Student Guide

Level: **basic**
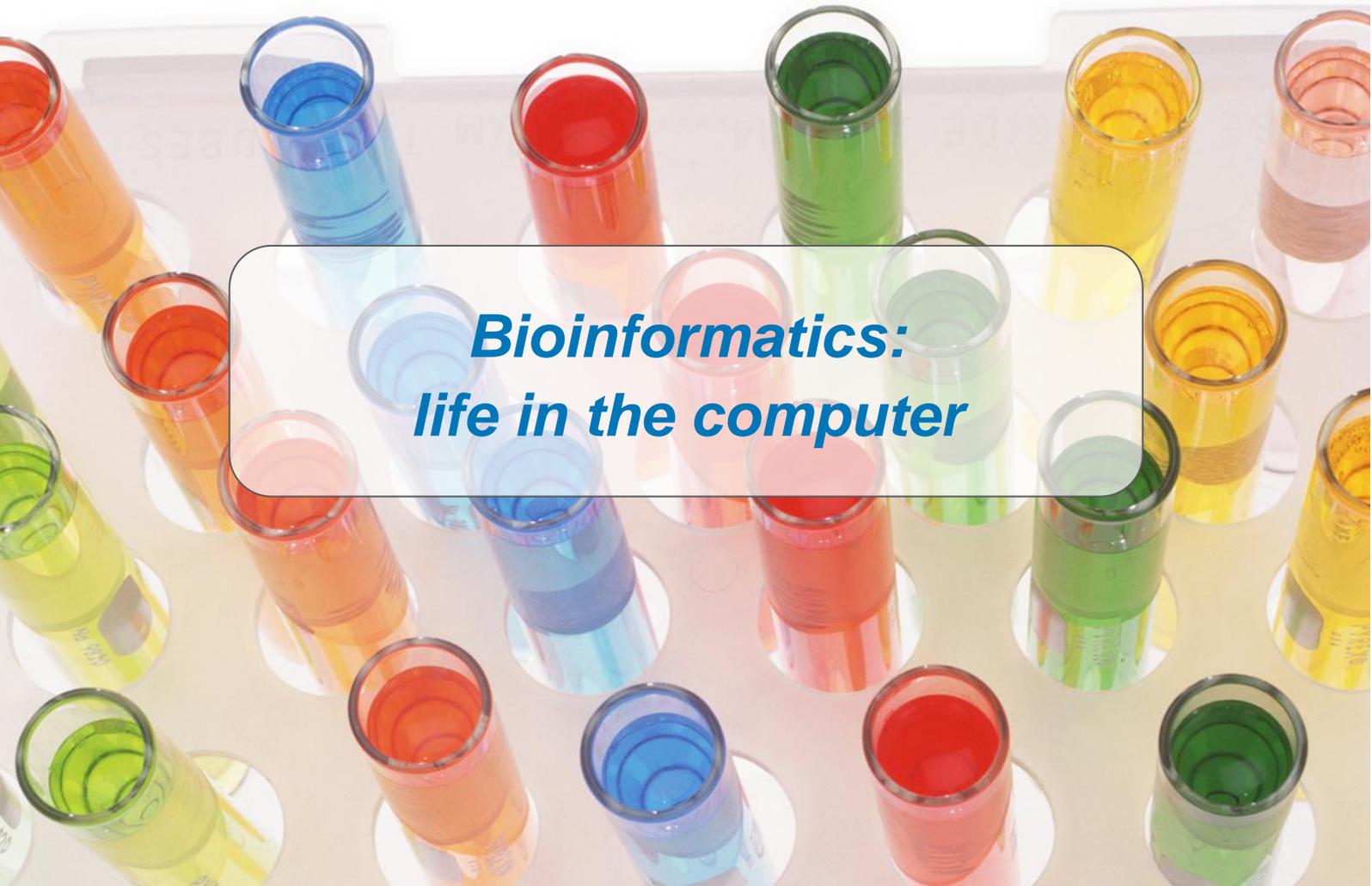
Bioinformatics:
life in the computer

bioinform@tica in de klas

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Scientific Discovery for the Classroom

Developed by the Netherlands Bioinformatics Centre in cooperation with the Centre for Molecular and Biomolecular Informatics of the Radboud University Nijmegen Medical Centre

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Bioinformatics: life in the computer

DNA, genes, proteins and genomes. That's what you will be working with the next couple of lessons! Two students of the university will give you a 2-hour long guest practicum about the newest techniques in DNA research. For this, you will need good preparation, and after the practicum, you will even go one step further. You will dive deeper in the subject, or you will learn more about science in society. Enjoy these lessons about molecules with big effects!

Introductory lesson

Name the processes that are indicated by the arrows.

From DNA to RNA: ………………………………………………………………

From RNA to amino acids: …………………………………………………………

What are the names of the amino acids encoded by these codons?

AUG: ……………………………………………   GCC: ……………………………………………

CGG: ……………………………………………   UGG: ……………………………………………

UAU: ……………………………………………   CUG: ……………………………………………

GCU: ……………………………………………   GGU: ……………………………………………

What is the one-letter code of the amino acids above? :   …   …   …   …   …   …   …   …

UGA is a stop codon. *Briefly explain how a stop codon works.*

……

Complete the table below: what is the consequence on different levels?

	An organism is being exposed to a lot of UV radiation	A liver cell divides	The DNA mutates in a non-coding region	One protein is folded in the wrong way
Organism				
Cell				
DNA				
Protein				

Practicum
Exercise 1
How can damaged rods lead to very poor vision at night for these patients?

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Exercise 2
a. Put the processes below in the right order: …………-……………-……………-……………

1. After folding of the amino acid chain: a protein
2. TTATCCGGGCTGATGGATGATCAT
3. Methionine-Isoleucine-Isoleucine-Histidine-Glutamine-Proline-Glycine
4. AUGAUCAUCCAUCAGCCCGGAUAA

b. Which amino acid does AUG encode? ………………………………………

Exercise 3
a. *a. Both of these nucleotide sequences encode the rhodopsin protein. Are these DNA or RNA sequences? How can you tell?*

DNA/RNA, because

……

b. *What does the first codon encode? And the last?*

First codon:

……

Last codon:

……

c. *Can you find the differences between the normal rhodopsin gene and the rhodopsin gene from the affected child?*

Yes / No

Exercise 4
a. *How many differences can you find between these two nucleotide sequences?*

………………………………………………

b. *Find the second difference. In which codon is this mutation?*

…………………………………………………..

c. *Which amino acid does this codon encode in the normal rhodopsin gene?*

……………………………….

d. *Which amino acid does this codon encode in the child's rhodopsin gene?*

…………………………

e. *Complete the table below. You don't have to fill out the last column yet: this one will be used in exercise 5.*

Mutation	Normal rhodopsin			Rhodopsin from child		Amino acid number
	Codon	Amino acid		Codon	Amino acid	
1	AAC	Asparagine (Asn)	N	AAU	Asparagine (Asn)	
2	UCG		S			186
3	UGU	Cysteïne (Cys)	C			
4	AUG		M			207
5	GCG	Alanine (Ala)	A			292
6	AAG		K		Glutamate (Glu)	
7	ACC	Threonine (Thr)	T			336

Exercise 5
a. *Copy the amino acid sequence to Word. Let Word count the amount of characters (Word Count). Of how many amino acids does rhodopsin consist?*
Every letter is one amino acid

……………………………

b. *For every 3 bases, 1 amino acid is displayed. Which amino acid is changed in the first mutation? Write your answer in the table in exercise 4*
Be aware that the 1-letter notation of asparagine (Asn) is N.

c. *Complete the rest of the table. We will need it later to mutate the protein in our 3D software.*

Exercise 6

a. The image below shows a schematic drawing of an eye. Where are the rods located?
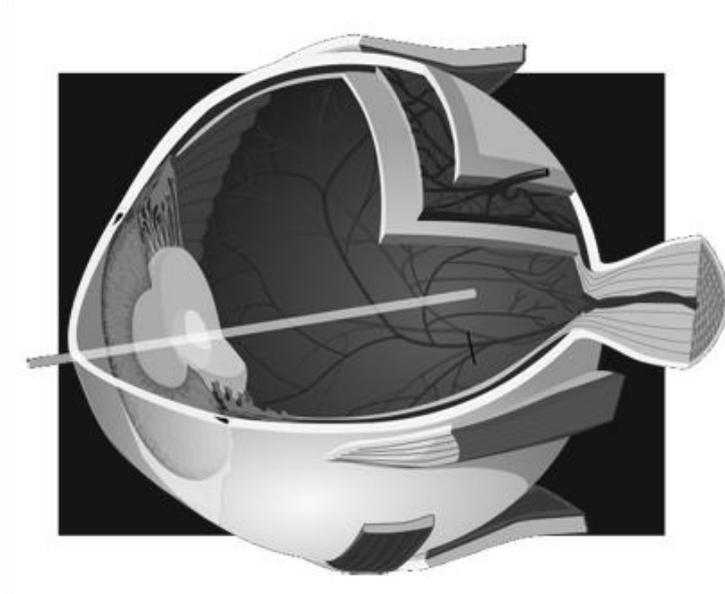
b. The image below shows a schematic of a rod cell. Where are the rhodopsin proteins located?

Retina of the eye

Light sensitive area

Licht
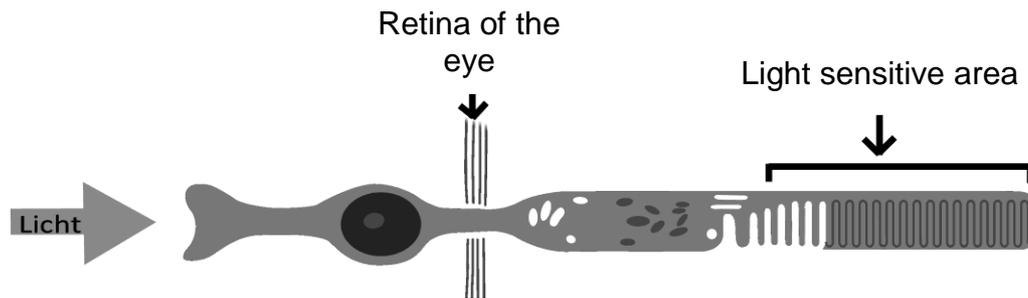
This is a rod cell. The cell nucleus is depicted in red.
Light coming from the outside is depicted with the arrow on the left.
The synapse (left end of the cell) inside of the retina can transfer signals to the brain.
In the light sensitive area, membrane discs are formed.

Exercise 7
a. Which chemical elements are depicted by the colored spheres (green, blue, red etc.)?

Red: …………………………………………………………..

Dark blue: …………………………………………………..

Light blue: …………………………………………………..

Green: ………………………………………………………

Pink: …………………………………………………………..

b. Is retinal active or inactive in the 3D protein? ……………………………………………………………

Exercise 8

a. *Look at mutation 1 in the table. Explain why this mutation does not result in a change in the protein. Of course, this is also the case for mutation 7.*

………

………

………

b. *Apply mutations 2, 3, 4 and 5 to rhodopsin in Yasara. This can be done just like mutation 6 (Lys on position 296 becomes Glu)*

c. *The protein only gives a signal to the brain when retinal is activated. Which mutations interfere with the activation of retinal?*

………

………

………

d. *Active retinal can only give a signal to the brain when it is connected to the rhodopsin. Which mutation(s) prevent interaction between retina land rhodopsin?*

………

………

………

e. *Does Mark and Marjolein's unborn child suffer from Retinitis Pigmentosa? Explain your answer using what you've learned about the mutations.*

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