helix. A-T pairs are held together with two hydrogen bonds, whereas C-G pairs are held together with three hydrogen bonds. C-G pairs therefore require more energy to break, and DNA molecules with a higher percentage CG content (%GC) require a higher temperature for the two DNA molecules in the double helix to separate (denature). Molecule TTTGCTGTAACTGA has 9 A-T pairs and 5 G-C pairs, giving it the lowest %GC content and the lowest melting temperature. AGTCGATCGTTTGC has 7 A-T pairs and 7 G-C pairs, so has the next-lowest melting temperature. GACTGCATGCTTCG has 6 A-T pairs and 8 G-C pairs and has the second-highest melting temperature. Finally, CCGTCGTAATCGGG has 5 A-T pairs and 9 G-C pairs, so has the highest melting temperature.
Page reference: pp38-39
a. AGTCGATCGTTTGC = 2
b. CCGTCGTAATCGGG = 4
c. GACTGCATGCTTCG = 3
d. TTTGCTGTAACTGA = 1

Type: multiple choice question
Title: Chapter 02 - Question 05
05) Which of the DNA sequences is complementary to 5’ CGTAAGTA 3’
***a.** 5’ TACTTACG 3’
Feedback: DNA is usually double-stranded. The two strands are complementary to one another. A pairs with T and C pairs with G, so where there is a C in one strand, there is a G in the complementary strand, etc. DNA strands are antiparallel, meaning that the 5’ end of one strand corresponds to the 3’ end of the other strand. Here, the first base is C, so the complementary base is G, but this is located at the 3’ end of the complementary strand. The full complementary strand is therefore 5’ TACTTACG 3’. It is convention to write DNA sequences in the 5’ to 3’ direction.
Page reference: p39
b. 5’ GCATTCAT 3’
Feedback: DNA is usually double-stranded. The two strands are complementary to one another. A pairs with T and C pairs with G, so where there is a C in one strand, there is a G in the complementary strand, etc. DNA strands are antiparallel, meaning that the 5’ end of one strand corresponds to the 3’ end of the other strand. Here, the first base is C, so the complementary base is G, but this is located at the 3’ end of the complementary strand. The full complementary strand is therefore 5’ TACTTACG 3’. It is convention to write DNA sequences in the 5’ to 3’ direction.
Page reference: p39
c. 5’ ATGAATGC 3’
Feedback: DNA is usually double-stranded. The two strands are complementary to one another. A pairs with T and C pairs with G, so where there is a C in one strand, there is a G in the complementary strand, etc. DNA strands are antiparallel, meaning that the 5’ end of one strand corresponds to the 3’ end of the other strand. Here, the first base is C, so the complementary base is G, but this is located at the 3’ end of the complementary strand. The full complementary strand is therefore 5’ TACTTACG 3’. It is convention to write DNA sequences in the 5’ to 3’ direction.
Page reference: p39
d. 5’ CGTAAGTA 3’
Feedback: DNA is usually double-stranded. The two strands are complementary to one another. A pairs with T and C pairs with G, so where there is a C in one strand, there is a G in the complementary strand, etc. DNA strands are antiparallel, meaning that the 5’ end of one strand corresponds to the 3’ end of the other strand. Here, the first base is C, so the complementary base is G, but this is located at the 3’ end of the complementary strand. The full complementary strand is therefore 5’ TACTTACG 3’. It is convention to write DNA sequences in the 5’ to 3’ direction.

Page reference: p39

Type: multiple choice question
Title: Chapter 02 - Question 06
06) Which of the following processes depends on complementary base pairing?
a. Protein translation
Feedback: Specific amino acids are directed to join a growing polypeptide according to complementarity between codons on mRNA and anti-codons on tRNA (which carry the specific amino acid).
Page reference: p50
b. RNA transcription
Feedback: DNA acts as a template during RNA transcription. The RNA molecule is built one unit at a time according to the complementary bases on the DNA template.
Page reference: p50
c. Hybridization
Feedback: Complementary base pairing is exploited in several laboratory techniques involving hybridization. Hybridization uses a nucleic acid probe of a specific sequence to look for that sequence in a large amount of nucleic acid, e.g., a full genome. Complementary interactions between the probe and the target sequence allow biologists to find the sequence of interest.
Page reference: p50
***d.** All of the options given are correct
Feedback: Translation, transcription, and hybridization all involve complementary base pairing interactions.
Page reference: p50

Type: multiple choice question
Title: Chapter 02 - Question 07
07) Which of the following statements about proteins and polypeptides is true?
a. All of the options given are correct
Feedback: A polypeptide is a single continuous chain of amino acids that is produced by translation. A protein can be made up of one polypeptide, but can also comprise several polypeptides. For example, hemoglobin is a single protein comprising four polypeptides.
Page reference: p42
***b.** Proteins are comprised of polypeptides
Feedback: A polypeptide is a single continuous chain of amino acids that is produced by translation. A protein can be made up of one polypeptide, but can also comprise several polypeptides. For example, hemoglobin is a single protein comprising four polypeptides.
Page reference: p42
c. Polypeptides are produced by transcription whereas proteins are produced by translation.
Feedback: RNA is produced by transcription. A polypeptide is a single continuous chain of amino acids that is produced by translation.
Page reference: p42
d. Proteins are the building blocks of polypeptides.
Feedback: Amino acids are the building blocks that make up polypeptides and proteins.
Page reference: p42

Type: multiple choice question
Title: Chapter 02 - Question 08
08) Select one factor that contributes to the higher stability of DNA compared to RNA
***a.** DNA has one hydroxyl group
Feedback: Both ribose (in RNA) and deoxyribose (in DNA) have a hydroxyl group at carbon 3': this is involved in forming the sugar phosphate backbone of the nucleic acid. Ribose (in RNA) has an extra hydroxyl group at carbon 2'. The extra –OH means that RNA is more chemically reactive than DNA and therefore is less stable.
Page reference: pp45-46
b. DNA is single-stranded
Feedback: DNA is usually double-stranded and RNA is usually single stranded.

Page reference: pp45-46
c. Ribonucleases degrade DNA
Feedback: Ribonucleases degrade RNA, not DNA, which is one of the reasons RNA is less stable than DNA.
Page reference: pp45-46
d. DNA contains guanine
Feedback: Both DNA and RNA contain guanine, so this is not a factor in their relative stabilities.
Page reference: pp45-46

Type: matching question
Title: Chapter 02 - Question 09
09) Match the missing words in the following phrase. The central [A] refers to the process by which DNA is [B] into [C], which is then [D] into a polypeptide.
Feedback: The central dogma refers to the process by which DNA is transcribed into mRNA, which is then translated into a polypeptide.
Page reference: p42
a. A = dogma
b. B = transcribed
c. C = mRNA
d. D = translated

Type: multiple choice question
Title: Chapter 02 - Question 10
10) What is cDNA?
***a.** A DNA copy of an RNA molecule
Feedback: Biologists copy RNA molecules into cDNA molecules in a range of scientific techniques.
Page reference: p46
b. A DNA molecule used for translation
Feedback: mRNA and tRNA molecules are involved in translation, not DNA molecules.
Page reference: p46
c. A DNA molecule that has been spliced
Feedback: Only RNA molecules are spliced.
Page reference: p46
d. An RNA molecule with cytosine instead of uracil
Feedback: RNA contains both cytosine and uracil.
Page reference: p46

Type: multiple response question
Title: Chapter 02 - Question 11
11) DNA contains thymine where RNA contains uracil. What are some of the evolutionary advantages for DNA having thymine rather than uracil? Please select all that apply.
Feedback: Uracil can pair readily with bases other than adenine, meaning that information transfer with thymine is more specific than with uracil. Cytosines in DNA can be converted to uracil when DNA is damaged: the cell recognizes this and repairs the damage. If uracil were a normal component of DNA, then this damage could not be recognized.
Page reference: p46
***a.** Thymine is more limited in its base-pairing than uracil
b. Cytosine can be readily converted to thymine
***c.** Uracil is recognized by DNA repair systems
d. Thymine base-pairs using three hydrogen bonds

Type: multiple choice question
Title: Chapter 02 – Question 12
12) What is the transcriptional profile of a cell?
***a.** The set of transcripts produced by a cell under particular circumstances.

Feedback: A transcription profile is the catalog of all the transcripts produced by a cell under specific circumstances, e.g., at a particular time in its life cycle or when exposed to specific nutritional conditions.
Page reference: p48
b. The complete set of transcripts it is possible for a cell to produce.
Feedback: The complete set of transcripts a cell could potentially make is the same for all cells, as this is inherent to the DNA. A transcriptional profile is the transcripts present under specific conditions.
Page reference: p48
c. The amount of one transcript produced over the whole of a cell's life.
Feedback: A transcriptional profile of a cell considers all transcripts, not just one transcript.
Page reference: p48
d. The cellular conditions needed to induce transcription.
Feedback: Cellular conditions help to control transcription, but the transcriptional profile looks at the transcripts themselves rather than the cellular conditions.
Page reference: p48

Type: multiple response question
Title: Chapter 02 - Question 13
13) Which of the following statements about RNA are true? Please select all that apply.
Feedback: Cells use the template/non-coding/antisense strand as a template to create RNA. The resulting RNA is therefore complementary to the template/non-coding/antisense strand, and the RNA has the same sequence as the coding/sense strand.
Page reference: p46
***a.** RNA has the same sequence as the coding DNA strand
b. RNA has the complementary sequence to the sense DNA strand
c. RNA has the same sequence as the template DNA strand
***d.** RNA has the complementary sequence to the antisense DNA strand

Type: true-false
Title: Chapter 02 - Question 14
14) True or false? A greater proportion of the human genome than bacterial genomes is transcribed.
a. True
Feedback: >90% of bacterial genomes is transcribed, whereas around 70% of the human genome is thought to be transcribed.
Page reference: p46
***b.** False
Feedback: >90% of bacterial genomes is transcribed, whereas around 70% of the human genome is thought to be transcribed.
Page reference: p46

Type: multiple choice question
Title: Chapter 02 - Question 15
15) Which of the following factors influence the final shape of a polypeptide?
a. The amino acid sequence
Feedback: The amino acid sequence does impact the final polypeptide shape, but this is influenced by the gene sequence and hence the mRNA sequence, so all these factors are important for the final polypeptide shape.
Page reference: p49
b. The gene sequence
Feedback: The gene sequence does impact the final polypeptide shape, but this then influences the mRNA sequences and hence the amino acid sequence, so all these factors are important for the final polypeptide shape.
Page reference: p49
c. The mRNA sequence

Feedback: The mRNA sequence does impact the final polypeptide shape, but this is influenced by the gene sequence and itself influences the amino acid sequence, so all these factors are important for the final polypeptide shape.
Page reference: p49
***d.** All of the options given are correct
Feedback: The gene sequence influences the mRNA sequence, which influences the amino acid sequence, so all these factors influence the final polypeptide shape.
Page reference: p49

Type: multiple response question
Title: Chapter 02 - Question 16
16) Which of the following characteristics are true of all amino acids? Please select all that apply.
Feedback: Amino acids are polar as they have an amino end (containing nitrogen) and a carboxyl end. Some, but not all, amino acids are hydrophobic. Two of the twenty natural amino acids contain sulfur (cysteine and methionine) **Page reference:** p30 Figure 2.2
***a.** They are polar
b. They are hydrophobic
c. They contain sulfur
***d.** They contain nitrogen

Type: multiple choice question
Title: Chapter 02 - Question 17
17) Which of the following RNA molecules is not involved in translation?
***a.** micro RNA
Feedback: MicroRNAs act to reduce gene expression, but are not directly involved in translation.
Page reference: p54
b. ribosomal RNA
Feedback: Ribosomal RNA (rRNA) is a component of ribosomes, where translation occurs.
Page reference: p54
c. messenger RNA
Feedback: Messenger RNA (mRNA) is directly translated.
Page reference: p54
d. transfer RNA
Feedback: Transfer RNA (tRNA) carries amino acids and interprets the genetic code during translation.
Page reference: p54

Type: matching question
Title: Chapter 02 - Question 18
18) The three-letter [A] on [B] is recognized by [C] during [D].
Feedback: The three-letter codon on mRNA is recognized by tRNA during translation.
Page reference: p50, p54
a. A = codon
b. B = mRNA
c. C = tRNA
d. D = translation

Type: multiple choice question
Title: Chapter 02 - Question 19
19) How many reading frames does the following mRNA contain?
5’ AGTCGTGATCAGTCA 3’
a. 2
Feedback: Three bases code for one amino acid, so there are always three possible reading frames in mRNA. In the sequence given, reading frame one starts with the first A, reading frame two starts with the first G, and reading frame three starts with the first T.
Page reference: p50

b. 4
Feedback: Three bases code for one amino acid, so there are always three possible reading frames in mRNA. In the sequence given, reading frame one starts with the first A, reading frame two starts with the first G, and reading frame three starts with the first T.
Page reference: p50
*__c.__ 3
Feedback: Three bases code for one amino acid, so there are always three possible reading frames in mRNA. In the sequence given, reading frame one starts with the first A, reading frame two starts with the first G, and reading frame three starts with the first T.
Page reference: p50
d. 6
Feedback: Three bases code for one amino acid, so there are always three possible reading frames in mRNA. In the sequence given, reading frame one starts with the first A, reading frame two starts with the first G, and reading frame three starts with the first T.
Page reference: p50

Type: matching question
Title: Chapter 02 – Question 20
20**)** Put the following RNA molecules in order of size, from largest to smallest (where largest = 1 and smallest = 3) **Feedback:** mRNAs are usually several thousand nucleotides in length, long noncoding RNAs are approximately 200-1000 nucleotides in length, and microRNAs are only 22 nucleotides in length.
Page reference: p54
a. 1 = mRNA
b. 2 = long noncoding RNA
c. 3 = microRNA

Type: multiple choice question
Title: Chapter 02 – Question 21
21) At which of the following stages does regulation of gene expression not occur?
*__a.__ Replication
Feedback: Replication, which is the copying of DNA molecules, is not involved in gene regulation.
Page reference: p54
b. Transcription
Feedback: Transcriptional regulation ensures that transcription only occurs in the correct cells at the correct time.
Page reference: p54
c. Translation
Feedback: Translational regulation controls translation so that polypeptides are produced only when needed.
Page reference: p54
d. Splicing
Feedback: Splicing removes sections of mRNA before it is translated. The control of splicing helps to regulate which final transcripts are translated and when.
Page reference: p54

Type: multiple choice question
Title: Chapter 02 - Question 22
22) Which of the following statements is true?
a. An open reading frame is a length of DNA sequence containing multiple start and stop codons
Feedback: An open reading frame is a region of DNA or RNA that has no stop codons.
Page reference: p55
b. The coding region is removed from mRNA before translation
Feedback: The coding region carries the information that will be translated, and is therefore retained in the mRNA.
Page reference: p55

c. Open reading frames carry the same information as introns
Feedback: Open reading frames carry the information that will be translated, whereas introns do not, and are removed before translation.
Page reference: p55
***d.** Introns are removed from mRNA during splicing
Feedback: Introns are spliced out of the precursor mRNA to form the mature mRNA, which is then translated.
Page reference: p55

Type: multiple choice question
Title: Chapter 02 - Question 23
23) Which of the following transcription elements is a protein?
***a.** Transcription factor
Feedback: A transcription factor is a protein that binds to DNA and regulates transcription
Page reference: p57
b. Transcriptional start site
Feedback: The transcriptional start site (also known as the core promoter) is a regulatory sequence positioned immediately upstream of a coding region that indicates where transcription should start.
Page reference: p57
c. Coding region
Feedback: The coding region is the sequence that will be translated.
Page reference: p57
d. Core promoter
Feedback: The transcriptional start site (also known as the core promoter) is a regulatory sequence positioned immediately upstream of a coding region that indicates where transcription should start.
Page reference: p57

Type: multiple response question
Title: Chapter 02 - Question 24
24) Which of the following techniques would be appropriate for determining the transcription profile of a cell? Please select all that apply.
Feedback: Microarray analysis and RNA-seq both provide information regarding the transcriptional status of a large number of genes simultaneously, and therefore can be used to generate a transcription profile for the cell. Electrophoresis can be used to examine nucleic acids, but this is not practical at the large scale needed to assess all the genes in a cell at the same time. Translation is not a laboratory technique.
Page reference: p63
***a.** Microarray analysis
***b.** RNA-seq
c. Electrophoresis
d. Translation

Type: multiple choice question
Title: Chapter 02 - Question 25
25) Which of the following happens during electrophoresis?
a. DNA moves away from the negative pole because of the positive charge on deoxyribose.
Feedback: Deoxyribose does not carry a charge.
Page reference: Tool Box 2.1 p32
***b.** DNA moves towards the positive pole because of the negative charge on phosphate.

Feedback: The phosphates in the DNA backbone carry a negative charge and the DNA thus travels from the negative to the positive pole when an electric current is applied.
Page reference: Tool Box 2.1 p32
c. DNA moves away from the positive pole because of the negative charge on phosphate.

Feedback: Phosphates in the DNA backbone carry a negative charge, but this would attract the DNA towards the positive pole.
Page reference: Tool Box 2.1 p32
d. DNA moves towards the negative pole because of the positive charge on deoxyribose.
Feedback: Deoxyribose does not carry a charge.
Page reference: Tool Box 2.1 p32