Memory Protocol 2024/25 Integrative Neurobiology

Systems

Nieder

1. *Development of the Pallium:*
   Picture of coronal section of the pallium (Insert Image)
   Draw where the 4 substructures of the pallium are located.
   Make a table in which you list the brain structures they develop into for birds and mammals.

2. *Retinotopy:*
   Picture of a fish, the two eyes of the viewer and V1.
   Complete the picture by drawing the connections from the eye to V1. Name all important structures and draw how the picture is depicted in V1

3. *How attention may change the activity of neurons:*
   Name and draw the 3 ways attention can affect a tuning curve of a neuron. Do not forget the labelling of the axes.

Veit

1. What is the Gate Control Theory? Explain it and give an example. (2p)
2. Explain topography, give two example and describe them (2p)
3. What does CPG stand for and what characteristics are underlying the CPG? In the movie “Mustafa: The Lion King”, the lion said, “Swimming is like running under water”. Comment on that statement, is it correct? Think of the cat example, dodging, or stumbling over an obstacle. (2p)
4. Describe the neurons influencing Purkinje cells and where the stimuli come from. (2p)
5. Imagine you measure extracellular a bunch of neurons. How do you disentangle the direction preference of such neurons towards its combined specific preference?
6. An arctic fox hunts with mice covered from snow by detecting high-pitched sounds. The fox wears modified headphones that attenuate auditory input on the right ear. Draw vectors of the direction it expects the mice and into which direction it would jump, for:
   a. Before it wears the headphones
   b. Right after it wears the headphones
   c. Late after it got put the headphones on
   d. Immediately after it removed the headphones
   e. Name the effect in d.

f. Name the mechanism underlying the sound source localization and in which brain area it is processed

7. Imagine you discovered a new lizard species. You initialize a vibrating stimulus on its toe when it moves its contralateral leg.

    a. Draw the potential reflex circuit. Indicate the anatomical structures, the fibers, the cell bodies, the terminal ends etc. (2p)

    b. How can you test whether only the spinal cord is necessary for this reflex? (1p)

    c. How can you test whether the cerebral cortex is involved or not? (1p)

    d. How can you test whether the reflex is mono-, or polysynaptic? (1p)

Behaviour and Cognition

Arrenberg

1. Ockham's Razor (1p) (Define it)
2. Symbol Manipulation and Signal flow (3p)
3. Explain and contrast them.
4. Single and double dissociation (3p)
5. Ames room (4p)
6. Vieth-Müller circle (2p)
    - Circle was given. Draw in the rest.
    - Explain what the line represents.
7. Explain the relation between depth and disparity (2p)
8. Masking experiment (3p)
    - Draw in the bars of perception.
    - Explain the underlying mechanisms of phenomenon.
9. Swivel chair experiment; rotation not stopped but maintained (2p)
    - Explain the eye movements and underlying mechanisms

Burgalossi

1. LTP time course graph (4p)
    - How is this curve experimentally generated?
    - Discuss whether post- before pre; correct or not?
    - What is measured fill out y-axis
    - NMDA-R-inhibitor in early phase. What happens?
2. Picture of odor habituation to repeated exposure (trials) (2p)
    - Describe the graph and name and explain the process underlying.
    - What phenomenon is seen in Trial 7?
        - Dishabituation although one new odor 2 was presented (discussable)
3. Picture of aplysia gill-withdrawal reflex and habituation graph. (3p)
    - Describe the experimental design, the data type collected and interpretation.
    - Name the underlying phenomenon.
    - Explain the neural mechanism in relation to the neural circuit.
4. Experimental fear conditioning with sound (1p)
    - Describe the experimental design (with US and CS), data type collected and interpret. (parts wrong in the interpretation; missed the prediction error)
5. Rescorla-Wagner-Model (3p)
    - Two graphs were shown. One showing the associative strength, the other showing the prediction error. You needed to explain whether the statement was correct that these graphs correctly represent the RWM.
6. Patient H.M. (2p)
    - How does patient H.M. prove two-stage memory and declarative from non-declarative memory
7. Sleep (2p)
    - Which brain oscillations are playing an important role? Explain the mechanism.

8. Reconsolidation theory (3p)
    - Given an elaborated experiment design, data type collected (results) and interpretation.

Cellular and Molecular
Total of 40P, as the other two exams

Benda
One big question with 17P and (one / two?) smaller questions…

1. Photoreceptors in light and dark. Capacitance is 60nF. Leak current with reversal potential at E_leak = -80 mV, conductance g_leak = 3nS; and photoreceptor current with reversal potential at E = 0mV and maximal conductance at g_max = 9nS.

a) Sketch the conductance change of the photoreceptor from complete darkness to brightness
b) Calculate the reversal potential in complete darkness
   Calculate the reversal potential in complete brightness
c) Sketch the I-V curves of the leak and photoreceptor current and mark the reversal potentials
d) Why does the membrane voltage not change at the reversal potential? Mark this in the previous plot (in c).
e) Calculate the time constants in light and darkness.
f) Sketch the two corresponding gain curves and mark the relevant frequencies in the plot.
g) Sketch the membrane potential over time in response to a 300 ms light stimulus. Draw the time from -100 ms to 600 ms. (assume the conductance changes instantaneously to the maximal conductance from dark to light)
h) …
i) Adaptation current with reversal potential E_a = -120 mV (no maximal conductance was given) and the following *activation* curve (0.5 at - 20? mV)
   …
   Redraw the plot from (g) but only for the switching on of the light (300 ms I believe?). In the same plot, sketch how the membrane potential would change over time (considering the adaptation current)

j) Sketch the steady-state I-V curve (a=0, a=1, and a=a_infinity) for the adaptation current
k) Given the holding potential at V_H = 0mV (i think it was Vh =-20mV, so we need to use a=0.5)
   -> I remember that he once mentioned “0 mV” and “-50 mV” in the question, I guess it was a typo so I decided for one of the two…
   Sketch the membrane current response over time for the test potentials: -120, -80, -50, -20, 0, 20? mV…

2. Non-linearities in the brain
a) Provide two examples for a non-linearity on the cellular level.
b) Why are non-linearities so important (in the brain)? Especially when considering linear systems. (2P)

Arrenberg

Development of the Nervous System

1) How does the innervation of the muscle limb in mammals change during development (1P)
2) How does the olfactory system form a topographic map (1P)
3) Eph/ephrin signalling (explain axonal targeting of RGC in the optic tectum) (3P)
   He provided the stripe assay as an example image but mentioned it suffices to only explain the mechanisms for the nasal and temporal RGC.

Genetics

Two questions (each 2P)

1) Explain “reverse” and “forward genetics” (Provide an example for each?)
2) Explain what the ?/UAS or Cre-loxP are.