Short questions (approx. 30 questions will be selected for the exam)

Please try to answer the short questions by a single expression if possible. If a drawing is required, it is specified by the question.

Lecture 1 sensorimotor integration

1) What do you know about Helen Keller? Does she support or contrast the view of Behaviorism?
2) Can you give examples from daily life for ballistic (feed forward) and closed-loop feed back control systems? Please give examples from neuroscience, too.
3) Draw a simple diagram explaining the mechanism of *EMD* (Reichardt detector).
4) Which experiments were performed by von Holst and Mittelstaedt (1950), which was performed by Sperry (1950). What was the main conclusion of both papers, what was the terminology used by these authors?
5) Pupillo-constriction in mammals: Please list the involved nuclei and draw the underlying neuronal circuit.
6) Describe the visual stimuli that elicit either prey capture or flight behavior, respectively, in the European toad (Bufo bufo).
7) What happens if a paramecium hits an obstacle?
8) Is the golgi-tendon reflex a monosynaptic reflex? Can you please draw the reflex arc?
9) Which simple trick determines positive or negative photo-taxis in artificial autonomous vehicles with two sensors and two drives?
10) Describe the influence of a dynamic random dot pattern on the perception of coherent motion and on the neuronal responses recorded from primate areas MT and MST (i.e. comparison to static background)
11) Please describe the circuits responsible for the positive phototaxis observed in Platynereis larvae.
12) The eye of a Platynereis larva is close to Darwin's description of a proto eye. What are the cellular components of this eye?
13) Can you please give examples of "*change blindness*". Is this blindness only observed in the lab? Can you please give some thoughts explaining this blindness?
14) What are "*fixed action pattern*"? Can you please give four examples? Who received the Noble price its discovery?
15) If you press gently against your right eye (while the left eye is covered), you perceive an apparent movement of the environment. What is the explanation of this apparent movement? How is this explanation supported by the observed movements of both eyes?
16) A thought experiment: what happens if your eye muscles are switched off (e,g. injection of Curare into the orbit) and you intend a gaze shift to the left?

17) During perfectly adjusted smooth pursuit eye movements, the retinal image of the moving is stationary. What does the subject perceive, moving or stationary target? How can this perception be explained?

18) If you want a cigarette, is it better to speak to the left or right ear of a person? Why? How about compliments?

19) What are the two alternative mechanisms that determine the selective direction of attention?

20) What is the source of information about the actual eye movement according the Inflow Thesis?

21) What is the source of information about the actual eye movement according the Outflow Thesis?

Lecture 2 learning

22) Can you give examples for tool use and tool fabrication in the animal kingdom?

23) Please describe the possible life cycles of transmitter vesicle in a typical chemical synapse.

24) Can you please specify how barn owls determine the elevation and the azimuth of a sound source?

25) What is the difference between the blink reflex of humans and rabbits?

26) Can you please describe an experiment showing sensitizing in Aplysia? What is the difference to a conditioned reflex (which is also possible to be studied in Aplysia)?

27) What is necessary to open an NMDA Glu-receptor?

28) What is thought to be the retrograde messenger during LTP?

29) Describe the descending pathway for singing in the song bird.

30) Please name three brain areas in mammals in which neurogenesis is very well established

31) Give an idea why robust neurogenesis is found in the song bird, but not in the mouse (both animals have similar weight).

32) What is the difference between zebra finches and canary bird with respect to their repertoire of songs?

33) What is the barrel cortex, in which animals?

34) What is the homo-synaptic facilitation in the neuro-muscular end-plate: draw a sketch of the observed EPSPs in the presence of tetrodotoxin.

35) Hippocampus: in the old days, it was though that the hippocampus is important for olfaction. What is the main argument against this view?

36) Which parameter is thought to determine whether LTP or LTD is elicited?

37) Does the surface of pre-synaptic terminals increase as a consequence of vesicle fusion?

38) Please compare the consequences of monocular deprivation in kittens at the age day 23 to 29 versus deprivation of adult cats.

39) Is it possible to compensate interaural time differences by interaural level differences in human subjects?

40) Please specify which maps are represented with the central nucleus of the inferior colliculus, the external nucleus of the inferior colliculus, and the optic tectum of barn owls?

41) Please explain briefly the basic mechanism of LTP as it is observed classically in the hippocampus.

42) What is the relationship between the location of visual RFs and inter-aural time differences in the optic tectum of owls? Can this relationship experimentally be changed in a predictive way? Is the age of the owl an important factor?

43) Can you please briefly describe the cerebellar events underlying the conditioned eye blink reflex in mice (please emphasize LTD)

44) Can you please describe an experiment showing that there is some plasticity in SI (area 3b) of adult monkeys (including the ultimate proof for central instead of peripheral re-organization).

45) Describe the relationship between the annual dynamics of song repertoire, number of new neurons, number of degenerating neurons, and the level of testosterone in the canary bird. What are the experimental steps to document neurogenesis in this bird?

Lecture 3 electric fish and vortices

46) Which electro-receptors exist in fishes? (two main categories) Can you please describe their response properties?

47) Describe the electric organ of an electric fish. From which cell type is the electric organ derived?

48) What is the JAR (for instance in Eigenmania)?

49) Can you give examples of strong electric fish?

50) Can you give examples of weak electric fish?

51) What are the electro-receptors of a shark?

52) Which sensory modalities are represented in the duckbill somatosensory cortex? Is it possible to visualize these representations in SI?

53) Can you please give typical electric signals of weak electric fish (one signal typical for orientation, one for communication).

54) Are there any indications for the ability to determine object distance in Gnathonemus? What parameter can be used in order to determine the distance independent of the size of an object? Which mistake occurred on the slide showing the electric images of spheres and cubes?

55) What is the basis of the high sensibility of the whiskers in seals even in cold water?

56) Please name the three electric organs of an electric eel

57) Which behavior can be observed in nocturnal electric fish in Lake Malawi?

58) A weak electric fish (for instance Gnathonemus) is exposed to the electric field of his own electric organ together with the fields of other fishes in his neighborhood. Is the fish confused by these fields?

Lecture 4 bats

59) Which are the mechanisms of frequency dispersion on the basilar membrane of mammals?

60) Describe the IC neuron response of bats during vocalization and during pure tone stimulation with the same frequency.

61) Cochlea implant: what is the function of the microprocessor of a cochlea implant?

62) What was the origin of the idea that flying foxes should be flying primates?

63) What mechanisms are used to process echoes with long delays (due to objects far far away)? Compare the mechanisms found in bats and dolphins.

64) How many rows of outer hairs cells do you have, how many rows of inner hair cells? In total, how many IHC and OHC do you have?

65) What are oto-acoustic emissions?

66) What is the direction of the K^+ flux in hair cells upon mechanical stimulation?

67) Describe the peculiar problem of CF bats during high-speed flights?

68) Which observations prepared the ground for the idea that the basilar membrane is an active device?

Lecture 5 visual system and methods

69) Describe briefly the pathway for visual information (from cones and rods to visual cortex) in mammals.

70) How is the middle temporal area (MT) defined? Where is this area located in the rhesus brain?

71) What is the difference with respect to the retinotopic organization of a cat's SC and a monkey's SC?

72) Which cortical structures can be revealed by cytochrom-oxidase staining?

73) Which possibilities exist to demonstrate trans-synaptic connections?

74) How many layers are found in the LGN? Please list them and identify their input.

75) Draw the receptive field of a simple, complex, and hyper-complex cell, respectively, from area 17 of rhesus monkeys.

76) How can you separate the responses of simple and complex cells in area 17?

77) Describe briefly the basics of PET.

78) Describe briefly the basics of fMRI.

79) Which layer of the visual cortex projects to the SC?

80) Explain the spatial and temporal properties of the magno-cellular and parvo-cellular system

81) Please give a synonym for V5.

82) How can trans-synaptic connections be shown in the MRI?

83) What is still the most prominent dye in order to study the morphology of a single neuron or retrograde connections?

84) Is there an alternative method (to the use of intra-cellular recordings) to measure the membrane potential?

85) What is the effect of a convolution of a grey scale image with an antagonistic center-surround filter?

86) What are "intrinsic signals"? How can they be recorded?

87) Explain briefly the metabolism of 2-deoxyglucose. Why is it possible to use 2-DG as a marker for metabolic activity?

88) What can be observed in the firing rate of retinal ganglion cells of mice or salamander if a periodic stimulus is omitted?

89) Please list the possibility to record action potentials from a single neuron

90) If you perform the "*antidromic collision test*", what event triggers the stimulation?

91) Please describe the three experimental conditions whose results show that single-unit activity recorded from the primate SC codes for the behavioral relevance of a stimulus, not for its physical properties.

92) Can you briefly describe the input (classes of retinal ganglion cells) to the dorsal and ventral visual pathway?

Lecture 6 gaze stabilization

93) Please explain the physics of the "*search-coil technique*" to measure gaze position. Please give two possibilities of what exactly is measured. What are the differences with respect to the application of this technique in human and animals?

94) Give approx. values for the human VOR gain in total darkness for rotations around the pitch, yaw, and roll axis, respectively.

95) Is the function of the OKR redundant to the function of the VOR? If not, what is the difference?

96) What is the name of the plane that holds all possible rotation axes of the eye (for a given head position)?

97) What is the effect of the contraction of the lateral rectus muscle on right eye gaze position if (1) the eye is in primary position and (2) the eye looks 30 deg upward?

98) List the neurons responsible for the shortest neuronal pathway of the VOR?

99) Please explain the mechanisms of VOR gain adaptation. What is needed to change the VOR gain, what is the neuronal substrate of this adaptation?

100) Give the formula describing the relation between firing rate of an extra-ocular motoneuron and the eye position in the preferred direction of the muscle.

101) Which phases contribute to the OKN? How can you describe each phase?

102) What is the difference between look (German "Schau") and stare (German "Stier") OKN? Please describe a stimulus that allows to separate look OKN from stare OKN.

103) Please explain why is the execution of OKN in rats is asymmetric, whereas the OKR in primates is symmetric?

104) What is the OFR, describe briefly the experimental condition in which OFR can be measured. Can you please give the approx. latency of the OFR in monkeys?

105) Which physical unit is measured by the hair cells in the cupula of the semicircular canals?

106) What is the first Purkinje reflex?

107) What is the "*Einstein's equivalent principle*"?

108) From which primal eye movements are saccades deduced in the course of evolution? What is the argument for this idea?

109) Which muscle fiber type is found in the extra-ocular muscles?

110) Please describe the neuronal substrate of horizontal OKR in primates - from the retina to the extra-ocular muscle.

111) Comparison of extra-ocular muscles and skeleton muscles: why is the absence of the twitch reflex in the extra-ocular muscles not disturbing?

112) What is the original classification of eye movements according the Dodge in 1903? How would you 100 yrs later classify the eye movements of a human subject?

113) Do all fibers of the extra-ocular muscle contact the orbit, how are the fibers called? What does each type of fiber contact? What is the presumable function of each type of fiber?

Lecture 7 gaze guidance

114) Describe the initiation of smooth-pursuit eye movements, name the different phases.

115) Is fixation identical to smooth-pursuit of a target moving at zero velocity?

116) Where are pre-motoneurons located which are involved in the generation of horizontal and vertical saccades, respectively?

117) Which saccadic property is encoded by the pulse, which is encoded by the step of the motoneurons' firing rate?

118) Please explain the Rashbass paradigm, what can be achieved by this paradigm?

119) Where are fixation cells found (within the monkey SC)?

120) What is the "*main sequence*"?

121) Which type of pre-motoneuron is responsible for the pulse, which type is responsible for the step in the pulse-step scheme in motoneurons' firing rate during saccades?

122) Pulse-step scheme during saccades: what happens if the pulse is too small? What if the pulse is too large?

123) What happens immediately after a lesion of the cerebellum (posterior vermis) with respect of saccades? Does this deficit recover? Which deficit does not recover over time?

124) Draw the gaze, eye and head position of a natural gaze shift of a human of approx. 30 deg amplitude.

125) Describe saccadic precision as a function of target eccentricity? How are post-saccadic position errors compensated?

126) Please explain a very successful paradigm to differentiate sensory, working memory, and motor saccade-related activity.

127) Why is the latency of saccades directed towards bright targets shorter compared to saccades directed towards dimmed targets?

128) Why is the latency of saccades elicited by the gap paradigm shorter than the latency of saccades elicited by the normal paradigm? How are the latencies of the pro and anti-saccades? What is the explanation for these differences in latencies? Finally, are there any differences in peak velocities of regular, express, pro and anti-saccades?

129) Explain the paradigm in which express saccades are robustly elicited. Why is the latency of express saccades shorter as the latency of regular saccades?

130) Which experimental result (with respect of eye-head coordination) suggests the presence of an internal representation of target velocity in space during combined eye and head tracking?

131) Please list all neuron involved in the generation of the pulse-step activity pattern of extra-ocular moto-neurons during a saccade. Give their response profiles and their interconnections.

132) How can you observe the amount of saccadic suppression in everyday conditions? Can you give some experimental evidence against the idea that saccadic suppression switches off vision totally during the execution of a saccade?

Lecture 8 motor learning adaptation

133) How can visual signals be used to simulate brainstem deficit (i.e. pulse-step mismatch) in healthy subjects?

134) Is it possible to adapt the initiation of smooth-pursuit? If yes, how?

135) Is the adaptation mechanism of pursuit initiation rather early or late in motion processing? How can this question be addressed?

136) Can you briefly describe the PEST strategy? What is the problem with this strategy, how can this problem be solved?

137) How can the VOR gain be increased?

138) How can the VOR gain be decreased?

139) During adaptation of saccade amplitude, are there any differences between inward and outward adaptation? What is the explanation for this possible asymmetry?

140) In the course of saccade amplitude adaptation, is there a generalization of retinal space and saccade direction?

141) Is the initial saccade amplitude during pursuit initiation influenced by target velocity? Where is the post-saccadic eye position with respect to target position? Compare the latency of saccades directed to moving target with the latency of saccades directed towards stationary target.

142) Explain the "*Deubel adaptation*" of saccade amplitude. What is special compared to classical adaptation of saccade amplitude?

Lecture 9 re-afference principle, multiple approaches

143) Please explain the basic mechanism underlying "*PAD*".

144) Please describe a "*simple*" experiment to demonstrate the existence of sensors in our extra-ocular muscles.

145) What is the source of eye movement related information according to the *inflow* and *outflow* hypothesis, respectively?

146) What oculomotor deficits are expressed if the medio-dorsal thalamus is reversibly inactivated by injections of Muscimol in a rhesus monkey?

147) Where can you find an "*omega neuron*" (not omega man Charlton Heston), what is the input and output of this neuron?

148) Is it possible to measure a neuronal response at the future receptive field (i.e. location of the receptive field after the execution of a saccade? What happens if the medio-dorsal thalamus is temporarily out of order?

149) What is the name of the apparent motion of a stationary background during the execution of smooth pursuit?

150) What is the perception of an after-image during passive and active movements of the eye?

151) What is the perception of a stationary object during passive and active movements of the eye?

152) How was silent singing and fictive singing, respectively, achieved in crickets? Discus the results of theses experiments with respect to the inflow versus outflow debate.