The list of questions from the course Neuroinformatics 2024

1. What is the function of glial cells ?
2. Draw schematically the basic structure of a neuron.
3. Draw the dependence of the concentration of potassium ion on the membrane voltage (hint: use the relation for the Nernst potential).
4. Plot the action potential and associated current across the cell membrane V=f(t), Ic=f(t).
5. What is the difference between electrical and chemical synapses ?
6. Describe at least three types of ion channels.
7. Draw the electrical schematic of the synapse model and the corresponding time courses.
8. What is the "Voltage Clamp Method" ?
9. Describe how the action potential of a neuron is generated - use the Hodgkin-Huxley model as an example.
10. What is the refractory period of a neuron?
11. What is the purpose of Ranveer's glow?
12. What is the difference between the Izhikevich model and the Hudgey-Huxley model?
13. What algorithm would you use to detect neurons that have been measured with a microelectrode?
14. What is the advantage of the "Leaky-Integrate and Fire" neuron over other models? Write the basic relationship.
15. On what parameters does the transfer/activation function of a neuron (gain function) depend? Draw its waveform.
16. What is the alpha function? Draw a graph and state the basic relationship.
17. Plot the ISI (inter-spike interval) of a regular firing neuron and compare it with the histogram obtained from the Poisson distribution.
18. Define the coefficient of variation CV.
19. What model can be used to simulate bursting neurons?
20. Give an example of a tuning curve.
21. When is the peri-stimulus-time histogram (PSTH) used ?
22. What is the basic principle of Hebbian plasticity?
23. Mathematically formulate Hebbian learning for a single neuron.
24. Why was Bliss and Lom's experiment (proof of the existence of long-term potentiation) such an important contribution to neuroscience?
25. Explain the principle of long-term potentiation (LPT) and long-term depression (LDT).
26.Plot the dependence of the change in weights on the presynaptic and postsynaptic firing times of the neuron. What type of learning is involved?
27.What is the purpose of the Morris Maze?
28. How can we simulate noise in neuron models?
29. How is the cortex organized?
30. Why are inhibitory neurons important?31. What is the main goal of the Connectome project?
32. How is visual information encoded in the brain (Huben and Wisel

experiment)?

33. What are evoked potentials?
34. How would you measure a person's somatosensory map?
35. How can we model short-term memory?
36. Why are random networks studied?
37. Explain the principle of "polychronous group activation".
38. How does learning take place in a Kohonen neural network?
39. Why are lateral connections important in self-organizing networks?
40. In which cases do we use a dynamic neural field?
41. Provide a basic memory partitioning scheme.
42. Name three Nobel Prize winners in neuroscience and describe their contributions.
43. List 10 methods that can be used for brain research.
44. Name the lobes of the brain and describe what type of information is processed in nothing?
45. Describe how visual pathways cross in optic chiasm?
46. What type of neurons does the LGN contain and what are they used for?
47. Name at least three perceptual disorders and describe them.
48. What is the difference between the dorsal and ventral visual pathways?
49. Which brain regions are responsible for short-term memory?
50. Which centres are responsible for speech production and comprehension and where are they located?
51. What is the functional specialization of each hemisphere?
52. Describe the main steps of the SOM algorithm (winner takes all principle)
53. What is the purpose of place cells?
54. What is the main principle of Functional magnetic resonance imaging (fMRI)?
55. Can you compare the human brain and the largest language models in number of parameters?
56. Define Bayes rule.
57. What parameters/signals do we monitor to implement a brain-computer interface (BCI)?
58. Draw the basic idea of a retinal prosthesis.
59. What is the main principle of diffusion-MRI?
60. Explain the concept of blood-brain barrier.