Personnr	*Namn*	*Mapp nr*

Rest-tentamen DFM3 Moment 2:

Nervsystemet – från jonkanal till beteende

2017-05-11

*Skriv redan från början ditt **MAPPNUMMER** på **alla sidorna**, och dessutom **namn & personnummer** på **försättsbladet**.*

Skrivningen består av 8 teman fördelade på 8 sidor.

OBS 1: Kontrollera att alla sidor finns med i din skrivningsmappoch lämna sedan in mappen med sidorna i nummerordning.

OBS 2: Det går inte att i sitt svar på en viss sida hänvisa till svaret på en annan sida, eftersom varje sida rättas av respektive ansvarig lärare.

OBS 3: Skriv tydligt.

Fotolegitimation skall visas när skrivningen lämnas in till vakten.

Med hänvisning till Uppförandekod-dokumentet, som Du säkert skrivit under i början av Din utbildning, vill vi här be Dig att intyga på heder och samvete att svaren på denna tentamen ej har tillkommit via fusk:

_____

underskrift

Betygsättning:

Max poäng:	60 poäng
Godkänt:	40 poäng

Skrivningsresultatet kommer att anslås i slutet av vecka 21 på plan 6, BZ.

Resultatet läggs också ut i PingPong.

LYCKA TILL !

2017-05-11

Mapp nr.	*Σ poäng*

Tema 1: Axonutväxt och synapsbildning (8p)

a) Hur kan axonet från ett nybildat neuron nå sitt rätta mål? Beskriv huvudprinciperna för guidning av växande axon. Utgå från ett ursprungsneuron i den dorsala delen av ryggmärgen som skickar sitt axon till ryggmärgens ventrala del och sedan vidare till ryggmärgens motsatta (kontralaterala) sida. (4 p)

b) Beskriv händelseförloppet från det att ett axonutskott fått kontakt med ett dendritutskott fram till dess att en färdig synaps bildats. Ange de viktigaste molekylära komponenterna.(4p)

Mapp nr.	*Σ poäng*

Tema 2: Postsynaptiska effekter – generering av aktionspotentialer (6p)

a) Redogör för vilka typer av svar som kan genereras i det postsynaptiska membranet (i det fall svaret är elektriskt) samt förklara hur detta sker. (3p)

b) Vilken betydelse har avståndet från en synaps till genereringsstället för aktionspotentialen? Motivera svaret. (2p)

c) Flera synapser måste som regel aktiveras för att generera en aktionspotential i det stimulerad neuronet. Förklara de två principiella sätt genom vilka summering av synaptisk aktivitet kan ske. (1p)

Mapp nr.	*Σ poäng*

Tema 3: Från foton till ögonmottagning (8p)

a) När ljus träffar en stav sker en förändring av permeabiliteten för en viss jon i yttermembranet, vilket medför en förändring i membranpotentialen. Vilken jon förändrar membranpotentialen? Förklara mekanismen. (2p)

b) Visa med en enkel skiss det anatomiska underlaget till pupillens ljusreflex. (3p)

c) En 50 årig kvinna uppsöker ögonmottagningen, då hon börjat se sämre. Hennes synbesvär består framför allt av svårigheter att se i mörker. Hon har varit hos optiker, som noterat att ingen förbättring kunde erhållas med glasögon. Den oftalmologiska utredningen visar att hon lider av retinitis pigmentosa och att endast det centrala synfältet finns kvar. Förklara detta fynd med utgångspunkt från näthinnans uppbyggnad av både stavar och tappar. (3p)

Mapp nr.	*Σ poäng*

Tema 4: Smak och lukt (7p)

1) Smak: Receptorerna för gustation finns i smaklökar. Smaklökar är belägna på tungpapillerna. Det finns 3 typer av papiller på tungan. Beskriv dessa tre papiller i termer av a) smak de är mest känsliga för, och b) den nerv som innerverar dem. (5p)

2) Lukt: Beskriv hur en doftmolekyl, som binds till en receptor, aktivera luktreceptorcellerna. (2p)

Mapp nr.	*Σ poäng*

Tema 5: Hur nervsystemet styr våra gångrörelser (8p)

Lokomotionen är ett basalt motoriskt beteende, vars reglermekanismer till stor del är nedärvda. Dessa mekanismer är relativt väl studerade, och innefattar strukturer på flera nivåer inom CNS.

a) Den rytmiska lokomotionsrörelsen genereras av ett centralt, motoriskt program. Definiera vad vi menar med detta och vad ett program består av. Ange även var inom CNS lokomotionsprogrammet är beläget, samt hur man experimentellt kunnat påvisa detta. (3p)

b) En viktig mekanism inom det centrala lokomotionsprogrammet är sk reciprok inhibition. Vad innebär denna mekanism och vad har den för betydelse för det rytmiska aktivitetsmönstret som genereras av programmet? (2p)

c) För att gångrörelsen ska starta, kommer andra strukturer inom CNS att engageras för att åstadkomma en aktivering av lokomotionsprogrammet. Ange vilka dessa strukturer är, samt redogör för aktiveringssignalernas väg till lokomotionsprogrammet. (3p)

Mapp nr.	*Σ poäng*

Tema 6: Cortikal motorisk kontroll (9 p)

Den överordnade kontrollen av våra rörelser innefattar ett flertal olika steg, från den första tanken på och beslutet om att göra en viss rörelse, t ex att skriva sitt mappnummer på alla tentamenspapper (vilket Du givetvis redan gjort), till själva genomförandet, exekveringen, av rörelsen. Du skall nu redogöra för den neurobiologiska bakgrunden till Din förmåga att med stor precision och med personlig (och likväl läslig!) stil skriva Ditt mappnummer på varje papper.

a) Primära motorcortex har en övergripande funktionell roll i kontrollen av våra rörelser. Vilken är denna roll? (1 p)

b) Neuron i primära motorcortex är "riktningskänsliga", dvs de aktiveras vid t.ex . en armrörelse i en viss riktning. Precisionen av denna riktningskänslighet hos neuronet är emellertid ganska dålig. Vilken är bakgrunden till att primära motorcortex ändå kan styra en armrörelse med stor precision i en viss riktning? (2 p)

c) Primära motorcortex samverkar med flera andra cortikala områden vilka också har viktiga roller att spela i den motoriska kontrollen. Ange benämning och ungefärlig lokalisation av dessa andra motoriska cortexområden (1 p)

d) Redogör för den roll dessa motoriska cortexområden spelar för den viljemässiga kontrollen av rörelser, gärna med exemplet ovan som utgångspunkt. (3 p)

e) När det gäller den descenderande kontrollen av handens finmotorik, alltså Din förmåga att greppa pennan mellan fingrarna och skriva Ditt nummer, finner man en speciell egenskap hos människa och andra primater. Vilken är denna egenskap och varför tror Du den är viktig för den finmotoriska kontrollen? (2 p)

Mapp nr.	*Σ poäng*

Tema 7: Språk (7p)

Framförallt två områden i associationscortex är viktiga för vårt språk.

a) vilka områden avses? (2p)

b) vad är karakteristiskt för en afasi primärt kopplad till respektive område? (2p)

c) Med lateralisering menas att en funktion främst är kopplad till den ena hjärnhalvan.

Ange om nedanstående funktioner i normalfallet i *huvudsak* är kopplade till

1) vänster hemisfär 2) höger hemisfär eller 3) båda hemisfärerna (3p):

- symbolförståelse
- objektigenkänning
- språkets emotionella innehåll

Mapp nr.	*Σ poäng*

Tema 8: Minne och minnesinkodning (7p)

Nervsystemet är oerhört plastiskt och syftet är att organismen ska kunna utveckla och anpassa sina beteenden så att de är så funktionella som möjligt. Denna plasticitet, som är störst i början på livet, är direkt kopplad till vår förmåga att lära oss av beteenden och erfarenheter. Ett flertal minnesfunktioner har utvecklats för att möta dessa komplexa krav.

a) Beskriv, gärna i en hierarkisk uppställning, olika kvalitativa minneskategorier och vilka neurala strukturer som står för den huvudsakliga inkodningen av minne i respektive minneskategori. (4p)

b) Ge ett konkret förslag på hur man bör framföra information i ett patientsamtal för att hjälpa patienten att under lång tid minnas den viktiga informationen du vill ge. Beskriv även de principer/mekanismer genom vilket detta förslag stödjer patientens minnesfunktion. (3p)

Karolinska Institutet
Läkarprogrammet Termin 3

Den friska människan 3

DFM3-mom 2, Rest tentamen VT18

Personnr	*Namn*	*Mapp nr*

Written Re-Examination DFM3 Part 2:

The Nervous System – From Ion Channels to Behaviour

2018-05-11, 9.00-13.00

*Skriv redan från början ditt **MAPPNUMMER** på **alla sidorna**, och dessutom **namn & personnummer** på **försättsbladet**.*

Skrivningen består av 8 teman fördelade på 8 sidor.

OBS 1: Kontrollera att alla sidor finns med i din skrivningsmapp och lämna sedan in mappen med sidorna i nummerordning.

OBS 2: Det går inte att i sitt svar på en viss sida hänvisa till svaret på en annan sida, eftersom varje sida rättas av respektive ansvarig lärare.

OBS 3: All answers should be written in English.

Fotolegitimation skall visas när skrivningen lämnas in till vakten.

Med hänvisning till Uppförandekod-dokumentet, som Du säkert skrivit under i början av Din utbildning, vill vi här be Dig att intyga på heder och samvete att svaren på denna tentamen ej har tillkommit via fusk:

_____

underskrift

Betygsättning:

Max poäng:	60 poäng
Godkänt:	40 poäng

Skrivningsresultatet kommer att anslås under vecka 22 på plan 6, BZ.

Resultatet läggs också ut i PingPong.

En extra rest-tentamen äger rum den 20 augusti kl. 09.00 – 13.00.

LYCKA TILL !

2018-05-11

Mapp nr.	*Σ poäng*

Theme 1. Physiology of the neuron (7p)

a) Describe the ionic mechanisms underlying the action potential including the afterhyperpolarization (3p)

b) Describe how the action potential is propagated in myelinated and unmyelinated axons, respectively. (2p)

c) What is the axon refractory period and how does the refractory period in an axon contribute to uni-directional propagation of the action potential? (2p)

Mapp nr.	*Σ poäng*

Theme 2. Synaptic transmission (8p)

a) Neurotransmitters can be stored in two distinct types of vesicle: synaptic vesicles (SV) and large dense-cored vesicles (LDV). Describe for each vesicle type: which neurotransmitter they contain (give two examples each), where they are produced and filled with neurotransmitter, where in the nerve terminal they are stored, and by which type of stimuli they release neurotransmitter. (8p)

Mapp nr.	*Σ poäng*

Theme 3. Pain (8p)

a) Describe the nerve fibers (primary afferents) that convey touch and pain, respectively. Where are the cell bodies located? How do they differ (diameter, myelination, conduction velocity)? (3p)

b) How are the impulses propagated in the two different systems (touch versus pain) on their way to the cerebral cortex? (3p)

c) What happens with the pain- and touch-signals after a half-sided damage (hemisection) of the spinal cord? (2p)

Mapp nr.	*Σ poäng*

Theme 4. The vestibular apparatus (8p)

You and a friend are at the Copenhagen Tivoli to celebrate an exam. You will ride the Super Rotations Express, a carousel that rotates rapidly in the horisonal plane, and the Free Fall that release you for a vertical trip. As you have studied sensory functions thoroughly you are well aware of how these entertaining activities will affect your vestibular apparatus.

a) Which are the components of the vestibular system and which of them will primarily be activated by the Super Rotations Express and Free Fall, respectively. (3p)

b) Describe how the sensory cells are activated when you ride the Super Rotations Express. (2p)

c) Your friend is riding a carousel in which she rotates rapidly (around her own axis). When the carousel stops you can see that her eyes are moving in an odd manner. What is this phenomenon called and how can it be explained? (3p)

Mapp nr.	*Σ poäng*

Theme 5. Spinal cord trauma (7p)

The care of patients with a spinal cord lesion in modern medicine builds on a modern knowledge of the spinal cord, spinal reflexes and muscle functions. Answer the questions below based on this knowledge.

A patient has a partial spinal cord lesion at the thoracic level that compromises movements of the legs. To inform the patient about his condition and prognosis you need to answer the following questions:

a) Which descending tracts are located in the lateral funiculus of the spinal cord, and which body parts are primarily affected after a lesion of these tracts? (2p)

b) How is the patients ability to walk affected by a selective lesion of the lateral funiculus? How is it affected by a larger lesion that also includes the medial reticulospinal tracts? Explain the difference. (3p)

c) An important consequence of a loss of supraspinal control is that the ability to control spinal reflexes is reduced or lost. Describe how such descending control normally regulates the flexor reflex? (2p)

Mapp nr.	*Σ poäng*

Theme 6. Role of the basal ganglia in motor control (8p)

The basal ganglia plays a vital role in the regulation of virtually all motor functions.

a) Describe briefly how this regulation is exerted (2p)

b) Two distinct signal pathways through the basal ganglia have been defined structurally and functionally. Describe briefly these pathways and their respective functional roles (4p).

c) In patients with Parkinson´s disease the basal ganglia does not function properly. Describe briefly how the symptoms can be explained in relation to the two signal pathways (2p)

Mapp nr.	*Σ poäng*

Theme 7. Diurnal Rhythms (7p)

Hypothalamus is a small brain region located above the optic nerve chiasm. Neurons in a subregion of hypothalamus plays an important role in the regulation of the diurnal rhythm. This happens through a complex interaction between a number of proteins that regulate gene transcription in a cyclic manner.

a) What is the name of the anatomical subregion in hypothalamus that plays a key role in the regulation of diurnal rhythms? (1p)

b) "Zeitgebers" play an important role in the regulation of diurnal rhythms. Light is the most important Zeitgeber for humans. Explain how light affects the diurnal rhythm and give examples of other zeitgebers than light. (3p)

c) Give examples of different body functions (such as secretion of endogenous chemical substances) that are regulated in a cyclical manner over a 24 hour cycle and specify which roles they have. (3p)

Mapp nr.	*Σ poäng*

Theme 8: Language (7p)

Two areas in the association cortex are important for language.

a) Which are these areas? (2p)

b) What is characteristic for aphasias linked with each of these two areas? (2p)

c) Lateralization means that a function is primarily linked with one hemisphere.

Specify whether the functions mentioned below are primarily linked with:

1) left hemisphere 2) right hemisphere or 3) both hemispheres (3p):

- understanding of symbols
- recognition of objects
- the emotional content of language

Karolinska Institutet
Läkarprogrammet Termin 3

Den friska människan 3

DFM3-mom 4, extra rest-tentamen VT18

Personnr	*Namn*	*Mapp nr*

Extra Written Re-examination DFM3 Module 4:

The Nervous System – From Ion Channels to Behaviour

2018-08-20

*Skriv redan från början ditt **MAPPNUMMER** på **alla sidorna**, och dessutom **namn & personnummer** på **försättsbladet**.*

Skrivningen består av 9 teman fördelade på 9 sidor.

OBS 1: Kontrollera att alla sidor finns med i din skrivningsmapp och lämna sedan in mappen med sidorna i nummerordning.

OBS 2: Det går inte att i sitt svar på en viss sida hänvisa till svaret på en annan sida, eftersom varje sida rättas av respektive ansvarig lärare.

OBS 3: All answers should be written in English.

Fotolegitimation skall visas när skrivningen lämnas in till vakten.

Med hänvisning till Uppförandekod-dokumentet, som Du säkert skrivit under i början av Din utbildning, vill vi här be Dig att intyga på heder och samvete att svaren på denna tentamen ej har tillkommit via fusk:

_____

underskrift

Betygsättning:

Max poäng:	60 poäng
Godkänt:	40 poäng

Skrivningsresultatet kommer att anslås på Pingpong under vecka 35.

LYCKA TILL !

Mapp nr.	*Σ poäng*

Theme 1. Physiology of the neuron (8p)

a) Describe the ionic mechanisms underlying the action potential including the afterhyperpolarization (3p)

b) Describe how the action potential is propagated in myelinated and unmyelinated axons, respectively. (3p)

c) What is the axon refractory period and how does the refractory period in an axon contribute to uni-directional propagation of the action potential? (2p)

Mapp nr.	*Σ poäng*

Theme 2. Synaptic transmission (6p)

Describe the molecular mechanisms underlying fusion of synaptic vesicles in nerve terminals. The answer should include the key proteins and their respective roles (6p).

Mapp nr.	*Σ poäng*

Theme 3. Neurotransmitters and receptors (6p)

a) Following release, the neurotransmitter acetylcholine is rapidly inactivated. What is the mechanism involved in the inactivation of acetylcholine? What happens when this mechanism is blocked? (2p)

b) Describe the mechanism by which the neurotransmitter glutamate is inactivated (1p)

c) Glutamate acts on two distinct types of receptor, AMPA and NMDA receptors. How do these receptors differ? (3p).

Mapp nr.	*Σ poäng*

Theme 4. Pain (6p)

a) Describe the different types of nerve fiber (primary afferents) that convey touch and pain, respectively. Where are the cell bodies located? How do they differ (diameter, myelination, conduction velocity)? (3p)

b) How are the impulses propagated in the two different systems (touch versus pain) on their way to the cerebral cortex? (3p)

Mapp nr.	*Σ poäng*

Theme 5. The visual system (8p)

Glaucoma is an ocular disorder with multi-factorial etiology. It can permanently damage vision in the affected eye and lead to blindness if left untreated. It affects the retina and is the second-leading cause of blindness after cataracts.

(a) The central fovea (of macula lutea) and the optic disc (blind spot) are two prominent structures of the retina. What characterizes the function of the central fovea compared to other parts of the retina and why does not light on the optic disc trigger nerve impulses in the optic nerve? (3p)

(b) Describe (with a schematic drawing of the eye and the cellular organization of the retina) how light reaches the photoreceptors and describe how the resulting nerve signals reach the optic nerve. Remember to indicate directions! (4p)

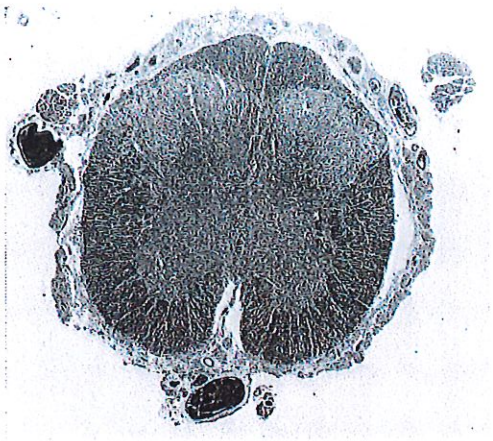
(c) In which nucleus do we find the first synapses in the pathway to the visual cortex (1p)

Mapp nr.	*Σ poäng*

Theme 6. Brainstem/Spinal cord - Neuroanatomy (6p)

a) Name the CNS regions shown on the sections (A-D) 2p

A



B

C

D

b) Explain how the brainstem receives blood and how the vessels are located in relation to the brainstem. 2p

c) Draw a simple picture of the spinal cord and indicate where the descending pathways that control locomotion are located. Also, show what part of the gray matter they control. 2p

Mapp nr.	*Σ poäng*

Theme 7. Motor functions: Cerebellum. (6p)

Cerebellum has an important role in the control of movements. Describe the following:

a) What aspects of motor control are regulated by the cerebellum? (2p)

b) Which are the two, principally different, kinds of information that are being processed in the cerebellum? (2p)

c) Describe, preferably in a schematic drawing, the important nerve cell types in the cerebellar cortex (2p)

Mapp nr.	*Σ poäng*

Theme 8. The reward system (7p)

The reward system is very important for guiding us in what we want and to reward us when we carry out different behaviours. One of the main functions of the reward system is to give different objects, people and behaviours a positive value so that we like them.

a) The Mesolimbic dopamine system is believed to play an important part in the reward system. Which brain regions are part of the mesolimbic dopamine system? Give evidence for this hypothesis. (4p)

b) This hypothesis has been questioned. Which evidence goes against that this system mediates reward? (1p)

c) Which role does the mesolimbic dopamine system play in addiction? (2p)

Mapp nr.	*Σ poäng*

Theme 9: Higher cognitive functions (7p)

a) Mention four different symptoms that are associated with damage to the frontal lobe. (4p)

b) What central function does anterior cingulum has for when we decide between different behaviours? (1p)

c) What parts of the prefrontal cortex and cingulum are involved in emotion regulation? (1p)

d) What parts of the prefrontal cortex and cingulum are involved in control of non-emotional regulation (1p)

Karolinska Institutet
Läkarprogrammet Termin 3

Den friska människan 3

DFM3-mom 2, Rest tentamen HT18

Personnr	*Namn*	*Mapp nr*

Written Re-Examination DFM3 Part 2:

The Nervous System – From Ion Channels to Behaviour

2LK009

2018-12-14, 9.00-13.00

*Skriv redan från början ditt **MAPPNUMMER** på **alla sidorna**, och dessutom **namn & personnummer** på **försättsbladet**.*

Skrivningen består av 8 teman fördelade på 8 sidor.

OBS 1: Kontrollera att alla sidor finns med i din skrivningsmapp och lämna sedan in mappen med sidorna i nummerordning.

OBS 2: Det går inte att i sitt svar på en viss sida hänvisa till svaret på en annan sida, eftersom varje sida rättas av respektive ansvarig lärare.

OBS 3: All answers should be written in English.

Fotolegitimation skall visas när skrivningen lämnas in till vakten.

Med hänvisning till Uppförandekod-dokumentet, som Du säkert skrivit under i början av Din utbildning, vill vi här be Dig att intyga på heder och samvete att svaren på denna tentamen ej har tillkommit via fusk:

_____

underskrift

Betygsättning:

Max poäng:	60 poäng
Godkänt:	40 poäng

Skrivningsresultatet kommer att anslås i slutet av vecka 2 på plan 6, BZ och i PingPong.

LYCKA TILL !

2018-12-14

Mapp nr.	*Σ poäng*

Theme 1: Physiology of the neuron (8p)

a) Describe the ionic mechanisms underlying the action potential including the afterhyperpolarization (3p)

b) Describe how the action potential is propagated in myelinated and unmyelinated axons, respectively. (3p)

c) What is the axon refractory period and how does the refractory period in an axon contribute to uni-directional propagation of the action potential? (2p)

Mapp nr.	*Σ poäng*

Theme 2: Synaptic transmission (7p)

Describe the molecular mechanisms underlying fusion of synaptic vesicles in nerve terminals. The answer should include the key proteins and their respective roles (7p).

Mapp nr.	*Σ poäng*

Theme 3: Pain (8p)

a) Describe the nerve fibers (primary afferents) that convey touch and pain, respectively. Where are the cell bodies located? How do they differ (diameter, myelination, conduction velocity)? (3p)

b) How are the impulses propagated in the two different systems (touch versus pain) on their way to the cerebral cortex? (3p)

c) What happens with the pain- and touch-signals after a half-sided damage (hemisection) of the spinal cord? (2p)

Mapp nr.	*Σ poäng*

Theme 4: The visual system (8p)

Glaucoma is an ocular disorder with multi-factorial etiology. It can permanently damage vision in the affected eye and lead to blindness if left untreated. It affects the retina and is the second-leading cause of blindness after cataracts.

(a) The central fovea (of macula lutea) and the optic disc (blind spot) are two prominent structures of the retina. What characterizes the function of the central fovea compared to other parts of the retina and why does not light on the optic disc trigger nerve impulses in the optic nerve? (3p)

(b) Describe (with a schematic drawing of the eye and the cellular organization of the retina) how light reaches the photoreceptors and describe how the resulting nerve signals reach the optic nerve. Remember to indicate directions! (4p)

(c) In which nucleus do we find the first synapses in the pathway to the visual cortex (1p)

Mapp nr.	*Σ poäng*

Theme 5: Motor functions – the basal ganglia (7p)

a) What are the differences between Parkinson's and Huntington's diseases? Explain the differences in terms of the behavioral dysfunction and the network organization of the basal ganglia. (5p)

b) Which neurons degenerate in Parkinson´s disease? (1p)

c) Which neurotransmitter do these neurons use? (1p)

Mapp nr.	*Σ poäng*

Theme 6: Cortical control of motor functions (8p)

The control of our movements includes a number of different steps, from the first thought and decision of a certain movement, to the actual execution of the movement. In this question you should give an account for the neurobiological basis of your ability to perform hand movements.

a) The primary motor cortex plays an important role in the control of our movements. Which is this role? (2p)

c) The primary motor cortex cooperates with other cortical areas which also have important roles in motor control. What are these areas called and where are they located? (2p)

d) Describe the role of these cortical areas in voluntary motor control. (4p)

Mapp nr.	*Σ poäng*

Theme 7: The reward system (7p)

The reward system is very important for guiding us in what we want and to reward us when we carry out different behaviours. One of the main functions of the reward system is to give different objects, people and behaviours a positive value so that we like them.

a) The mesolimbic dopamine system is believed to play an important part in the reward system. Which brain regions are part of the mesolimbic dopamine system? Give evidence for this hypothesis. (4p)

b) This hypothesis has been questioned. Which evidence goes against that this system mediates reward? (1p)

c) Which role does the mesolimbic dopamine system play in addiction? (2p)

Mapp nr.	*Σ poäng*

Theme 8: Language (7p)

Two areas in the association cortex are important for language.

a) Which are these areas? (2p)

b) What is characteristic for aphasias linked with each of these two areas? (2p)

c) Lateralization means that a function is primarily linked with one hemisphere.

Specify whether the functions mentioned below are primarily linked with:

1) left hemisphere 2) right hemisphere or 3) both hemispheres (3p):

- understanding of symbols
- recognition of objects
- the emotional content of language

Mapp nr.	*Σ points*

Theme 1: Electrical properties of neuronal cells (8p)

This theme deals with ion channels, membrane potential and intrinsic properties of neurons. There are four multiple choice questions with five suggested answers of which one or several are correct. Please mark the appropriate answer(s) for each of these questions.

1) The electrical activity of neurons is generated by ion flow though ion channels. Which of the following statement(s) is (are) incorrect regarding ion channels: (2 p)

- 1: The flow of ions through ion channels requires energy in form of ATP
- 2: The direction of the flux of ion is only determined by the driving force
- 3: Ion channels allow all ions to pass through
- 4: Ion channels have a selectivity filter to specifically recognize and select a given ion type
- 5: Ion channels are membrane lipids that allow ion to pass only in one direction

2) The resting membrane potential of neurons is around -65 mV and is determined by: (2 p)

- 1: Passive flow of ions
- 2: Voltage-gated ion channels
- 3: Leak K^+ and Na^+ channels
- 4: Na/K ATPase
- 5: Non-gated ion channels

3) Action potentials transmit the electrical signals along the axons of neurons. Which of the following statement(s) is (are) correct: (2 p)

- 1: Action potentials are generated in the dendrites of neurons
- 2: There is an influx of Ca^{2+} via voltage-gated channels during action potentials
- 3: The rising phase of an action potential is mediated by Ca^{2+} influx
- 4: Action potentials propagate from soma to axon terminals with constant amplitude
- 5: The slow afterhyperpolarization controls the frequency of action potentials

4) The passive membrane properties of neurons determine the efficacy of summation of synaptic inputs. Which of the following statement(s) is (are) incorrect: (2 p)

- 1: The time and space constants does not vary between different types of neurons
- 2: The spatial summation increases with an increased space constant
- 3: The temporal summation decreases with increased space constant
- 4: Neurons with small time and space constants have less efficient summation
- 5: The shape of action potentials is determined by the time constant of the neuron

Mapp nr.	*Σ points*

Theme 2: Neurotransmitters (6p)

a) Which is the major excitatory neurotransmitter in the brain? (1p)

b) Describe how it is synthesized. (1p)

c) Describe how it is inactivated (1p)

d) This neurotransmitter activates two principal types of ionotropic receptors with different properties. What are these receptors called and how do their properties differ? (3p)

Mapp nr.	*Σ points*

Theme 3: Sensory systems: Pain physiology (8 p)

Pain impulses, from for example a fingertip, travel a considerable distance before they affect us. Describe the structures that are sensitive to nociceptive stimulation, (the nociceptors) and the path of pain signals from the periphery (in e.g. the skin) until they reach consciousness. Which different types of neurons and which CNS structures participate in the conduction of pain signals and where are the cell-bodies of these neurons and their synaptic connections located? Also describe the most important pathways and CNS regions involved in descending pain modulation. (8 p)

Mapp nr.	*Σ points*

Theme 4: Sensory systems: Vision (8 p)

1) When light hits a rod, a change in the permeability of a particular ion occurs in the outer membrane, which causes a change in the membrane potential. Which ion changes the membrane potential? Explain the mechanism. (3p)

2) Show with a simple drawing the anatomical basis of the pupil's light reflex. (3p)

3) A 50-year-old woman goes to the eye clinic when she starts to see worse. Her vision problems mainly consist of difficulties to see in the dark. The optician noted that no improvement could be obtained with glasses. The ophthalmological investigation shows that she suffers from retinitis pigmentosa and that only the central field of vision remains. Explain this finding, starting from the retina's composition of both rods and cones. (2p)

Mapp nr.	*Σ points*

Theme 5: Motor functions I: Spinal cord (8 p)

How is locomotion generated? Describe the organization of the locomotor system by answering the following questions:

a) Give a definition of the locomotor pattern generator (CPG) and describe its role and location in the CNS (4p)

b) How is the locomotor CPG activated? (2p)

c) Describe the role of sensory input for the control of locomotion. (2p)

Mapp nr.	*Σ points*

Theme 6: Motor functions II: Cortical control of motor functions (8p)

The control of our movements includes a number of different steps, from the first thought and decision of a certain movement, to the actual execution of the movement. In this question you should give an account for the neurobiological basis of your ability to perform hand movements.

a) The primary motor cortex plays an important role in the control of our movements. Which is this role? (2p)

c) The primary motor cortex cooperates with other cortical areas which also have important roles in motor control. What are these areas called and where are they located? (2p)

d) Describe the role of these cortical areas in voluntary motor control. (4p)

Mapp nr.	*Σ points*

Theme 7: Emotion (7 p)

Emotions are important to motivate the decisions and behaviours that people chose to engage in, in different situations. For example, emotions are essential at protecting us from a wide range of threats, such as physical threats (e.g. snakes), psychological stress (e.g. shame), social threats (e.g. social exclusion) etc. Rightfully, the involved neural circuits are often called "survival circuits". In addition, our ability to detect and analyse other people's emotions are essential for our ability to understand other people's intentions and for successful social interactions. Disturbances in the ability to regulate emotions can be related to phobias, post traumatic stress disorder (PTSD), panic attacks and schizophrenia.

A) Name the three components necessary for an emotion (3p)

B) Name the main neural structure that is central for producing emotions, it is also involved in detecting and learning about emotional relevant aspects in the surrounding. (1p)

C) Name the neural structure responsible for down-regulating emotions (1p)

D) Name and describe an additional neural structure central for emotions (you are free to chose any relevant structure as long as you can accurately motivate why). (2p)

Theme 8:I: Sleep, 4p

Mapp nr.	*Σ points*

a) Sleep is an essential phenomon of the brain. Describe the role of thalamus for the regulation of sleep and wakefulness. (2p)

b) What are the acute consequences of sleep deprivation for how the brain will work the next day. Decribe 4 aspects (2p)

Mapp nr.	*Σ points*

Tema 8:II PU

Svara med utgångspunkt från PU-dagarna.

1) Definera följande begrepp, och förklara varför dom är viktiga ur ett kliniskt perspektiv. (3p)

- Klassisk betingning

- Operant inlärning

Mapp nr.	*Σ points*
9	7,2

Theme 1: Electrical properties of neuronal cells (8p)

This theme deals with ion channels, membrane potential and intrinsic properties of neurons. There are four multiple choice questions with five suggested answers of which one or several are correct. Please mark the appropriate answer(s) for each of these questions.

1) The electrical activity of neurons is generated by ion flow though ion channels. Which of the following statement(s) is (are) incorrect regarding ion channels: (2 p)

- o 1: The flow of ions through ion channels requires energy in form of ATP
- o 2: The direction of the flux of ion is only determined by the driving force
- o 3: Ion channels allow all ions to pass through
- o 4: Ion channels have a selectivity filter to specifically recognize and select a given ion type
- o 5: Ion channels are membrane lipids that allow ion to pass only in one direction

2) The resting membrane potential of neurons is around -65 mV and is determined by: (2 p)

- ✓ o 1: Passive flow of ions
- o 2: Voltage-gated ion channels
- o 3: Leak K^+ and Na^+ channels
- ✓ o 4: Na/K ATPase
- o 5: Non-gated ion channels

3) Action potentials transmit the electrical signals along the axons of neurons. Which of the following statement(s) is (are) correct: (2 p)

- o 1: Action potentials are generated in the dendrites of neurons
- o 2: There is an influx of Ca^{2+} via voltage-gated channels during action potentials
- o 3: The rising phase of an action potential is mediated by Ca^{2+} influx
- o 4: Action potentials propagate from soma to axon terminals with constant amplitude
- o 5: The slow afterhyperpolarization controls the frequency of action potentials

4) The passive membrane properties of neurons determine the efficacy of summation of synaptic inputs. Which of the following statement(s) is (are) incorrect: (2 p)

- o 1: The time and space constants does not vary between different types of neurons
- o 2: The spatial summation increases with an increased space constant
- o 3: The temporal summation decreases with increased space constant
- o 4: Neurons with small time and space constants have less efficient summation
- o 5: The shape of action potentials is determined by the time constant of the neuron

Mapp nr.	*Σ points*
9	5

Theme 2: Neurotransmitters (6p)

a) Which is the major excitatory neurotransmitter in the brain? (1p)

glutamate 1

b) Describe how it is synthesized. (1p)

c) Describe how it is inactivated (1p)

Glutamate is transported by glutamate transporters into astrocytes for re-usage/re-uptake. Glutaminase syntetase transforms glutamate into glutamine and it is transported back with glutamate transporters into the nerve terminal where glutaminase transforms glutamine back to glutamate for reusage as neurotransmitter 1

d) This neurotransmitter activates two principal types of ionotropic receptors with different properties. What are these receptors called and how do their properties differ? (3p)

Glutamate activates the ionotropic; AMPA-receptors, Kainate-receptors and NMDA-receptors. (all ionotropic receptors)

AMPA and Kainate are nonselective katjon receptors, permeable to K^+ and Na^+. They are ligand-activated and when glutamate binds to them, an influx of Na^+ occurs. AMPA and kainate are ligand gated ionotropic receptors. 3

NMDA receptors are also nonselective katjon-receptors, permeable to Na^+, K^+ but also to Ca^{2+}. NMDA gets activated when binding to glutamate (ligand-activation) but it has Mg^{2+} sitting in the receptor and blocking it, therefore it requires depolarization to get activated, when depolarization occurs, Mg^{2+} dissociates and the blockage are gone. NMDA receptors are therefore both ligand and voltage dependant. In order to get activated.

Mapp nr.	*Σ points*
9	8

Theme 3: Sensory systems: Pain physiology (8 p)

Pain impulses, from for example a fingertip, travel a considerable distance before they affect us. Describe the structures that are sensitive to nociceptive stimulation, (the nociceptors) and the path of pain signals from the periphery (in e.g. the skin) until they reach consciousness. Which different types of neurons and which CNS structures participate in the conduction of pain signals and where are the cell-bodies of these neurons and their synaptic connections located? Also describe the most important pathways and CNS regions involved in descending pain modulation. (8 p)

The nociceptors can be unimodal: sensitive to a specific noxious stimuli; tex chemical, heat mm., polymodal: sensitive to all types of noxious stimuli, and silent: silent nociceptors gets activated during for example an inflammation.
The primary afferent fibers that convey the pain signals from periphery nociceptors to the brain are C-fibers and A-delta fibers.
C-fibers convey slow, dull pain, often from visceral organs. The fibers are very thin and with no myelin, they convey the signal at a speed of 0,5-2 m/s.
A-delta fibers convey fast, sharp pain. The fibers are thin (but not as thin as c-fibers) and with myelin. They convey the pain signal at 5-30 m/s. 8
From the nociceptor, the signal travel via C and A-delta fibers to the basal root ganglion (in the dorsal horn) where the afferent 1:st order neurons have their cell bodies. In the rexed lamina in the dorsal horn, the first order neurons secretes excitatory neurotransmitters (substance P/glutamate) in substantia gelatinosa and synapses with the second order neurons. In the anterolaterala spinothalamic pathway, the decussation to the contralateral side happens down here; after the synapse in the dorsal horn, the fibers decussates directly to the contralateral side. The anterolaterala spinothalamic tract then travels up to the thalamus, where it synapses to the third order neurons in VPLV in thalamus. The signal then travels to the sensory cortex. The pain does not reach consciousness before it reaches cortex.
Descending pain modulation
Central descending pain modulation is made via PAG, periaqueductal gray that projects into 2 important nucleus; locus coeruleus that secretes noradrenaline and raphe nucle that secretes serotonin. Serotonine and noradrenaline can modulate directly or indirectly via activation of inhibitory interneurons. continues →

Mapp nr. 9	*Σ points* 8

Theme 4: Sensory systems: Vision (8 p)

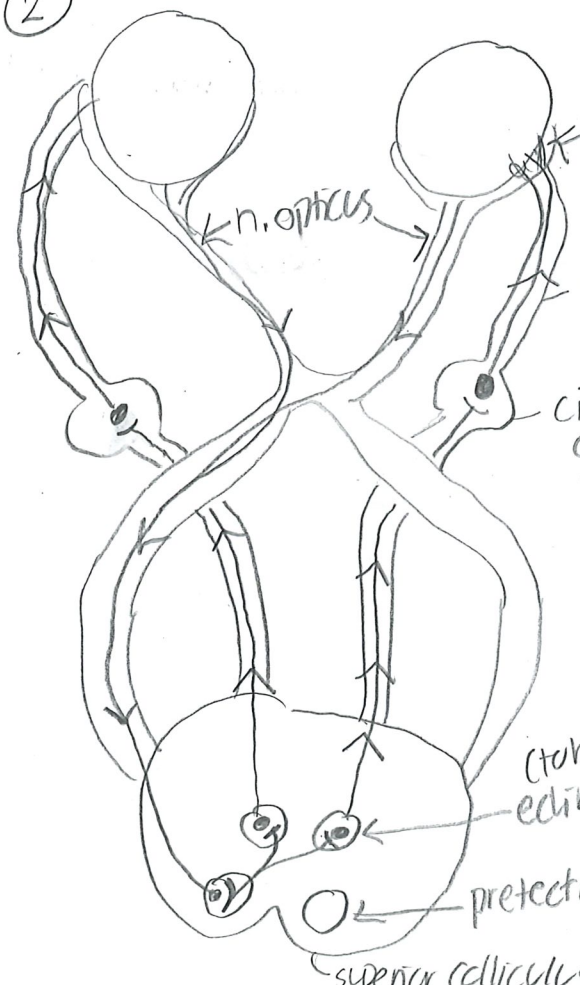
1) When light hits a rod, a change in the permeability of a particular ion occurs in the outer membrane, which causes a change in the membrane potential. Which ion changes the membrane potential? Explain the mechanism. (3p)

2) Show with a simple drawing the anatomical basis of the pupil's light reflex. (3p)

3) A 50-year-old woman goes to the eye clinic when she starts to see worse. Her vision problems mainly consist of difficulties to see in the dark. The optician noted that no improvement could be obtained with glasses. The ophthalmological investigation shows that she suffers from retinitis pigmentosa and that only the central field of vision remains. Explain this finding, starting from the retina's composition of both rods and cones. (2p)

(1) Rods are rich in rhodopsin. When light hits the eye, rhodopsin activates the G-protein Transducin. Transducin dissociates and activates Phosphodiesterase that breakes down cGMP → GMP. That inactivates Na^+-channels. No depolarization occurs, no activity. It is Na^+ that changes the membrane potential.

(2)



Light hits the eye, a signal travels through n. opticus to pretectum where it synapses and then there is a bilateral connection to edinger-westphal nucleus where a second synapse occurs, then the signal travels via n. oculomotorius (CN III) that is parasympatethic innervated, and it synapses in ciliary ganglion. N. oculomotorius innervates the m. constrictor papillae, it constricts the pupil muscles sphincter papillae

Use the other side of the page if you need more space

Mapp nr. 9	*Σ points* 8

Theme 5: Motor functions I: Spinal cord (8 p)

How is locomotion generated? Describe the organization of the locomotor system by answering the following questions:

a) Give a definition of the locomotor pattern generator (CPG) and describe its role and location in the CNS (4p)

The CPG for loccmotor is situated in the spinal cord. It enables us to make sequences of movement rather than just activate a simple muscle. The CPG is a network of neurons that activate and inhibit the right neurons at the right time, which enables us to alter the walk, t.ex. via the stance and swing phase during walking. It also keeps posture and control of the trunk while doing so. CPG:s can be inert or learnt, we have to practise to learn how to walk but it has been shown that even though the connections between the brain and CPG for loccmotion has not yet been fully developed, a really young child can walk when being supported while doing so.

4

b) How is the locomotor CPG activated? (2p)

Locomotor CPG are controlled by MLR, mesencephalic locomotor region. A signal is sent from cortex to basal ganglia (where striatum disinhibits MLR), the correct motor program is selected and a signal is sent to MLR that controls CPG for loccmotion. MLR forms reticulospinal tract that sends a signal to CPG for locomotor in the spinal cord, via the ventral horn the signal is transferred to the neves innervating the right muscles. cortex → basal ganglia → MLR → reticulospinal tract → CPG for loccmotion → ventral horn

At rest substantia nigra pars reticulata and globus pallidus interna inhibits MLR (D_1, direct pathway) but when wanted, striatum get excitatory signals from cortex, striatum inhibits (via GABA) substantia nigra pars reticulata and globus pallidus interna - no inhibition of MLR!

2

c) Describe the role of sensory input for the control of locomotion. (2p)

When you start to move, afferent info is sent to spinal cord and cerebellum. This can correct the movement if the result is not the expected. cerebellum gets efference copy and proprioception and can send out signal that controls the movement via spinal cord. The spinal cord can activate interneurons, that regulate the movements. Therefore you can alter and correct the movements during the movement.

2 spinocerebellum

Mapp nr. 9	*Σ points* 6,5

Theme 6: Motor functions II: Cortical control of motor functions (8p)

The control of our movements includes a number of different steps, from the first thought and decision of a certain movement, to the actual execution of the movement. In this question you should give an account for the neurobiological basis of your ability to perform hand movements.

a) The primary motor cortex plays an important role in the control of our movements. Which is this role? (2p)

The primary motor cortex activates the right upper motor neurons. Upper motor neurons can activate many lower motor neurons. In primary motor cortex, layer/lamina V, pyramidal cells gets activated, giving rise to tractus corticospinalis that affects the muscle and the movements.

1,5

c) The primary motor cortex cooperates with other cortical areas which also have important roles in motor control. What are these areas called and where are they located? (2p)

Premotorcortex, just in front of (ventrally) primary motor cortex.

Supplementary cortex

1,5

d) Describe the role of these cortical areas in voluntary motor control. (4p)

Premotorcortex plans the movement, sensory info is sent to Premotorcortex and it gets info about the state of the body compared to the outer environment. Important for example when you are about to stepp over a log.

3,5

Supplementary cortex is involved with planning of learned movements. It get's info about the brain itself.

Mapp nr. 9	*Σ points* 6

Theme 7: Emotion (7 p)

Emotions are important to motivate the decisions and behaviours that people chose to engage in, in different situations. For example, emotions are essential at protecting us from a wide range of threats, such as physical threats (e.g. snakes), psychological stress (e.g. shame), social threats (e.g. social exclusion) etc. Rightfully, the involved neural circuits are often called "survival circuits". In addition, our ability to detect and analyse other people's emotions are essential for our ability to understand other people's intentions and for successful social interactions. Disturbances in the ability to regulate emotions can be related to phobias, post traumatic stress disorder (PTSD), panic attacks and schizophrenia.

A) Name the three components necessary for an emotion (3p)

Behaviour: tex facial expression

Physiology: bodily reaction, tex swetting.

Cognition: subjective reactions/thoughts.

3

B) Name the main neural structure that is central for producing emotions, it is also involved in detecting and learning about emotional relevant aspects in the surrounding. (1p)

Amygdala

1

C) Name the neural structure responsible for down-regulating emotions (1p)

caudal cingulate cortex

0

D) Name and describe an additional neural structure central for emotions (you are free to chose any relevant structure as long as you can accurately motivate why). (2p)

anterior cingulate cortex, it is important for how you value things, and therefore connected to emotions, how you feel about a person/ things for example.

2

Mapp nr.	9	Σ points	4

Theme 8:I: Sleep, 4p

a) Sleep is an essential phenomon of the brain. Describe the role of thalamus for the regulation of sleep and wakefulness. (2p)

2

When Thalamus gets signal from the arousal system, thalamic neurons works as relay neurons, they are depolarized. When signals from arousal system gets inhibited (via VLPO, ventral lateral preoptic nucleus) the thalamic relay neurons is transformed into oscillating neurons, they are then hyperpolarized. The oscillating thalamic neurons are synchronizing the brain, making it falling to sleep.

The inactivation of arousal system and activation of VLPO is gradually formed, therefore it takes a little while before the brain falls into sleep. And when the thalamic neurons gets signals from arousal system, the thalamic neurons gets depolarized again, now working as relay neurons again.

b) What are the acute consequences of sleep deprivation for how the brain will work the next day. Decribe 4 aspects (2p)

The next day your attention span gets shorter.

You will be distracted more easily.

The consolidation of short-term memories into long-term memories will be less efficient.

Your hunger will increase.

2

Mapp nr. 9	*Σ points* 3

Tema 8:II PU

Svara med utgångspunkt från PU-dagarna.

1) Definera följande begrepp, och förklara varför dom är viktiga ur ett kliniskt perspektiv. (3p)

- Klassisk betingning innebär att ett visst beteende är betingat, detta sker m.h.a. olika stimuli. Ett typiskt exempel är Pavlovs hundar. Hundarna dreglade innan de fick mat. Ett stimuli - en klocka användes och lät innan hundarna fick mat, de dreglade då. (pga maten, inte klockan) Efter en tid dreglade hundarna bara de hörde ljudet av klockan. Detta kan användas kliniskt, tex kan patienten börja ta sin medicin i samband med en särskild rutin som känns mysig. Tex. ta sin insulin dos i samband med morgonkaffet. På så vis betingas insulinmedicinering med något mysigt, positivt. Detta förstärker beteendet. Utsläckning kan användas för att bli av med en vana, detta innebär att själva "belöningen" tas bort, tex om patienten slutar gå ner i vikt eller t.o.m. går upp i vikt trots träning, då kommer träning som från början var positivt betingat (=viktnedgång) inte längre ge viktnedgång (belöningen) och detta resulterar i att patienten slutar träna → andra sidan

- Operant inlärning

Operant inlärning innebär att man förstärker eller bestraffar olika beteenden. Positiv förstärkning innebär att man lägger till något som för patienten upplevs som positivt, tex kan den inlagda patienten få sin familj på besök på avdelningen. Negativ förstärkning innebär att ett negativt associerat stimuli tas bort, tex om man opererar bort en smärtsam gallsten.

Positiv bestraffning innebär att något som är negativt associerat för patienten läggs till, tex att sätta in en smärtsam strålbehandling.

Negativ bestraffning är istället att ta bort något som för patienten är positivt associerat, tex att be patientens familj att lämna sjukhuset.

Operant inlärning är betydelsefullt kliniskt pga att det påverkar patientens tillit och tilltro till sjukvården och sjukvårdspersonal. Detta påverkar compliance. Detta kan även påverka nocebo och placebo vilket kan påverka bl.a. behandlingen i sig. Man kan använda operativ inlärning för att påverka hur patienten sköter sin sjukdom och hälsa. Också hur patienten tänker kring sin kropp. vilket har en stor påverkan på hur resultatet av patientens vård blir.

Mapp nr.	*Σ points*

Theme 1: Electrical properties of neurons (8p)

a) Describe the ionic mechanisms underlying the action potential including the early and late afterhyperpolarizations (5p)

b) Describe the mechanisms underlying unidirectional propagation of the action potential along an axon (3p)

Mapp nr.	*Σ points*

Theme 2. Synaptic transmission (8p)

Describe the molecular mechanisms underlying fusion of a synaptic vesicle with the plasma membrane. The important proteins and their roles should be included in the description.

Mapp nr.	*Σ points*

Theme 3. Vision (8p)

a) Describe the anatomy of the eye with a simple drawing in which the main structures are marked (4p)

b) Describe the histology of the retina with a simple drawing including its different cell types. Indicate the direction of light (4p)

Mapp nr.	*Σ points*

Theme 4. Pain (7p)

a) Describe the detailed pathway of a pain signal from your finger until it reaches the cortex (4p)

b) Describe the neuronal mechanisms underlying the pain withdrawal reflex (=flexor reflex) (3p)

Mapp nr.	*Σ points*

Theme 5. Motor control I (8p)

Describe the control system for locomotion (8p)

Mapp nr.	*Σ points*

Theme 6 Motor control II (6p)

Describe the functions of the following cortical regions in motor control.

a) The primary motor cortex

b) The medial premotor cortex (=supplementary motor cortex)

c) The lateral premotor cortex

Mapp nr.	*Σ points*

Theme 7. Sleep and circadian rhythms (7p)

Hypothalamus is critical for many regulatory functions, including the circadian rhythm.

a) Which nucleus in hypothalamus is critical for generation of the circadian rhythm (1p)

b) What are the main functions of circadian rhythms in humans? (3p)

c) Describe briefly the different stages that you go through during a night of sleep (3p)

Mapp nr.	*Σ points*

Theme 8. Functions of brain lobes (8p)

Different functions can be attributed to the different lobes of the brain. Describe briefly main functions linked with:

a) The temporal lobe

b) The occipital lobe

c) The frontal lobe

d) The parietal lobe

Re-exam: 2LK009 DFM3 Part 2 The Nervous System/1BI042 Biomedicin Neuroscience

Mapp nr. 4	*Σ points* 7

Theme 1: Electrical properties of neurons (8p)

a) Describe the ionic mechanisms underlying the action potential including the early and late afterhyperpolarizations (5p)

4

During the early part, Na^+-channels are closed, and the slower K^+ channels are starting to close. There is still K^+ passing through, out. Because they are slow to close, the membrane potential goes even lower than the resting membrane potential. However, as the channels close completely, the driving force through ion channels drive the potential towards the equilibrium for K^+ again. (about -65mV).

late

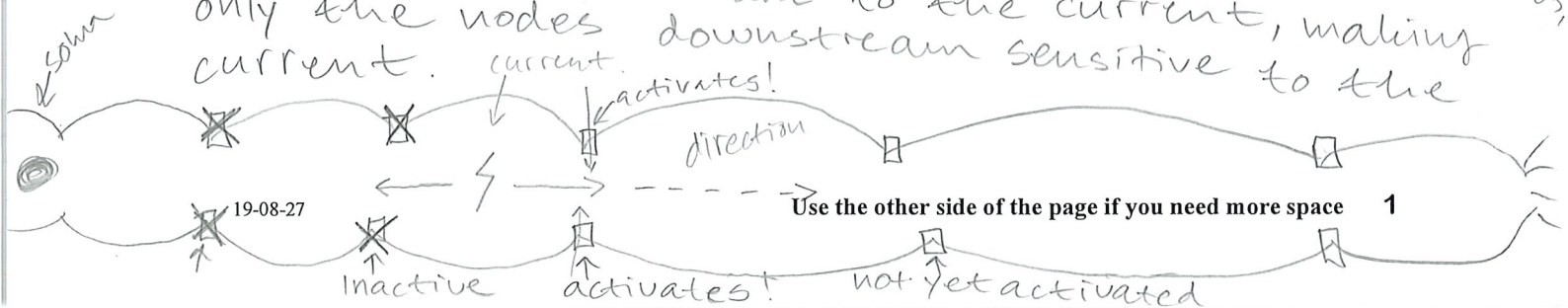
During the early part of afterhyperpolarization, the Na^+-channels are inactivated, making it impossible to start a new AP. During the late part of afterhyperpolarization, it is difficult, BUT not impossible to start a new AP, it just requires a bigger stimuli.

b) Describe the mechanisms underlying unidirectional propagation of the action potential along an axon (3p)

3

The propagation along the axon is partly a passive flow of current. It flows down to each Nodes of Ranvier, which is the only place with Na^+-channels and other ion-channels. The other parts of the axon is insulated by myelin. When the current reaches the Node of Ranvier, the Na^+-channels are activated, causing an inflow of Na^+, and propagation of current.

The current flows on to the next node. It only flows in ONE direction since the Nodes that it recently passed has just been active, leading to the closing and inactivation of the Na^+-channels, making them "immune" to the current, making only the nodes downstream sensitive to the current.



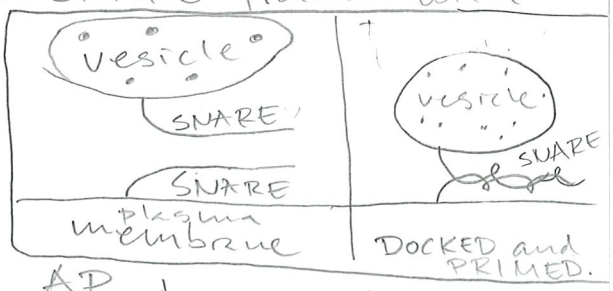
Re-exam: 2LK009 DFM3 Part 2 The Nervous System/1BI042 Biomedicin Neuroscience

Mapp nr. 4	*Σ points* 6,5

Theme 2. Synaptic transmission (8p)

Describe the molecular mechanisms underlying fusion of a synaptic vesicle with the plasma membrane. The important proteins and their roles should be included in the description.

The synaptic vesicle and the plasma membrane each have SNARE proteins on their surface. 6,5
When the presynaptic membrane isn't depolarized, the synaptic vesicles reach the plasma membrane and "docks" onto a specific SNARE protein with the help of complexin, which helps with docking and priming.

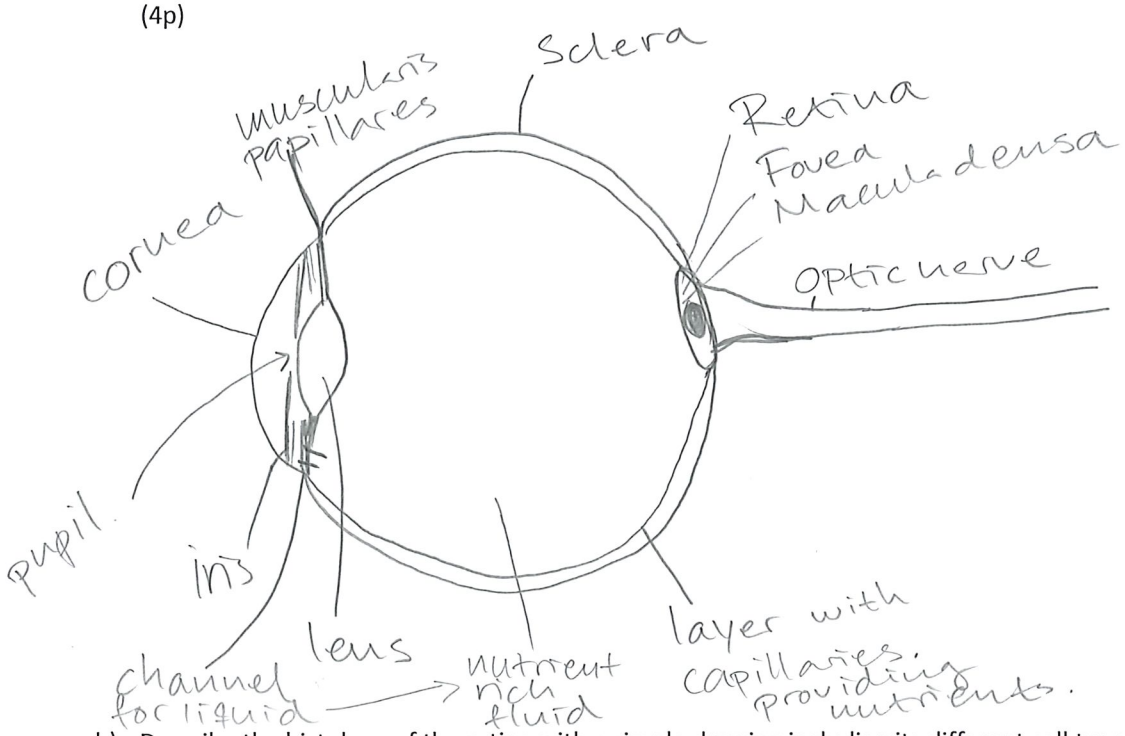


The vesicle is now ready in position in case of an AP depolarizing the presynapse. The SNARE-complex has connected themselves to each other. Twirling together. The membranes aren't fused together yet, thanks to a protein called synaptobrevin. (also on SNARE-complex.)
When the presynapse is reached by an AP, the membrane depolarizes, and Ca^{++}-channels open, making Ca^{++} flow in. Ca^{++} "connects to", or is detected by a protein on the SNARE-complex called synaptotagmin. Synaptotagmin makes synaptobrevin move, and thereby gives signal for vesicle-membrane fusion. The membranes fuse, making a part of the plasma membrane. Exocytosis. the synaptic vesicle-wall Neurotransmitter from the vesicle leaks out into the synaptic cleft.

Mapp nr. 4	*Σ points* 6

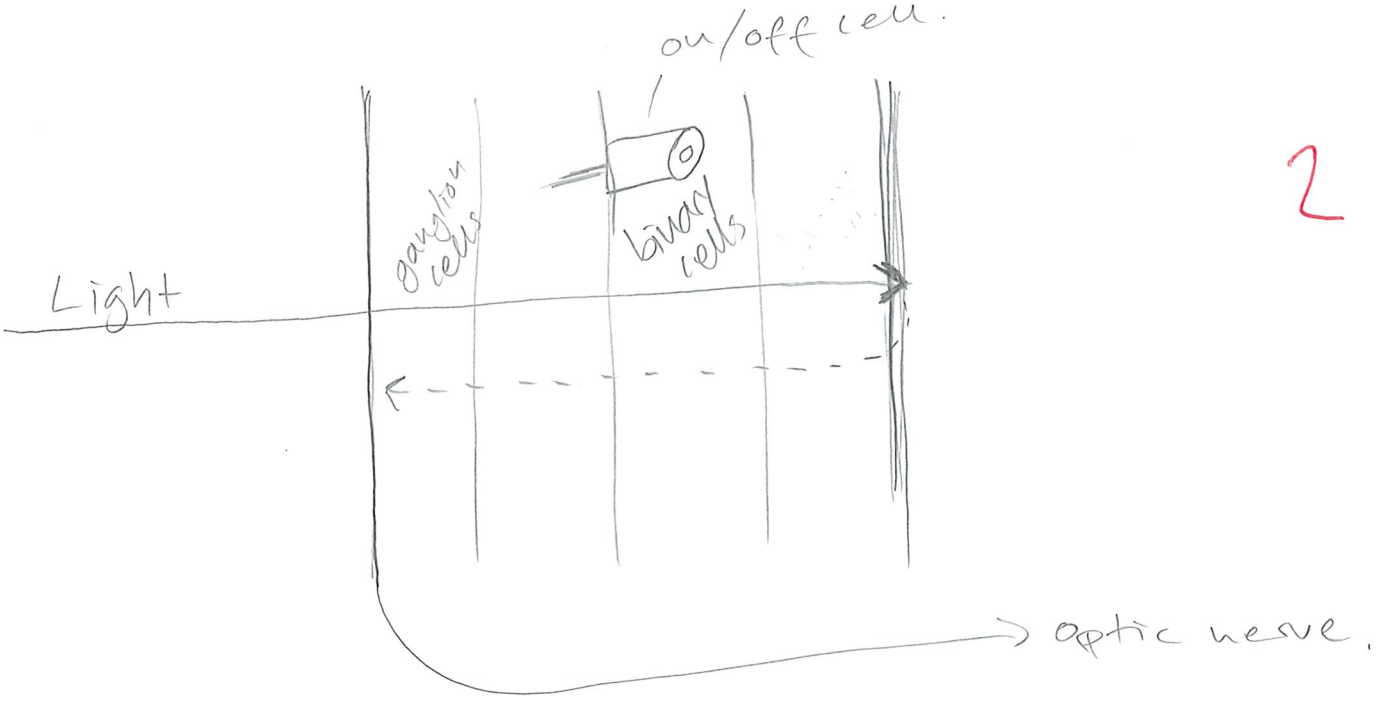
Theme 3. Vision (8p)

a) Describe the anatomy of the eye with a simple drawing in which the main structures are marked (4p)



4

b) Describe the histology of the retina with a simple drawing including its different cell types. Indicate the direction of light (4p)



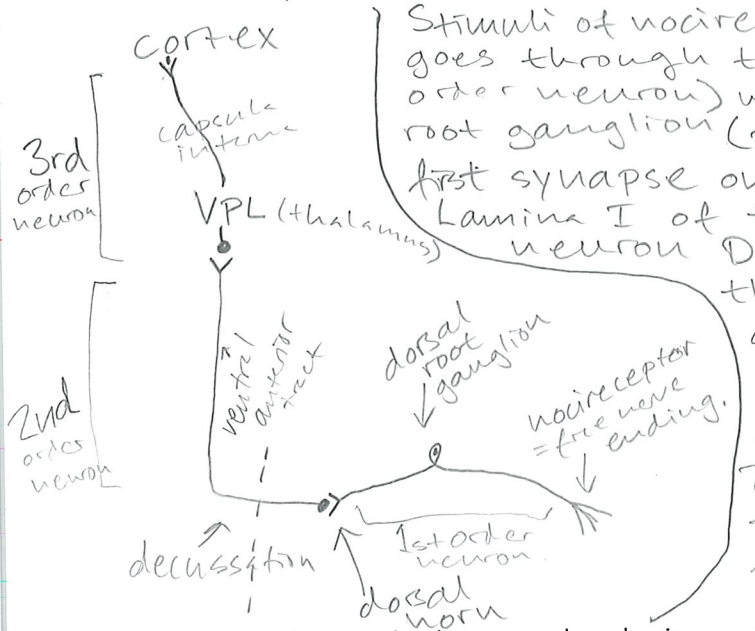
2

Re-exam: 2LK009 DFM3 Part 2 The Nervous System/1BI042 Biomedicin Neuroscience

Mapp nr. 4	*Σ points* 7

Theme 4. Pain (7p)

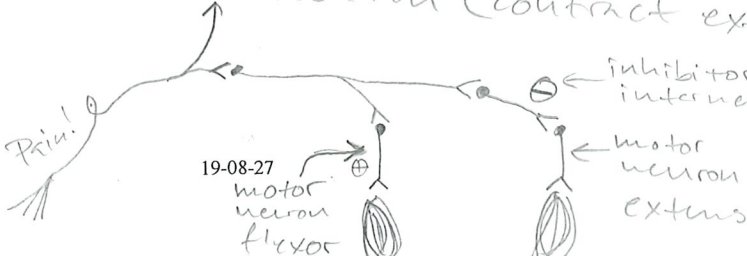
a) Describe the detailed pathway of a pain signal from your finger until it reaches the cortex (4p)



Stimuli of nocireceptor (free nerve ending). Signal goes through this neuron (which is the 1st-order neuron) with its cell body in the dorsal root ganglion (probably Aδ-fiber) and makes its first synapse on the 2nd order neuron in Lamina I of the dorsal horn. This 2nd order neuron DECUSSATES the midline and then ascends in the ventral anterior tract of the spinal cord. It terminates on the 3rd order neuron in the VPL-nucleus in the thalamus. This 3rd order neuron then ascends through the capsula interna to the somatosensory cortex. 4

b) Describe the neuronal mechanisms underlying the pain withdrawal reflex (=flexor reflex) (3p)

When a painful stimuli occurs, and stimulates a nociceptor, sending an ascending signal to the dorsal horn, it also sends a collateral to a circuit which governs the flexor reflex. It's designed almost like a CPG, made to withdraw the limb in question from which the painful stimuli arise. The collateral interneuron splits into two branches. One leading to motoneurons stimulating the flexor muscle to contract. The other branch leads to an inhibitory interneuron, probably with GABA as NT, which then terminates on a motor neuron causing it to relax. (thats why we have an inhibitory IN) stimulating the extensor muscle, This leads to a synergistic motion of withdrawal. Sometimes collaterals are also sent to the corresponding limb on the other side of the body (decussates), but with inverted action (contract extensor, relax flexor.). 3



Mapp nr. 4	*Σ points* 8

Theme 5. Motor control I (8p)

Describe the control system for locomotion (8p)

The mesencephalic locomotion region send decending input to local circuits giving rise to CPG, thereby controlling initiation of locomotion. 8

via the reticular formation → It also can modulate pace etc by regulating the input frequency. The reticular formation also has a part in regulation via the cerebellum.

Sensory input can also regulate the locomotion, often via the cerebellum and the reticular formation.

Sensory input is often the main regulatory (pace, ascending up a hill, walking over rocks etc.) mediator, but it is sometimes sufficient to initiate locomotion.

Mapp nr. 4	*Σ points* 3,5

Theme 6 Motor control II (6p)

Describe the functions of the following cortical regions in motor control.

a) The primary motor cortex

Intention of movement.
Planning, "imagening".
"What is it that i want to do?"

1

b) The medial premotor cortex (=supplementary motor cortex)

Integration of movement according to sensory input.
Fine tuning of movements.
Emotional aspect.

0,5

c) The lateral premotor cortex

Also integration of movements according to additional sensory input.
Fine tuning.
Balance integration.

2

Mapp nr. 4	*Σ points* 7

Theme 7. Sleep and circadian rhythms (7p)

Hypothalamus is critical for many regulatory functions, including the circadian rhythm.

a) Which nucleus in hypothalamus is critical for generation of the circadian rhythm (1p)

Nucleus suprachiasmaticus sends signals to a nucleus in the thalamus (VPO ?) which then sends input to the corpus pineale to produce melatonin. 1

b) What are the main functions of circadian rhythms in humans? (3p)

To determine when to sleep and when to be awake and establish the 24-hour "phase".
Its an internal clock making us tuned to the 24h-cycle.
Regulating different brain and endocrine regions to behave according to what hour in the cycle it is. 3
We have different "awake"-centers.

c) Describe briefly the different stages that you go through during a night of sleep (3p)

NON-REM sleep:

Phase 1 - β-waves. Closed eyes but still awake. 3

Phase 2 - theta waves. Lowering frequency and higher amplitude of EEG-waves.

Phase 3 - Lowering frequency further. Even higher amplitude. Here we can se "spikes" of theta waves.

Phase 4 - Deep sleep. Lowest frequency, Highest amplitude. Most "productive" sleep stage. Most REST.

REM - Brain waves are almost β-almost like awake. Paralyzed body, Dreaming. Eye movements.

Mapp nr. 4	*Σ points* 6,5

Theme 8. Functions of brain lobes (8p)

Different functions can be attributed to the different lobes of the brain. Describe briefly main functions linked with:

a) The temporal lobe

Audition, hearing. Speech (Broca's area). 1

b) The occipital lobe

Vision.
Visual pathway. 2

c) The frontal lobe

Desicion-making. Speech 2
Motivation.

d) The parietal lobe

Motor control
Somato sensory-systems. 1,5
Intgration of sensory systems and motor systems.

Personnr	*Namn*	*Mapp nr*

Written Re-examination DFM3 Part 2:
The Nervous System – From Ion Channels to Behaviour
2019-12-13

Write already in the beginning of the exam time your ***Folder number*** *on all pages, and your* ***name and personal number*** *on the cover page.*

The exam consists of 8 themes distributed over 9 pages.

Note 1: Check that all pages are present. When you leave the folder make sure that the pages are in order according to the question numbers.

Note 2: You may not in your answer refer to an answer to a different theme as they will be corrected by different teachers.

Note 3: All answers should be written in English (apart from Theme 8:II).

A photo ID should be presented when you hand in the exam.

With reference to the code of conduct we ask you to certify thatthere has been no cheating involved in providing the answers to this exam:

_____

Signature

Grades:

Maximum:	60 points
Passed:	40 points

The results will be displayed in Canvas in week 2 and you can then pick up your exam at the course secretariat.

GOOD LUCK!

Mapp nr.	*Σ poäng*

Theme 1: Electrical properties of neuronal cells (8p)

a) Describe the ionic mechanisms underlying the action potential including the early and late afterhyperpolarizations (5p)

b) Describe the mechanisms underlying unidirectional propagation of the action potential along an axon (3p)

Mapp nr.	*Σ poäng*

Theme 2: Synaptic transmission (8p)

Describe the molecular mechanisms underlying fusion of a synaptic vesicle with the plasma membrane. The important proteins and their roles should be included in the description.

Mapp nr.	*Σ poäng*

Theme 3: Sensory systems: Pain (8 p)

1) How is chronic pain defined? (1p)

2) There are different types of nociceptors. What characterizes:

a) a polymodal nociceptor?

b) a silent nociceptor? (2p)

3) Pain is defined as: "An unpleasant sensory and emotional experience associated with actual or potential tissue damage; or described in terms of such damage". Name three ways to assess pain intensity in an adult human patient suffering from a chronic pain condition. (3p)

4) A pain patient describes extreme tenderness. She feels pain when hugged by her grand-children and even perceives the pressure form her handbag as painful. What is the medical term for this kind of sensation? (1p)

5) What is Lissauer's tract (also called posterolateral tract)? (1p)

Mapp nr.	*Σ poäng*

Theme 4: Sensory systems: Hearing (8 p)

1. The major function of the middle ear is to match low-impedance (low resistance) airborne sounds to the higher-impedance fluid of the inner ear. Most of the energy is reflected when going from low-impedance to high-impedance. However, the middle ear compensates for this loss of energy by two different mechanisms. Name these two processes that result in little loss of energy from the middle ear to the inner ear. (4p)

2. Humans use at least two different strategies to localize sound in the horizontal plane. Describe these two different strategies and name the region of the brain where these two different strategies take place. (4p)

Mapp nr.	*Σ poäng*

Theme 5: Motor systems (8p)

Describe the control system for locomotion. You may use a simple drawing. (8p)

Mapp nr.	*Σ poäng*

Theme 6: Motor functions: Cerebral cortex (6p)

Describe the functions of the following cortical regions in motor control.

a) The primary motor cortex

b) The medial premotor cortex (=supplementary motor cortex)

c) The dorsal premotor cortex

Mapp nr.	*Σ poäng*

Theme 7: Sleep (7p)

a) Sleep is an essential phenomon of the brain. With respect to the more general regulation of sleep and wakefulness, describe the role of thalamus for sleep and wakefulness. (3p)

b) What are the acute consequences of sleep deprivation for how the brain will work the next day. (4p)

Mapp nr.	*Σ poäng*

Theme 8:I: Higher functions – the reward system (4p)

The reward system is very important for guiding us in what we want and to reward us when we carry out different behaviours. One of the main functions of the reward system is to give different objects, people and behaviours a positive value so that we like them.

a) The Mesolimbic dopamine system is believed to play an important part in the reward system. Which brain regions are part of the mesolimbic dopamine system? Give evidence for this hypothesis. (3p)

b) Which role does the mesolimbic dopamine system play in addiction? (1p)

Mapp nr.	*Σ poäng*

Tema 8:II: PU-relaterad fråga (3p)

PU-relaterad fråga. Du arbetar som läkare. Med utgångspunkt från vad du lärt dig under kursen och PU-dagen, beskriv hur du lägger upp patientsamtalet så att det stödjer dina patienters förmåga att komma ihåg vad som sägs under samtalet och så att de följer din ordination om medicinering. (3p)

Mapp nr.	*Σ poäng*
02	7

Theme 1: Electrical properties of neuronal cells (8p)

a) Describe the ionic mechanisms underlying the action potential including the early and late afterhyperpolarizations (5p)

In the cell membrane, there is ion channel that if exposed to stimuli will get active; This stimules needs to "hit" a certain threshold.

SO; given that an EPSP is "big" enough, voltage-gated Na^+ will open and Na^+ will enter the cell, further depolarizing the cell. They are open for a short time and will to start to close. Meanwhile, k^+-chanel will open and start releasing k^+ out of the cell, repolarizing it.

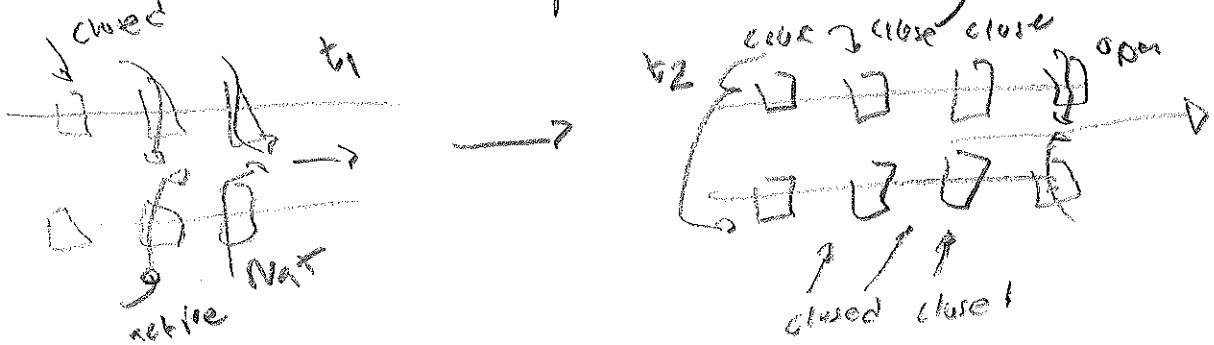
Because k^+-chanels are open longer period, cell will get polarized beyond its resting membrane potential. During this period, it is refractory, no action potential can be elicated.

b) Describe the mechanisms underlying unidirectional propagation of the action potential along an axon (3p)

Because the Na^+-channels is open for a briet time period and gets inactivated so that no stimli can start opening them, the action potential will move just "down"-streamn.

3

Activating new Na^+-channels and not being able to reactivate previously active ones "forces" the action potential along a one way.



Final Written Re-Exam DFM3 Part 2 – The Nervous System

1. What is true about the resting membrane potential?

	A	It does not depend on the intracellular K+ concentration
	B	It does not depend on the extracellular K+ concentration
X	C	It can be calculated by using the Goldmann equation
	D	A and C are correct
	E	A, B and C are correct
	F	A and B are correct

2. What is true about the action potential?

	A	Its shape does not depend on the time constant
	B	It propagates actively along an axon
	C	The early afterhyperpolarization does not regulate the frequency of action potentials
	D	The late afterhyperpolarization does not regulate the frequency of action potentials
X	E	A and B are correct.
	F	C and D are correct.

3. What is true about the neuron´s electrical properties?

	A	Synaptic summation depends on voltage-gated channels
	B	Synaptic summation depends on ligand-gated channels
	C	Synaptic summation depends on the time constant
	D	Synaptic summation depends on the space constant
	E	A and B are correct.
X	F	C and D are correct.

4. What is true about the neuron´s electrical properties?

X	A	Synaptic summation depends on the length of dendrites
	B	Synaptic summation is independent of the membrane area of the cell body
	C	Inhibitory synapses does not occur on the soma and proximal dendrites
	D	Excitatory synapses does not occur on distal dendrites
	E	A and B are correct.
	F	C and D are correct.

5. What is true about action potential propagation?

	A	Its conduction velocity does not depend on the diameter of the axon
X	B	Its conduction velocity depends on myelin
	C	Its conduction velocity depends on the axon diameter only in unmyelinated axons
	D	Its conduction velocity depends on the axon diameter only in myelinated axons
	E	A and B are correct.
	F	B and C are correct.

6. What is true about the action potential refractory period?

	A	The absolute refractory period depends on inactivation of Na+ channels
	B	The relative refractory period depends on inactivation of K+ channels
	C	Action potentials can not be triggered during the relative refractory period
	D	Action potentials can not be triggered during the absolute refractory period
X	E	A and D are correct.
	F	B and C are correct.

7. What is true about excitability?

	A	Astrocytes are excitable
	B	Oligodendrocytes are not excitable
	C	Excitability depends on leak channels
	D	Excitability depends on voltage-gated ion channels
	E	A and C are correct.
X	F	B and D are correct.

8. What is true about ion channels?

X	A	Ligand-gated channels do not determine the resting membrane potential
	B	Voltage-gated channels do not occur in axons
	C	Ligand-gated channels do not occur in cell bodies
	D	Leak channels do not determine the resting membrane potential
	E	A and B are correct.
	F	C and D are correct.

9. What is true about glutamate?

	A	It is an excitatory neurotransmitter
	B	It is an inhibitory neurotransmitter
	C	It occurs in (small) synaptic vesicles
	D	It occurs in large dense cored vesicles
X	E	A and C are correct
	F	B and D are correct

10. What is true about these neurotransmitters?

	A	Dopamine can activate metabotropic receptors
	B	Serotonin can activate metabotropic receptors
	C	GABA does not activate metabotropic receptors
	D	GABA does not activate ionotropic receptors
X	E	A and B are correct
	F	C and D are correct

11. What is true about neuropeptides?

	A	Dopamine is a neuropeptide
	B	Serotonin is a neuropeptide
X	C	Enkephalin is a neuropeptide
	D	Cholecystokinin can not be stored in large dense cored vesicles
	E	A and B are correct
	F	C and D are correct

12. What is true about neurotransmitter inactivation?

	A	Acetylcholine is inactivated by enzymatic degradation
	B	Glutamate is inactivated by enzymatic degradation
	C	Acetylcholine is inactivated by uptake
	D	Glutamate is inactivated by uptake
X	E	A and D are correct
	F	B and C are correct

13. What is true about neurotransmitter synthesis?

	A	Glutamate is a precursor of GABA
	B	Glutamine is a precursor of glutamate
	C	Acetylcholine is a precursor of choline
	D	Dopamine is a precursor of L-DOPA
X	E	A and B are correct
	F	C and D are correct

14. What is true about electrical synapses?

	A	They do not contain connexin
	B	They do not contain connexons
	C	The perform unidirectional propagation of signals
X	D	An excitatory impulse is attenuated as it passes through an electrical synapse
	E	A and C are correct
	F	B and D are correct

15. What is true about chemical synapses?

	A	They contain synaptobrevin
	B	They contain synaptotagmin
	C	They contain syntaxin
	D	They contain SNAP25
X	E	All of the above are correct
	F	A and B are correct

16. What is true about synaptic vesicles?

X	A	Regular (small) synaptic vesicles are recycled in nerve terminals
	B	Large dense cored vesicles are recycled in nerve terminals
	C	Fusion of large dense cored vesicles does not depend on SNARE proteins
	D	Fusion of (small) synaptic vesicles does not depend on SNARE proteins
	E	A and C are correct
	F	B and D are correct

17. General sensory physiology: Which feature(s) of a sensory stimulus is/are centrally represented?

	A	Location
	B	Duration
	C	Modality
	D	Intensity
X	E	All the above
	F	A + C + D

18. Somatosensory system: Rapidly adapting receptors in the skin are involved in:

	A	Discriminative touch with very fine spatial resolution (shape and texture).
	B	Discriminative touch: skin deformation, motion, grip control.
	C	Detection of stretches of the skin.
	D	Detection of high-frequency vibratory and deep pressure stimuli.
	E	All the above
X	F	B + D

19. Somatosensory system: Which of the following statement(s) about proprioception is/are correct?

	A	Golgi tendon organs inform about changes in muscle tension.
	B	Muscle spindles inform about changes in muscle length.
	C	Primary (Ia) nerve endings produce a sustained response.
	D	Secondary (II) nerve endings produce a rapidly adapting response.
X	E	A + B are correct
	F	All the above are correct.

20. Pain: What do nociceptor neurons and non-nociceptor somatosensory neurons have in common?

	A	Unspecialized nerve endings.
X	B	Cell body most often located in the dorsal root ganglia.
	C	Synaptic contact with projection neurons in lamina I.
	D	Same conduction velocity.
	E	Highly-myelinated axons.
	F	All the above.

21. Pain: How would a lesion restricted to the right side of the spinal cord at the lower thoracic level alter perception of pain and touch in the acute phase?

X	A	Reduced sensation of pain on the lower left side and mechanosensory deficit on the lower right side of the body, while upper body has normal sensation.
	B	Reduced sensation of pain on the lower right side and mechanosensory deficit on the lower left side of the body, while upper body has normal sensation.
	C	Reduced sensation of pain on the left side of the whole body and mechanosensory deficit on right side of the whole body.
	D	Reduced sensation of pain on the lower right side, while the lower left side and the upper body have normal sensation.
	E	Reduced sensation of pain on the lower left side, mechanosensory deficit on the lower left side, while the right side and the upper body have normal sensation.
	F	Reduced sensation of pain and mechanosensory deficit on the both sides of the lower part of the body, while upper body has normal sensation.

22. Pain: Which statement regarding the descending control of pain is *false*?

	A	Pathways from rostroventral medulla, locus coeruleus and nucleus raphe magnus are involved in descending inhibition.
	B	The opioidergic, serotonergic, and noradrenergic systems all contribute to descending control of pain.
	C	Descending pathways can exert both excitatory and inhibitory influences on the activity of dorsal horn neurons.
	D	Descending control is mediated by synaptic contacts onto dorsal horn projection neurons, nociceptive afferents, excitatory and inhibitory interneurons, and the synaptic terminals of other descending pathways.
X	E	Phantom limb pain develops due to cerebral reorganization and reduced activity in descending inhibitory pathways.
	F	None of the above are false.

23. Vision: During accommodation, the shape of the _____ is changed by the _____ in order to see objects accurately at varying distances.

	A	lens; zonule fibers
X	B	lens; ciliary muscle
	C	pupil; ciliary muscle
	D	pupil; zonule fibers
	E	iris; zonule fibers
	F	None of the above

24. Vision: Which of the following correctly matches rods and cones with their properties?

	A	Rods: high spatial resolution; cones: color vision
X	B	Rods: high sensitivity to light; cones: high spatial resolution
	C	Rods: color vision; cones: low spatial resolution
	D	Rods: high sensitivity to light; cones: low spatial resolution
	E	Rods: low sensitivity to light; cones: color vision
	F	None of the above

25. Higher visual functions: A man is brought to the emergency room after a car crash. A doctor shines a light in his right eye and only the right pupil constricts. Which of the following regions is most likely damaged?

	A	Primary visual cortex
X	B	Edinger-Westphal nucleus
	C	Lateral geniculate nucleus
	D	Internal capsule
	E	Striate cortex
	F	All of the above

26. Audition: How does ionic composition of endolymph differ from most extracellular fluids?

	A	It is K^+-poor and Na^+-rich.
	B	It is Ca^{2+}-poor and Na^+-rich.
	C	It is K^+-rich and Na^+-rich.
	D	It is Ca^{2+}-poor and Na^+-poor.
X	E	It is K+-rich and Na+-poor.

	F	It is Ca^{2+}-poor and K^{+} poor.

27. Audition: The lateral superior olive uses which of the following properties of interaural sound for localization?

	A	Time
	B	Frequency
	C	Waveform
	D	Period
X	E	Intensity
	F	None of the above

28. Audition: Which structure(s) connect(s) adjacent stereocilia?

X	A	Tip links
	B	Kinocilium
	C	Inner hair cells
	D	Outer hair cells
	E	Microtubules
	F	Nerve fibers

29. Vestibular system: After stereocilia move toward the kinocilium,

	A	mechanically-gated channels close.
	B	the hair cell hyperpolarizes
	C	there is an efflux of calcium
	D	there is a decreased release of transmitter from the hair cell.
X	E	there is increased signaling in the vestibular nerve.
	F	The cell does not respond

30. Vestibular system: Which reflex allows a person to visually focus on an object as the head rotates?

	A	Vestibulocervical reflex
	B	Vestibulospinal reflex
X	C	Vestibulo-ocular reflex
	D	Vestibular-cerebellar reflex
	E	Vestibulomotor reflex
	F	All of the above

31. Taste: _____ papilla, located posteriorly on the tongue, would respond most strongly to a _____ tastant.

	A	Foliate; umami
	B	Fungiform; salt
	C	Circumvallate; sweet
	D	Foliate; sour
X	E	Circumvallate; bitter
	F	None of the above

32. Olfaction: Which structure separates the olfactory epithelium from the olfactory bulbs?

	A	Olfactory tract
	B	Odorants
	C	Pyriform cortex

X	D	Cribiform plate
	E	Sphenoid bone
	F	Mitral cells

33. What is true about afferents to the spinal cord?

	A	Ib afferents originate from muscle spindles
	B	Ia afferents originate from Golgi tendon organs
X	C	Ib afferents respond primarily to active muscle contraction
	D	Ia afferents respond primarily to active muscle contraction
	E	A and C are correct
	F	A and D are correct

34. What is true about descending pathways in the spinal cord?

X	A	The reticulospinal tract is important for control of locomotion
	B	The reticulospinal tract is important for finger movements
	C	The medial corticospinal tract is important for finger movements
	D	The vestibulospinal tract is important for finger movements
	E	A and C are correct
	F	B and D are correct

35. What is true about the flexion reflex?

	A	It is elicited by activation of Ia afferents
	B	It is elicited by activation of Ib afferents
X	C	It is an innate (inherited) reflex
	D	It is a learned reflex
	E	A and C are correct
	F	B and D are correct

36. What is true about the central pattern generator for locomotion?

	A	It is is innate (inherited)
	B	It is learned
	C	Its activity is fine-tuned by cerebellum
	D	It encodes the precise locomotor pattern and does not need to be tuned
X	E	A and C are correct
	F	B and D are correct

37. Which of the following motor acts is/are encoded by innate central motor programs in humans?

	A	Piano playing
	B	Swallowing
	C	Swimming

	D	Walking
	E	A and C are correct
X	F	B and D are correct

38. What is true about the basal ganglia?

X	A	They contain GABAergic medium spiny neurons
	B	They contain dopaminergic medium spiny neurons
	C	The direct pathway limits movements
	D	The indirect pathway initiates movements
	E	A and D are correct
	F	B and C are correct

39. What is true about dopaminergic control of movements?

	A	Dopamine D1 receptors facilitate the indirect pathway
	B	Dopamine D1 receptors facilitate the direct pathway
	C	Dopamine secretion in striatum is increased in Parkinson´s disease
	D	Dopamine secretion in striatum is decreased in Parkinson´s disease
	E	A and C are correct
X	F	B and D are correct

40. What is true about the subthalamic nucleus?

	A	It is part of the indirect pathway
	B	It is part of the direct pathway
	C	It plays a role in inhibiting movements
	D	It plays a role in facilitating movements
X	E	A and C are correct
	F	B and D are correct

41. What is true about the cerebellum?

	A	The cerebrocerebellum receives input from the spinal cord
	B	The vestibulocerebellum is important for speech
	C	The spinocerebellum is important for speech
X	D	The vestibulocerebellum is important for eye movements
	E	A and C are correct
	F	B and D are correct

42. What is true about Purkinje cells?

	A	They are GABAergic
	B	They receive input from parallel fibers
	C	They receive input from climbing fibers
	D	They are glutamatergic
X	E	A, B and C are correct
	F	B, C and D are correct

43. What is true about cerebellar long-term depression?

	A	It takes part in motor learning
	B	It depends on calcium
	C	It depends on NMDA receptors
	D	It depends on metabotropic glutamate receptors

	E	A, B and C are correct
X	F	A, B and D are correct

44. What is true about the primary motor cortex?

	A	It is important for postural control
	B	It encodes direction of voluntary movements
	C	It is located in the parietal lobe
	D	It is located in the frontal lobe
	E	A and C are correct
X	F	B and D are correct

45. Which of these cortical regions is particularly important for visually guided movements?

	A	The primary motor cortex
X	B	The dorsal premotor cortex
	C	The supplementary motor area
	D	The ventral premotor cortex
	E	Both A and B
	F	Both C and D

46. Which of these CNS structure(s) play particularly important role(s) in the control of eye movements?

X	A	The frontal lobe
	B	The parietal lobe
	C	Medulla oblongata
	D	Spinal cord
	E	Both A and C
	F	Both B and D

47. Autonomic Nervous system
In the postganglionic neurons of the sympathetic nervous system, integration of information from multiple levels of the spinal cord is achieved by

	A	Adaptation
	B	Range fractionation
X	C	Convergence
	D	Lateral inhibition
	E	Topographical organization
	F	Divergence

48. Memory
The hippocampus supports the following processes during memory and learning:

	A	Short term storage of explicit memories
	B	Long term storage of explicit memories
	C	Consolidation from short- to long-term memory
	D	Procedural memory
X	E	A & C
	F	B & D

49. Attention
The following areas are part of the cortical network for attentional control

	A	Ventral prefrontal cortex
	B	Temporo-parietal cortex
	C	Insular cortex
	D	Hippocampus
	E	A, B & C
X	F	A & B

50. Stress
The human body responds to stress with

	A	Redistribution of Leukocytes
	B	Activation of the adrenal medulla
	C	Increased release of HPA axis hormones
	D	Activation of the medial corticospinal tract
	E	B, C & D
X	F	A, B & C

51. Circadian Rhythms
The suprachiasmatic nucleus

	A	Is responsible for controlling circadian rhythms
	B	Forms part of the limbic system
	C	Receives input from light-sensitive retinal ganglion cells
	D	Synthesizes hormone melatonin to promote sleep when light is absent
X	E	A & C
	F	A, C & D

52. Sleep
Which of these is not a possible consequence of disturbed sleep

	A	distractibility
	B	disturbed metabolism
	C	Susceptibility to infection
X	D	Procedural memory loss
	E	reduced sex drive
	F	Increased risk for cardiovascular disease

53. Emotion
Which statement is true?
Physiological arousal…

	A	Is high during sadness
	B	Is characterized by low skin conductance
	C	Can be picked up by electrodes placed around the eye region
	D	Is a sign of parasympathetic nervous activity
X	E	Can be triggered by activation of the amygdala
	F	Cannot be regulated by cognitive fear circuits

54. Cognition and Placebo

Placebo analgesia

	A	Occurs during treatment with ineffective drugs
	B	Occurs during treatment with effective drugs
	C	Is caused by the patient's expectations
	D	Depends on the release of endogenous opioids
X	E	All of the above
	F	A, C & D

55. Higher cognitive functions

Which brain area is known to elicit error signals when conflicting information has to be processed?

	A	Hippocampus
	B	Striatum
	C	Amygdala
	D	Basal ganglia
X	E	Anterior Cingulate Cortex
	F	Dorsolateral prefrontal Cortex

56. Reward

Which of the following regions is not part of the mesolimbic reward system?

	A	Striatum
	B	Hypothalamus
	C	Pituitary gland
	D	Ventral Tegmental area
	E	Prefrontal cortex
X	F	Nucleus Coeruleus

57. Integrative brain functions

Which statement is not true?

Hub regions in the brain…

	A	connect specialized functional modules
	B	are clustered along a central axis
X	C	are particularly robust to neurodegenerative disease
	D	integrate cognitive, affective and social functioning
	E	are part of the default mode network
	F	are central to understanding cortical connectivity

Final Written Re-Exam DFM3 Part 2 – The Nervous System

1. What is true about the resting membrane potential?

	A	It does not depend on the intracellular K+ concentration
X	B	It depends on the extracellular K+ concentration
	C	It can be calculated by using the Nernst equation
	D	A and C are correct
	E	A, B and C are correct
	F	A and B are correct

2. What is true about the action potential?

	A	Its shape depends on the time constant
	B	Its shape depends on the length constant
	C	The early afterhyperpolarization regulates the frequency of action potentials
	D	The late afterhyperpolarization regulates the frequency of action potentials
	E	A and B are correct.
X	F	C and D are correct.

3. What is true about the neuron´s electrical properties?

	A	Synaptic summation depends on voltage-gated channels
	B	Synaptic summation depends on ligand-gated channels
	C	Synaptic summation depends on the time constant
	D	Synaptic summation depends on the space constant
	E	A and B are correct.
X	F	C and D are correct.

4. What is true about the neuron´s electrical properties?

	A	Synaptic summation is independent on the length of dendrites
	B	Synaptic summation is independent of the membrane area of the cell body
	C	Inhibitory synapses occur on the soma and proximal dendrites
	D	Excitatory synapses occur on distal dendrites
	E	A and B are correct.
X	F	C and D are correct.

5. What is true about action potential propagation?

	A	Its conduction velocity depends on the diameter of the axon
	B	Its conduction velocity depends on myelin
	C	Its conduction velocity depends on the axon diameter only in unmyelinated axons
	D	Its conduction velocity depends on the axon diameter only in myelinated axons
X	E	A and B are correct.
	F	B and C are correct.

6. What is true about the action potential refractory period?

X	A	The absolute refractory period depends on inactivation of Na+ channels
	B	The relative refractory period depends on inactivation of K+ channels
	C	Action potentials can not be triggered during the relative refractory period
	D	Action potentials can be triggered during the absolute refractory period
	E	A and B are correct.
	F	C and D are correct.

7. What is true about excitability?

	A	Astrocytes are not excitable
	B	Oligodendrocytes are not excitable
	C	Excitability depends on leak channels
X	D	Excitability depends on voltage-gated ion channels
	E	A and C are correct.
	F	B and D are correct.

8. What is true about ion channels?

	A	Ligand-gated channels determine the resting membrane potential
	B	Voltage-gated channels do not occur in axons
	C	Ligand-gated channels do not occur in cell bodies
X	D	Leak channels determine the resting membrane potential
	E	A and B are correct.
	F	C and D are correct.

9. What is true about glutamate?

X	A	It is an excitatory neurotransmitter
	B	It is an inhibitory neurotransmitter
	C	It does not occur in (small) synaptic vesicles
	D	It occurs in large dense cored vesicles
	E	A and C are correct
	F	B and D are correct

10. What is true about these neurotransmitters?

	A	Dopamine can activate metabotropic receptors
	B	Serotonin can activate metabotropic receptors
	C	GABA can metabotropic receptors
	D	GABA can activate ionotropic receptors
X	E	All of the above
	F	A and C are correct

11. What is true about neuropeptides?

	A	Dopamine is not a neuropeptide
	B	Serotonin is not a neuropeptide
	C	Enkephalin is not a neuropeptide
	D	Cholecystokinin is not a neuropeptide
X	E	A and B are correct
	F	C and D are correct

12. What is true about neurotransmitter inactivation?

	A	Acetylcholine is not inactivated by enzymatic degradation
	B	Glutamate is not inactivated by enzymatic degradation
	C	Acetylcholine is not inactivated by uptake
	D	Glutamate is not inactivated by uptake
	E	A and D are correct
X	F	B and C are correct

13. What is true about neurotransmitter synthesis?

X	A	Glutamate is a precursor of GABA
	B	Glutamate is a precursor of glutamine
	C	Acetylcholine is a precursor of choline
	D	Dopamine is a precursor of L-DOPA
	E	A and C are correct
	F	B and D are correct

14. What is true about electrical synapses?

	A	They do not contain connexin
	B	They contain connexons
	C	The perform unidirectional propagation of signals
	D	An excitatory impulse is attenuated as it passes through an electrical synapse
	E	A and C are correct
X	F	B and D are correct

15. What is true about chemical synapses?

	A	They contain synaptobrevin
	B	They contain synaptotagmin
	C	They contain syntaxin
	D	They contain SNAP25
X	E	All of the above are correct
	F	A and B are correct

16. What is true about synaptic vesicles?

	A	Regular (small) synaptic vesicles are not recycled in nerve terminals
X	B	Large dense cored vesicles are not recycled in nerve terminals
	C	Fusion of large dense cored vesicles does not depend on SNARE proteins
	D	Fusion of (small) synaptic vesicles does not depend on SNARE proteins
	E	A and C are correct
	F	B and D are correct

17. General sensory physiology: Which feature(s) of a sensory stimulus is/are centrally represented?

	A	Location
	B	Duration
	C	Modality
	D	Intensity
X	E	All the above
	F	A + C + D

18. Somatosensory system: Rapidly adapting receptors in the skin are involved in:

	A	Discriminative touch with very fine spatial resolution (shape and texture).
	B	Discriminative touch: skin deformation, motion, grip control.
	C	Detection of stretches of the skin.
	D	Detection of high-frequency vibratory and deep pressure stimuli.
	E	All the above
X	F	B + D

19. Somatosensory system: Which of the following statement(s) about proprioception is/are correct?

	A	Golgi tendon organs do not inform about changes in muscle tension.
	B	Muscle spindles do not inform about changes in muscle length.
	C	Primary (Ia) nerve endings do not produce a sustained response.
	D	Secondary (II) nerve endings do not produce a rapidly adapting response.
	E	A + B are correct
X	F	C + D are correct

20. Pain: What do nociceptor neurons and non-nociceptor somatosensory neurons have in common?

	A	Unspecialized nerve endings.
X	B	Cell body most often located in the dorsal root ganglia.
	C	Synaptic contact with projection neurons in lamina I.
	D	Same conduction velocity.
	E	Highly-myelinated axons.
	F	B + D are correct.

21. Pain: How would a lesion restricted to the right side of the spinal cord at the lower thoracic level alter perception of pain and touch in the acute phase?

X	A	Reduced sensation of pain on the lower left side and mechanosensory deficit on the lower right side of the body, while upper body has normal sensation.
	B	Reduced sensation of pain on the lower right side and mechanosensory deficit on the lower left side of the body, while upper body has normal sensation.
	C	Reduced sensation of pain on the left side of the whole body and mechanosensory deficit on right side of the whole body.
	D	Reduced sensation of pain on the lower right side, while the lower left side and the upper body have normal sensation.
	E	Reduced sensation of pain on the lower left side, mechanosensory deficit on the lower left side, while the right side and the upper body have normal sensation.
	F	Reduced sensation of pain and mechanosensory deficit on the both sides of the lower part of the body, while upper body has normal sensation.

22. Pain: Which statement regarding the descending control of pain is *false*?

	A	Pathways from rostroventral medulla, locus coeruleus and nucleus raphe magnus are involved in descending inhibition.
	B	The opioidergic, serotonergic, and noradrenergic systems all contribute to descending control of pain.
	C	Descending pathways can exert both excitatory and inhibitory influences on the activity of dorsal horn neurons.
	D	Descending control is mediated by synaptic contacts onto dorsal horn projection neurons, nociceptive afferents, excitatory and inhibitory interneurons, and the synaptic terminals of other descending pathways.
X	E	Phantom limb pain develops due to cerebral reorganization and reduced activity in descending inhibitory pathways.
	F	None of the above are false.

23. Vision: During accommodation, the shape of the _____ is changed by the _____ in order to see objects accurately at varying distances.

	A	lens; zonule fibers
X	B	lens; ciliary muscle
	C	pupil; ciliary muscle
	D	pupil; zonule fibers
	E	iris; zonule fibers
	F	None of the above

24. Vision: Which of the following correctly matches rods and cones with their properties?

	A	Rods: high spatial resolution; cones: color vision
X	B	Rods: high sensitivity to light; cones: high spatial resolution
	C	Rods: color vision; cones: low spatial resolution
	D	Rods: high sensitivity to light; cones: low spatial resolution
	E	Rods: low sensitivity to light; cones: color vision
	F	None of the above

25. Higher visual functions: A man is brought to the emergency room after a car crash. A doctor shines a light in his right eye and only the right pupil constricts. Which of the following regions is most likely damaged?

	A	Primary visual cortex
X	B	Edinger-Westphal nucleus
	C	Lateral geniculate nucleus
	D	Internal capsule
	E	Striate cortex
	F	All of the above

26. Audition: How does ionic composition of endolymph differ from most extracellular fluids?

	A	It is K^+-poor and Na^+-rich.
	B	It is Ca^{2+}-poor and Na^+-rich.
	C	It is K^+-rich and Na^+-rich.
	D	It is Ca^{2+}-poor and Na^+-poor.
X	E	It is K+-rich and Na+-poor.

	F	It is Ca^{2+}-poor and K^{+} poor.

27. Audition: The lateral superior olive uses which of the following properties of interaural sound for localization?

	A	Time
	B	Frequency
	C	Waveform
	D	Period
X	E	Intensity
	F	None of the above

28. Audition: Which structure(s) connect(s) adjacent stereocilia?

X	A	Tip links
	B	Kinocilium
	C	Inner hair cells
	D	Outer hair cells
	E	Microtubules
	F	Nerve fibers

29. Vestibular system: After stereocilia move toward the kinocilium,

	A	mechanically-gated channels close.
	B	the hair cell hyperpolarizes
	C	there is an efflux of calcium
	D	there is a decreased release of transmitter from the hair cell.
X	E	there is increased signaling in the vestibular nerve.
	F	The cell does not respond

30. Vestibular system: Which reflex allows a person to visually focus on an object as the head rotates?

	A	Vestibulocervical reflex
	B	Vestibulospinal reflex
X	C	Vestibulo-ocular reflex
	D	Vestibular-cerebellar reflex
	E	Vestibulomotor reflex
	F	All of the above

31. Taste: _____ papilla, located posteriorly on the tongue, would respond most strongly to a tastant.

	A	Foliate; umami
	B	Fungiform; salt
	C	Circumvallate; sweet
	D	Foliate; sour
X	E	Circumvallate; bitter
	F	None of the above

32. Olfaction: Which structure separates the olfactory epithelium from the olfactory bulbs?

	A	Olfactory tract
	B	Odorants
	C	Pyriform cortex

X	D	Cribiform plate
	E	Sphenoid bone
	F	Mitral cells

33. What is true about afferents to the spinal cord?

	A	Ib afferents do not originate from muscle spindles
	B	Ia afferents do not originate from Golgi tendon organs
	C	Ib afferents do not respond to active muscle contraction
	D	Ia afferents do not respond to passive muscle stretch
X	E	A and B are correct
	F	C and D are correct

34. What is true about descending pathways in the spinal cord?

	A	The reticulospinal tract is important for control of locomotion
	B	The reticulospinal tract is important for finger movements
	C	The lateral corticospinal tract is important for finger movements
	D	The vestibulospinal tract is important for finger movements
X	E	A and C are correct
	F	B and D are correct

35. What is true about the flexion reflex?

	A	It is elicited by pain afferents
	B	It is elicited by activation of Ib afferents
	C	It is an innate (inherited) reflex
	D	It is a learned reflex
X	E	A and C are correct
	F	B and D are correct

36. What is true about the central pattern generator for locomotion?

	A	It is is not innate (inherited)
	B	It is not learned
	C	Its activity is not fine-tuned by cerebellum
	D	It encodes the locomotor pattern but needs to be tuned
	E	A and C are correct
X	F	B and D are correct

37. Which of the following motor acts is/are encoded by innate central motor programs in humans?

	A	Swallowing
	B	Piano playing
	C	Swimming

	D	Breathing
X	E	A and D are correct
	F	B and C are correct

38. What is true about the basal ganglia?

	A	They do not contain GABAergic medium spiny neurons
	B	They do not contain dopaminergic medium spiny neurons
	C	The direct pathway limits movements
	D	The indirect pathway limits movements
	E	A and D are correct
X	F	B and C are correct

39. What is true about dopaminergic control of movements?

	A	Dopamine D1 receptors facilitate the direct pathway
	B	Dopamine D1 receptors facilitate the indirect pathway
	C	Dopamine secretion in striatum is increased in Parkinson´s disease
	D	Dopamine secretion in striatum is decreased in Parkinson´s disease
X	E	A and D are correct
	F	B and D are correct

40. What is true about the subthalamic nucleus?

	A	It is part of the indirect pathway
	B	It is part of the direct pathway
	C	It plays a role in inhibiting movements
	D	It plays a role in facilitating movements
X	E	A and C are correct
	F	B and D are correct

41. What is true about the cerebellum?

	A	The cerebrocerebellum is important for speech
	B	The vestibulocerebellum is important for speech
	C	The spinocerebellum receives input from the spinal cord
	D	The spinocerebellum is important for eye movements
X	E	A and C are correct
	F	B and D are correct

42. What is true about Purkinje cells?

	A	They are GABAergic
	B	They receive input from parallel fibers
	C	They receive input from climbing fibers
	D	They are glutamatergic
X	E	A, B and C are correct
	F	B, C and D are correct

43. What is true about cerebellar long-term depression?

	A	It does not take part in motor learning
	B	It does not depend on calcium
X	C	It does not depend on NMDA receptors
	D	It does not depend on metabotropic glutamate receptors

	E	A and C are correct
	F	B and D are correct

44. What is true about the primary motor cortex?

	A	It is important for postural control
X	B	It encodes direction of voluntary movements
	C	It is located in the parietal lobe
	D	It is located in the temporal lobe
	E	A and D are correct
	F	B and C are correct

45. Which of these cortical regions is particularly important for visually guided movements?

	A	The primary motor cortex
X	B	The dorsal premotor cortex
	C	The supplementary motor area
	D	The ventral premotor cortex
	E	Both A and B
	F	Both C and D

46. Which of these CNS structure(s) play particularly important role(s) in the control of eye movements?

	A	The frontal lobe
	B	The parietal lobe
	C	Mesencephalon
	D	Spinal cord
X	E	Both A and C
	F	Both B and D

47. Autonomic Nervous system
In the postganglionic neurons of the sympathetic nervous system, integration of information from multiple levels of the spinal cord is achieved by

	A	Adaptation
	B	Range fractionation
X	C	Convergence
	D	Lateral inhibition
	E	Topographical organization
	F	Divergence

48. Memory
The hippocampus supports the following processes during memory and learning:

	A	Short term storage of explicit memories
	B	Long term storage of explicit memories
	C	Consolidation from short- to long-term memory
	D	Procedural memory
X	E	A & C
	F	B & D

49. Attention
The following areas are part of the cortical network for attentional control

	A	Ventral prefrontal cortex
	B	Temporo-parietal cortex
	C	Insular cortex
	D	Hippocampus
	E	A, B & C
X	F	A & B

50. Functions of brain lobes
Which of the following statement(s) is/are true

	A	The parietal lobe is important for motivation
	B	The occipital lobe is important for recognition of objects
	C	The occipital lobe is important for planning
X	D	The temporal lobe is important for recognition of objects
	E	A & D
	F	B & C

51. Circadian Rhythms
The suprachiasmatic nucleus

	A	Is responsible for controlling circadian rhythms
	B	Forms part of the limbic system
	C	Receives input from light-sensitive retinal ganglion cells
	D	Synthesizes hormone melatonin to promote sleep when light is absent
X	E	A & C
	F	A, C & D

52. Sleep
Which of these is not a possible consequence of disturbed sleep

	A	Distractibility
	B	Disturbed metabolism
	C	Susceptibility to infection
X	D	Procedural memory loss
	E	Reduced sex drive
	F	Increased risk for cardiovascular disease

53. Emotion
Which statement is true?
Physiological arousal…

	A	Is high during sadness
	B	Is characterized by low skin conductance
	C	Can be picked up by electrodes placed around the eye region
	D	Is a sign of parasympathetic nervous activity
X	E	Can be triggered by activation of the amygdala
	F	Cannot be regulated by cognitive fear circuits

54. Language

Language

	A	Wernicke´s area is important for formation of speech
	B	Broca´s area is important for formation of speech
	C	The left hemisphere is commonly dominant for speech
	D	The right hemisphere is commonly dominant for speech
	E	A and D
X	F	B and C

55. Higher cognitive functions

Which brain area is known to elicit error signals when conflicting information has to be processed?

	A	Hippocampus
	B	Striatum
	C	Amygdala
	D	Basal ganglia
X	E	Anterior Cingulate Cortex
	F	Dorsolateral prefrontal Cortex

56. Reward

Which of the following region/regions is/are part of the mesolimbic reward system?

	A	Striatum
	B	Suprachiasmatic nucleus
	C	Locus Coeruleus
	D	Ventral Tegmental area
	E	B and C
X	F	A and D

57. Integrative brain functions

Which statement is not true?

The prefrontal cortex is important for:

	A	Planning
	B	Decision making
X	C	Visual interpretation
	D	Behavioural inhibition
	E	Working memory
	F	D and BE

Mapp nr.	*Σ poäng*

Theme 1: Physiology of the neuron (8p)

a) Describe the ionic mechanisms underlying the action potential including the afterhyperpolarization (3p)

b) Describe how the action potential is propagated in myelinated and unmyelinated axons, respectively. (3p)

c) What is the axon refractory period and how does the refractory period in an axon contribute to uni-directional propagation of the action potential? (2p)

Mapp nr.	*Σ poäng*

Theme 2: Synaptic transmission (7p)

A) Describe the molecular mechanisms underlying fusion of synaptic vesicles in nerve terminals. The answer should include the key proteins and their respective roles (5p).

B) Explain the term facilitation and explain the underlying mechanism (2p).

Mapp nr.	*Σ poäng*

Theme 3: Pain (8p)

A) Describe key differences in the characteristics of projected pain versus referred pain (4 p)

B) There are several endogenous mechanisms that may inhibit or reduce pain signalling. Give one example of how inhibitory pain modulation via descending systems can regulate ascending activity at the level of the spinal cord. Include examples of transmitter substances involved in this process in your answer. (3 p)

C) Which nerve fibers mediate nociception that is interpreted as sharp, easily localized pain? (1p)

Mapp nr.	*Σ poäng*

Theme 4: The visual system (8p)

A) Stimulating a rod with light leads to membrane hyperpolarization. Explain the details of phototransduction in the rods. (4p)

B) The pupillary light reflex causes a decrease in the diameter of the pupil that follows light stimulation of the retina. Describe the anatomical pathway that regulates this reflex. (3p)

C) You are examining the pupillary light reflex in a patient. When you stimulate the left eye with light the pupil in the left eye decreases in diameter but NOT the right pupil. Explain the reason for this. (1p)

Mapp nr.	*Σ poäng*

Theme 5: Motor functions – the basal ganglia (8p)

A) Describe the pathway that is refered to as the direct pathway. Which nuclei are involved? Which neurotransmitters are used and what is the role in motor control (4p)

A) Describe the pathway that is refered to as the indirect pathway. Which nuclei are involved? Which neurotransmitters are used and what is the role in motor control (4p)

Mapp nr.	*Σ poäng*

Theme 6: Cortical control of motor functions (7p)

The control of our movements includes a number of different steps, from the first thought and decision of a certain movement, to the actual execution of the movement. In this question you should give an account for the neurobiological basis of your ability to perform hand movements.

a) The primary motor cortex plays an important role in the control of our movements. Which is this role? (2p)

b) The primary motor cortex cooperates with other cortical areas which also have important roles in motor control. What are these areas called and where are they located? (2p)

c) Describe the role of these cortical areas in voluntary motor control. (3p)

Mapp nr.	*Σ poäng*

Theme 7: Cognitive functions (6p)

Different cognitive functions have been linked with different lobes of the brain.

A) State two functions that are located in the frontal lobe (2p)

B) State one function that is located in the occipital lobe (1p)

C) State two functions that are located in the temporal lobe (2p)

D) State one function that is located in the parietal lobe (1p)

Mapp nr.	*Σ poäng*

Theme 8: Language (8p)

Two areas in the association cortex are important for language.

a) Which are these areas? (2p)

b) What is characteristic for aphasias linked with each of these two areas? (4p)

c) Lateralization means that a function is primarily linked with one hemisphere. Give two examples of functions and state on which side it is (most often) located. (2p)

Mapp nr.	*Σ poäng*
140	8

Theme 1: Physiology of the neuron (8p)

a) Describe the ionic mechanisms underlying the action potential including the afterhyperpolarization (3p)

Something like a receptor potential can trigger an action potential. The action potential involves a transient change from negative to more positive membrane potential due to changes in ion permeability

If a stimulus is strong enough to change the resting membrane potential to a threshold potential - an AP will be generated. When the threshold potential is reached, voltage gated Na^+ will open - allowing Na^+ to flow into the cell along its concentration gradient. Since Na^+ carries a positive current (its electrochemical equilibrium is positive) - the neuronal membrane will be depolarized. The rising and overshoot phases are mediated by the Na^+ influx, when a certain level of depolarization is reached, voltage gated K^+ channels open - allowing K^+ to flow out of the cell and repolarize the membrane potential. The Na^+ channels also inactivate. The K^+ activation is relatively slow - meaning that the membrane potential will transiently be lower than the resting membrane potential. This constitutes the refractory period. it also depends on the long lasting inactivation of the Na^+ channels

hyperpolarization

3

b) Describe how the action potential is propagated in myelinated and unmyelinated axons, respectively. (3p)

The unmyelinated axons are relatively poor electrical conductors, meaning that the action potential travels relatively slow in unmyelinated axons. The action potential serves as a self-generating booster system to be able to conduct the electrical signals over longer distances, even with poor conductance.

Myelinated axons have a higher conduction velocity because they've been insulated with myelin, meaning that no current can leak from the axons. At specific points the axon is unmyelinated - the Nodes of Ranvier. Without them, APs wouldn't be generated as no ions could flow. It is at the Nodes of Ranvier we find the voltage gated Na^+ channel. A new action potential is generated at every node and then flows passively to the next

3

c) What is the axon refractory period and how does the refractory period in an axon contribute to uni-directional propagation of the action potential? (2p)

The refractory period of an action is the period where the axon is less likely to generate an AP, when K^+ flows inside through voltage gated K^+ channels after depolarization, it repolarizes the membrane. But the K^+ hyperpolarization is persistent and makes the axon membrane more permeable to K^+ than at rest. This makes the membrane potential more negative than at rest. The persistent inactivation of the Na^+ channels also contribute to the refractory. This means that a much larger current must be generated to reach the threshold potential and generate an AP, making it much more unlikely to happen, since the axon parts before the AP are in a refractory state - the AP propagates forward since the threshold potential is easier reached.

2

Use the other side of the page if you need more space

Mapp nr.	*Σ poäng*
140	7

Theme 2: Synaptic transmission (7p)

A) Describe the molecular mechanisms underlying fusion of synaptic vesicles in nerve terminals. The answer should include the key proteins and their respective roles (5p).

The fusion of synaptic vesicles with the plasma membrane is dependent on Ca^{2+} flowing into the cell. Ca^{2+} activates CMK-II, which phosphorylates synapsin that keep vesicles tethered together. They can then make their way to the plasma membrane & be primed for fusion. The vesicle membrane & synaptic membrane have SNARE proteins. The vesicle has v-SNARES like synaptobrevin & the plasma membrane has t-SNARES like SNAP-25 & syntaxin. When the SNARES are organized so that the right V-SNARE finds the right t-SNARE, they form a complex that spans the two membranes, bringing them close together for fusion.
The vesicles also have proteins called synaptotagmins. They act like Ca^{2+} concentration detectors. When the Ca^{2+} rises, it binds to synaptotagmins in the vesicles which triggers vesicle fusion. this causes the membranes to bend & fuse.

5

B) Explain the term facilitation and explain the underlying mechanism (2p).

Facilitation is the short term strengthening of a synapse by increasing the amount of neurotransmitter being released. This occurs after 2+ actions potential reach the synapse within short time of each other. when an AP reaches the presynaptic terminal it causes Ca^{2+} to flow inside the cell, triggering vesicle fusion & neurotransmitter release. The process to remove the Ca^{2+} is much slower. This means that if a second action potential comes directly after the first one, the Ca^{2+} hasn't been restored to normal levels - increasing the Ca^{2+} level even more, which allows for even more neurotransmitter release & therefore a stronger synaptic transmission

2

Use the other side of the page if you need more space

Mapp nr.	*Σ poäng*
140	8

Theme 3: Pain (8p)

A) Describe key differences in the characteristics of projected pain versus referred pain (4 p) 4

Projected pain is the normal pain percieved from an area that has been damaged. This is pain mediated by activated nociceptors in for example the skin or muscles. The pain signals travel from the point of damage along Aδ & C-fibers to Rexeds laminae 1, 2 & 5 in the dorsal horn nuclei. This is localized pain.

Reffered pain on the other hand is when the pain is felt in other areas than where the damage has occured. One example is pain in visceral organs - you cannot feel the pain in the organs themselves, instead the pain afferents reach Rexeds lamina 5 and is felt in other areas. If you have pain in eg a hand, it can feel like it spreads to the arm & shoulder.

B) There are several endogenous mechanisms that may inhibit or reduce pain signalling. Give one example of how inhibitory pain modulation via descending systems can regulate ascending activity at the level of the spinal cord. Include examples of transmitter substances involved in this process in your answer. (3 p) 3

When the pain signal reaches the cortex it can activate several descending pain relieving systems. It can project to the Periaqueductal Grey (PAG) → sites like Raphes nuclei containing serotonin producing neurons & the locus coeruleus with dopaminergic neurons. The projections from these sites to the dorsal horn of the spinal cord can either directly inhibit the nociceptive signals, or activate local inhibitory interneurons that release inhibitory GABA & enkecephalins.

C) Which nerve fibers mediate nociception that is interpreted as sharp, easily localized pain? (1p) 1

Sharp, easily localized pain is mediated by afferent Aδ-fibers

A delta fibers (I am bad at making the delta symbol).

Use the other side of the page if you need more space

Mapp nr. (40)	*Σ poäng* 8

Theme 4: The visual system (8p)

A) Stimulating a rod with light leads to membrane hyperpolarization. Explain the details of phototransduction in the rods. (4p)

The rods are depolarized in the dark. This means that there is a high value of neurotransmitter release in the dark as voltage-gated channels are open. The rods contain a photopigment called 11-cis-retinal that is associated with the protein rhodopsin, when the retinal absorbs a photon, one of the double bond between carbon atoms in its structure is broken, leading to a conformational change to all-trans retinal. This in turn changes the structure of the rhodopsin, which activates transducin. Transducin can then inhibit cAMP, which closes the cGMP gated ion channels.

In the rods there is an outer segment with cGMP gated ion channels that allow Na^+ & Ca^{2+} to flow and create an inward current. There is also an outward current through K^+ ion channels. When the light causes cGMP levels to decrease, it leads to a decrease in the inward current, meaning that more K^+ flow out than cations flow in, hyperpolarizing the rod.

B) The pupillary light reflex causes a decrease in the diameter of the pupil that follows light stimulation of the retina. Describe the anatomical pathway that regulates this reflex. (3p)

The pupillary light reflex is stimulated when visual signals stimulate the pretectum. The pretectum then projects to the Edinger-Westphal nucleus that is close to the oculomotor nerve. The neurons in the EW nucleus sends their axons along the oculomotor nerve to the ciliary ganglion. This innervates the iris constrictor muscle & causes it to contract, which then decreases the diameter of the pupil to regulate the amount of light hits the retina.

This is a reflex stimulated when sufficient light has hit the retina.

C) You are examining the pupillary light reflex in a patient. When you stimulate the left eye with light the pupil in the left eye decreases in diameter but NOT the right pupil. Explain the reason for this. (1p)

The projection of the pupillary light reflex is bilateral. When stimulating one eye directly, triggering the reflex in that eye, the same reflex is triggered in the other eye - the consensual response. The pupillary reflex is therefore present in both eyes even if only one is stimulated by light.

If the consensual pupillary light doesn't exist, such as in this case, it means that something is wrong with this reflex pathway, like the edinger westphal nucleus or oculomotor nerve on responsible for the reflex on that side

Use the other side of the page if you need more space

Mapp nr.	*Σ poäng*
140	7,5

Theme 5: Motor functions – the basal ganglia (8p)

A) Describe the pathway that is refered to as the direct pathway. Which nuclei are involved? Which neurotransmitters are used and what is the role in motor control (4p)

The direct pathway is activated when we want to perform a movement. Normally when we are still, the thalamus is tonally inhibited, which stops motor signals.

The basal ganglia have 2 primary input structures, the caudatus & putamen that form the striatum, and 2 outputs - the globus pallidus & substantia nigra - the pallidum.

The striatum contains inhibitory medium spiny neurons that can have one of 2 dopamine receptors - D_1 or D_2. When movement is initiated, dopamine is released from the substantia nigra after cortical stimulation, which bind to the D_2 neurons. This starts the direct pathway where the medium spiny neurons of the striatum inhibit the inhibitory pallidum. Inhibition of the inhibitory structure leads to excitation in the thalamus and the motor signals can be sent.

This is the go-system that activates when we want to move.

4

A) Describe the pathway that is refered to as the indirect pathway. Which nuclei are involved? Which neurotransmitters are used and what is the role in motor control (4p)

The indirect pathway also mediated by medium spiny neurons in the striatum. The neurons in the indirect pathway have the other type of dopamine receptor, D_2. When this receptor is stimulated by dopamine from the SN, it activates the indirect pathway that goes from the striatum to the external globus pallidus before that structure affects the internal globus pallidus. This extra step means that the MSN inhibit the inhibitory GPE, which allows the GPi to inhibit the thalamus → no movement is executed.

The indirect dopamine receptors have a much lower threshold than the active pathway ones, meaning that a strong intent/executive signal from the motor areas must exist to produce enough dopamine to stimulate the direct pathway

3,5

Use the other side of the page if you need more space

Mapp nr. 140	*Σ poäng* 7

Theme 6: Cortical control of motor functions (7p)

The control of our movements includes a number of different steps, from the first thought and decision of a certain movement, to the actual execution of the movement. In this question you should give an account for the neurobiological basis of your ability to perform hand movements.

a) The primary motor cortex plays an important role in the control of our movements. Which is this role? (2p)

The primary motor cortex is necessary for executing all voluntary movements. It is important for the organization of movement. It activates several descending motor pathways that project to e.g upper motor neurons & interneurons in the spinal cord, which execute the wanted movement through contacts with lower motor neurons. 2

b) The primary motor cortex cooperates with other cortical areas which also have important roles in motor control. What are these areas called and where are they located? (2p)

The primary motor cortex also communicates with motorareas like the premotorcortex on the basolateral precentral gyrus, the frontal cortex (important for planning/deciding on movements) in the frontal lobe, and the association cortices like the sensory cortices like the primary somatosensory cortex on the postcentral gyrus. The premotorcortex can also be divided into the dorsal premotorcortex, the supplemental motor area and the ventral premotorcortex - all on the precentral gyrus, dorsal to the primary motor cortex. 2

c) Describe the role of these cortical areas in voluntary motor control. (3p)

The frontal cortex is important for the planning of voluntary movements, making decisions about movements and the creation of motor memory & motor learning.

The premotor cortex have different parts that ac involved
- dorsal premotor cortex is important for the movements of the limbs
- the supplemental motor area is important for executing complex movement sequences and executing simultaneous movement of different body parts
- the ventral premotor cortex is involved in multisensory integration. 3

The motor areas recieve input from the somatosensory cortices to coordinate motor responses to sensory stimulus

Use the other side of the page if you need more space

Mapp nr.	*Σ poäng*
140	6

Theme 7: Cognitive functions (6p)

Different cognitive functions have been linked with different lobes of the brain.

A) State two functions that are located in the frontal lobe (2p)

The frontal lobe is involved in planning & decision making. The orbitofrontal cortex also regulates the activity of the amygdala and therefore the strength of emotions It is also involved in working memory processes. 2

B) State one function that is located in the occipital lobe (1p)

The occipital lobe is involved in vision. The visual cortex & striate cortex are located along the calcarine fissure 1

C) State two functions that are located in the temporal lobe (2p)

The temporal lobe has the temporal association cortex which is involved in object recognition and identification. 2

The temporal lobe also has the auditory cortex and is therefore involved in the processing of sound

D) State one function that is located in the parietal lobe (1p)

The parietal lobe has the parietal association cortex that is involved in attentiveness. – paying attention to certain stimuli. 1

Use the other side of the page if you need more space

Mapp nr. 140	*Σ poäng* 7

Theme 8: Language (8p)

Two areas in the association cortex are important for language.

a) Which are these areas? (2p)

Wernicke's area
Broca's area

2

b) What is characteristic for aphasias linked with each of these two areas? (4p)

Broca's area involves the understanding of language whilst Wernicke's area is involved in the production of language. Damage to Broca's are means that you no longer can process language input whilst damage to Broca's area leads to an inability to form comprehensible language. You can understand language & produce sounds but the sounds produced are not the language / communication you wish to express

3

c) Lateralization means that a function is primarily linked with one hemisphere. Give two examples of functions and state on which side it is (most often) located. (2p)

One example of lateralization is the parietal associational cortices. The right parietal lobe and its association cortex is responsible for attention on both the contralateral and ipsilateral side of the body. The left parietal lobe is only responsible for a little bit of contralateral attention. Attention is more associated with the right parietal lobe, some right hemisphere
Language is lateralized to the left hemisphere.

2

Use the other side of the page if you need more space