Exercise sheet 6: Proteins & Translation

Exercise 1 - The genetic code

The standard genetic code describes how 64 possible codons encode 20 amino acids and the stop translation signal. It enables DNA-encoded mRNA to be translated into amino acid sequences and is common to all living organisms on Earth.

Note

Above you can see the RNA codon table (or "Code-Sonne"). It can be used to translate a sequence of nucleotide triplets into a sequence of amino acids. The tabe is read from the inside to the outside. e.g. the triplet `AUG` would translate to Methionine (the start codon).

Question 1A Which aminoacid is encoded by the codon **UAC**?

Hint : Possible Answers

- ☐ Histidine
- ☐ Proline
- ☐ Tyrosine

Correct Answer

- ☐ Histidine
- ☐ Proline
- ☒ Tyrosine

Question 1B How many codons encode the aminoacid Valine?

Hint : Possible Answers

- ☐ 4
- ☐ 2
- ☐ 3

Correct Answer

- ☒ 4
- ☐ 2
- ☐ 3

Question 1C Which aminoacid sequence encodes the following codons?

`AUG-UGC-CUU-ACU-AAA-AGU-CGU-CAU-GAC-GAG-CUG-UAC-GGG-UGA`

Hint : Possible Answers

- ☐ Met-Cys-Leu-Trp-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly
- ☐ Met-Trp-Leu-Thr-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly
- ☐ Met-Cys-Leu-Thr-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly

Correct Answer

- ☐ Met-Cys-Leu-Trp-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly
- ☐ Met-Trp-Leu-Thr-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly
- ☒ Met-Cys-Leu-Thr-Lys-Ser-Arg-His-Asp-Glu-Leu-Tyr-Gly

Exercise 2 - Protein structures

Question 2A Name the parts corresponding to the figure below

Hint The Names are:

alpha carbon amino group, carboxyl group and side chain.

Correct Answer

A. amino group
B. side chain
C. alpha carbon
D. carboxyl group

Question 2B Select the peptide bound in the following dipeptide.

Hint A peptide bond is an amide type of covalent chemical bond linking two consecutive alpha-amino acids via the carbon atom nr. 1 of the first and the nitrogen atom nr 2 of the second amino acid.

Correct Answer B

Question 2C The 3D structure of a protein is very important for its function. Name the structure types in the figure below.

Hint Match the names

- primary structure
- secondary structure
- tertiary structure
- quaternary structrue
- alpha-helix
- beta-sheet. Note that can be multiple correct options.

Correct Answer

A. primary structure
B. secondary structure, beta sheet
C. secondary structure, alpha helix
D. tertiary structure
E. quaternary structure

Exercise 3 - What are enzymes?

Enzymes are important molecules because they can substantially speed up chemical reactions and enhance their specificity. They are sometimes referred to as biocatalysts. Catalysts are compounds that influence chemical reactions being used up as a result. In other words, they are reusable. A single enzyme molecule processes about 100.000 to 5 million molecules every minute.

Shortly explain the function of the further mentioned enzymes regarding their role in prokaryotic translation or transcription

Question 3A DNA Polymerase III

Correct Answer DNA Polymerase III is responsible for bacterial chromosomal DNA replication, along with the helicase and primase, at the replication fork.

Question 3B DNA Ligase

Correct Answer The DNA Ligase catalyze the formation of a phosphodiester bond between the 5'-P group of one single DNA strand with the adjacent 3'-OH group of another chain.

Question 3C RNA Polymerase

Correct Answer RNA Polymerases are enzymes responsible for copying a DNA sequence into an RNA sequence, during the process of transcription.

Question 3D RNAse H

Correct Answer Ribonucleases H are enzymes that cleave the RNA of RNA/DNA hybrids that form during replication and repair and which could lead to DNA instability if they were not processed.

Question 3E DNA Helicase

Correct Answer DNA Helicases are enzymes that are able to unwind DNA by the use of the energy-equivalent ATP. They play essential roles in DNA replication, DNA repair, and DNA recombination in all organisms.

Question 3F DNA Primase

Correct Answer DNA primase catalyses the synthesis of short RNA molecules used as primers for the DNA polymerase during DNA replication

Exercise 4 - The RCSB Protein Database - PDB

Protein structures are hard to resolve. Therefore, identified protein structures are stored in according databases to enable a fast access and to gather all data associated. An example is the RCSB Protein Data Base (PDB).

Lapinaite, A., Knott, G. J., Palumbo, C. M., Lin-Shiao, E., Richter, M. F., Zhao, K. T., ... & Doudna, J. A. (2020). DNA capture by a CRISPR-Cas9–guided adenine base editor. Science, 369(6503), 566-571.

Access the protein information of the above shown protein SpCas9 with PDB-ID ABE8e and answer the following questions:

https://www.rcsb.org/

Question 4A From which organism is this protein?

Correct Answer *Streptococcus pyogenes* and *Escherichia coli*

Note

This is an artificially designed Protein containing the CRISPR-associated endonuclease Cas9 from *Streptococcus pyogenes* and the t-RNA adenine deaminase A v8e (TadA-8e) from *Escherichia coli*.

Question 4B How many amino acids does this protein consist of?

Correct Answer 1361