



The exam will last 3h

The exam consists of 4 questions – read them carefully & completely before answering

You can use drawings or schemes to illustrate or support your answers.

You can answer in English or French..



**Question 1 Ion channels****10 points**

Ion channels, or ionotropic receptors, comprise one of the largest groups of signalling proteins divided in different sub-families. Upon the presence of a cognate stimulus, a conformational change takes place leading to channel opening.

**a)** Make a general sketch of a membrane with one of the ion channels discussed during the course, in the membrane before “closed” and after activation “open”. Name the channel.

**(2 points)**

Upon activation of the channel of your choice, it's ion pore opens and ions will flow through.

**b)** Indicate to which ions your channel is permeable,  
in which direction the ions will flow,  
how this will affect the membrane's potential,  
and what will be the physiological effect.

**(4 points)**

**c)** Explain the term allosterism in relation to ion channels .

**(2 points)**

**d)** Design an experiment that you would use to determine whether the channel of your choice is selective for either anions or cations.

**(2 points)**

**Question 2 Membranes****10 points**

Membranes are highly dynamic systems that are vital to many of the cellular functions. About one-third of our genes encode for membrane proteins, and many cellular processes take place within or at the interface of membranes.

The famous scientist Erich Sackmann stated that *“Life in all it’s diversity became possible after nature had found the trick with the membrane”*.

**a-i) what is /are the tricks, what can only be with membranes**

**a)** Mention two properties of membranes that are involved in signaling in it’s broadest sense. Discuss these shortly.

**(2 points)**

For each additional property an extra bonus point, max 2.

**b)** Lipidation is the process that enzymatically conjugates hydrophobic moieties to proteins, which causes the proteins to become attached to the membrane. Nature could have chosen to bestow this protein with a transmembrane domain. Speculate what could be the advantages and or disadvantages of lipidation.

**(2 points)**

**c)** Design two protein containing molecules **X** and **Y** which would allow you to specifically visualize i) lipid rafts or ii) non-raft regions of the plasma membrane of living cells by fluorescence microscopy.

**(2 points)**

**d)** Proteins can be directed to membranes for instance through poly-basic domains or pleckstrin homology domains. Shortly mention the structural features of the 2 domains, and describe for each of the domain under which conditions it can be bound to or released from the membrane .

**(4 points)**

**Question 3. Protein domains..... 10 points**

An organism has to be able to rapidly adapt to changes in its surroundings. This is only possible if the molecular interactions involved in cellular signalling pathways within the cell can change rapidly as well.

- a)** Which kind of molecular interactions and organisations do permit such rapid adaptations? (2 points)

Many proteins are composed of a linear arrangement of small globular domains spaced by flexible linker regions, like beads on a string. Protein domains are composed of 50 to 150 consecutive amino acids. They fold autonomously and have a precise function.

- b)** Describe the general principle of how a membrane binding domain binds to the membrane and shortly mention the 3 types of interactions involved. (3 points)
- c)** Describe one such a domain and its specific lipid interaction in some more detail, and discuss how its binding to the membrane could be modulated. (3 points)
- d)** Protein-protein interactions are in many cases mediated by binding of a domain of one protein to the other protein. Describe one such a domain, and how the interaction could be modulated (2 points)

**Q4. Receptor dimers..... (10 points) points**

Several signalling pathways involve dimers of receptor proteins. These receptor proteins are involved in the regulation of growth and cell division. Their activity is strongly regulated.

- a)** What are the roles of receptor dimerisation in activation of these receptors? (4 points)
- b)** Describe one signalling pathway from ligand binding to the induction of gene transcription. (3 points)
- c)** How is the receptor mentioned under **b)** kept inactive, and inactivated after ligand-induced activation? (3 points)