

## DNA, RNA and Protein Synthesis

### 1. Define:

**Nucleotide** – Nucleotides are small, organic molecules made up of a pentose sugar (ribose or deoxyribose), a phosphate group and one nitrogenous base (adenine, guanine, cytosine, thymine or uracil). Nucleotides are used as the "building blocks" of nucleic acids (DNA and RNA). They are also used to form high-energy compounds (ATP, GTP, etc.), coenzymes (NAD, FAD, etc.) and serve as regulatory compounds (cyclic-AMP and cyclic-GMP).

**Okazaki fragments** – Okazaki fragments are small segments of DNA that form on the lagging strand during DNA replication. Because DNA-dependent DNA polymerase can only add nucleotides to the 3' end of a growing nucleotide chain, the leading strand is built in a continuous sequence; but the other strand, the lagging strand, must be built in segments that require the DNA double-helix to unwind until a new primase binding site is made available. Primase builds a small RNA segment that can serve as a primer and then DNA polymerase can add nucleotides to it. Each Okazaki fragment contains a small section of RNA nucleotides that must be removed (by DNA polymerase I) and then ligase enzymes bind the fragments together to complete the new DNA strand.

**Sigma factor** – Sigma factors are proteins that bind with the core enzymes of the RNA polymerase complex found in prokaryotic cells. Sigma factors recognize specific sections of DNA known as promoter sites and are required to initiate transcription (RNA synthesis). When a sigma factor binds to the promoter site on the DNA strand, a core enzyme (a four-part complex) binds with it, and transcription proceeds. Without sigma factors, the RNA polymerase enzymes of prokaryotes cannot recognize promoter sites, and cannot initiate transcription.

**Aminoacyl-t-RNA-synthetase** – Aminoacyl-t-RNA-synthase enzymes catalyzes the attachment of amino acid molecules to specific t-RNA molecules to form Aminoacyl-t-RNA molecules (also called 'charged' t-RNA). There are many slightly different aminoacyl-t-RNA-synthetase enzymes, each one able to catalyze a specific reaction between an amino acid and a t-RNA molecule. In bacteria they are separate, but in eukaryotic cells they may occur in high molecular weight multienzyme complexes.

**Peptidyl transferase** – Peptidyl transferase is a ribozyme (23S r-RNA), associated with ribosomes and responsible for catalyzing the formation of peptide bonds between amino acids during protein synthesis (translation).

2. Nucleotides/ ribose
3. Nucleic acids/ phosphodiester
4. Deoxyribose/ thymine
5. Pyrimidine/ hydrogen
6. Purines/ complimentary pyrimidine

7. Antiparallel
8. Nucleotide/ a phosphate group
9. Replication/ origin of replication
10. Polymerases (DNA-dependent DNA and RNA polymerase) / DNA ligase
11. Replication (semiconservative replication)/ Okazaki fragments
12. 3'/ RNA polymerase (sometimes called primase)/ DNA ligase
13. Transcription/ nucleoside triphosphates or activated nucleotides (ATP, GTP, CTP, etc.)  
When these contain the sugar ribose they may be designated as rNTPs.
14. All RNA molecules/ 2.) it involves polymerase enzymes (in this case, DNA-dependent RNA polymerase)/ 3.) it requires energy in the form of nucleoside triphosphates (rNTPs) or activated nucleotides.
15. Promoter/ sigma factor/ energy
16. Sigma factor/ messenger-RNA (m-RNA), transfer-RNA (t-RNA) or ribosomal-RNA (r-RNA)
17. Post-transcriptional modification/ introns
18. Spliceosomes/ exons
19. Ribosomal-RNA (r-RNA)/ transfer-RNA (t-RNA)
20. Messenger-RNA (m-RNA)/ polycistronic
21. Aminoacyl-t-RNA-synthases/ anticodon
22. Messenger-RNA (m-RNA)/ the enzymes (aminoacyl-t-RNA synthetase) that catalyzed the formation of bonds between amino acids and t-RNA molecules.
23. Anticodon/ aminoacyl-t-RNA synthases.
24. Codon
25. Translation/ ribosomes
26. Anticodon/ codon
27. Anticodon/ messenger-RNA (m-RNA) molecules/ peptidyl transferase
28. Termination of the amino acid chain. These are stop or terminator codons.

29. The m-RNA base sequence = AGAUGUCAAAACCCGUAUGGAAUGGUUG

The amino acid sequence = arginine, cysteine, glutamine, threonine, arginine, methionine, glutamic acid, tryptophan, leucine

In this case, yes, because there are no stop or terminator codons. The AUG at the middle of the sequence would encode methionine, but is not recognized as a start codon in this example because it is not at the beginning.

30. The nucleotide sequence of each structural gene determines the codon sequence of a specific m-RNA molecule, which in turn determines the amino acid sequence (primary structure) of a specific polypeptide. This determines the activity the protein will have. If the protein is an enzyme, it will catalyze a specific chemical reaction (part of metabolism). Since all metabolic pathways involve enzymes (proteins) or ribozymes (RNA), they are all controlled by the nucleotide sequences of genes (DNA).
31. Peptide/ ribosome/ stop or terminator codon
32. Polyribosome or polysome
33. Polyribosome or polysome/ peptidyl transferase
34. Ribosomal-RNA (r-RNA)/ microcystins