Pázmány Péter Catholic University

Faculty of Information Technology and Bionics

Department of Neuroscience

**BASICS OF NEUROBIOLOGY**

**Midterm Test**

**10th November 2016**

**Name: .......................................................................**

**Points: 100 /**

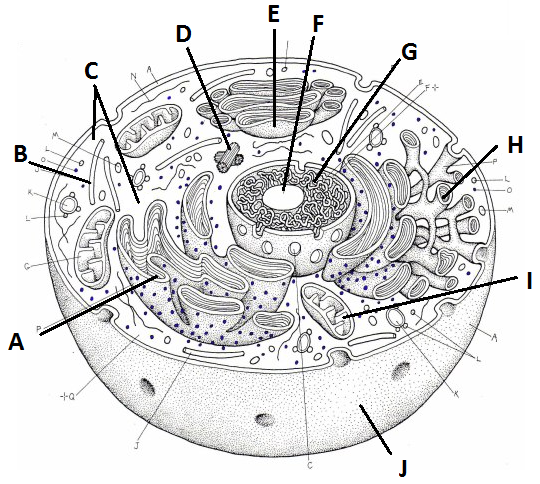
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Signature of examiner Signature of examinee

(Sign upon acceptance of correction)

**Cellular morphology and function (10 points).**

**Pair the marked cellular organelles with the statements below!**

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1. It has glycoproteins and glycolipids embedded. \_\_\_\_\_\_\_\_\_
2. Site of metabolic actions and signal transduction. \_\_\_\_\_\_\_\_\_\_
3. The rRNA is produced here. \_\_\_\_\_\_\_\_\_
4. Newly synthetized proteins are trafficked to their inner space. \_\_\_\_\_\_\_\_\_
5. It stores and releases calcium in excitable tissues. \_\_\_\_\_\_\_\_\_
6. Macromolecule maturation and tagging, formation of liposomal vesicles are located here. \_\_\_\_\_\_\_\_\_
7. Its matrix contains circular DNA, ribosomes and several different types of enzymes. \_\_\_\_\_\_\_\_\_
8. It is composed of alpha and beta tubulin. \_\_\_\_\_\_\_\_\_
9. They organize the growth of microtubules. \_\_\_\_\_\_\_\_\_
10. Transcription takes place here. \_\_\_\_\_\_\_\_\_

**Synaptic transmission and receptors (21 points).**

1. **Characterise the excitatory and inhibitory synapses according to the given aspects. (8)**

**Excitatory synapse Inhibitory synapse**

**Commonly used neurotransmitter** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1 example)**

**Ion flow across postsynaptic** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**membrane (ion type, direction)**

**Shape of synaptic vesicles**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Nature of synaptic specialization** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(regarding post-, pre-membrane**

**thickness)**

**(B) Characterise the chemical and electrical synapses according to the given aspects. (8)**

**Chemical synapse Electrical synapse**

**Distance between pre-, and** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**postsynaptic cell membranes**

**Ultrastructural components** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Synaptic delay** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Direction of transmission** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(C) Generation of action potentials. Identify the ion channel operations involved at the marked time frames! (5)**

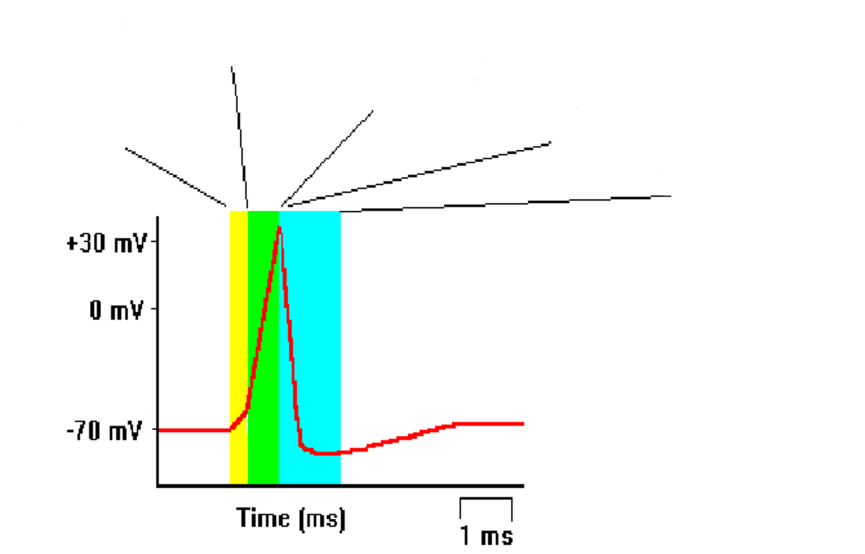
1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**5**

**4**

**3**

**2**

**1**

**Glial morphology and function (15 points).**

**(A) Underline the correct phrases. (5)**

1. Schwann cells derive from the *neural tube / neural crest.*
2. A single Schwann cell hosts *one single axon / several axons* in its cell body in non-myelinated fibers.
3. Postganglionic fibers of the autonomous nervous system are composed of *non-myelinated / myelinated* axons.
4. Macroglial cells develop from *neuropithel / mesodermal* cells.
5. In the CNS the white matter is rich in *protoplasmic/fibrous* astrocytes.

**(B) Render the different glial cell types to the properties listed below. Multiple choice might be possible. (10)**

**A = astrocyte O = oligodendroglia S = Schwann cell M = microglia E = ependyma**

They act as the resident immune cells in the CNS. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They contain GFAP. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They develop from the mesoderm. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They may host dozens of axons. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They control the extracellular calcium homeostasis. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Its synonym is Hortega-glia. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They are coupled by gap junctions. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They are situated at the border of the cerebrospinal fluid and the extracellular space liquid compartments. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

They have major role in the formation of the Blood Brain Barrier. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Tanycytes are specialized type of them. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Neurotransmitters, receptors (14 Points).**

**(A) Fill in the form with the missing component of receptor-ligand relationships: (5)**

AMPA/kainate receptor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Noradrenalin

5HT3 receptor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Acetylcholine

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ GABA

**(B) Complete the text below! (9)**

Regular neurotransmitters cannot \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ through the cell membrane; their effects are mediated by receptors present in the postsynaptic membrane. These special proteins show high-affinity binding for transmitter ligands. Ligand binding alters the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of the receptor evoking postsynaptic response. Ionotopic receptors perform as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ion channels, while \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ receptors are bound to G-proteins via their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (type) neurotransmitters use G-protein coupled receptors exclusively. These receptors contain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ transmembrane proteins. The G-protein has alpha, beta, and gamma subunits. The alpha subunit together with the bound GTP dissociates and affects a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, for which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_can be an example.

**Nerve endings (5 points)**

**Decide whether the following statements are true (T) or false (F). Give an explanation why.**

Motoneurons that innervate striated muscles use dopamine as neurotransmitter. \_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Postganglionic nerve fibers of the sympathetic and parasympathetic branches of autonomic nervous system do not establish synapses with the target cells. \_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Golgi tendons are the receptors of the spinal stretch reflex. \_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Thermoreceptors are also addressed as nociceptors. \_\_\_\_\_\_\_\_

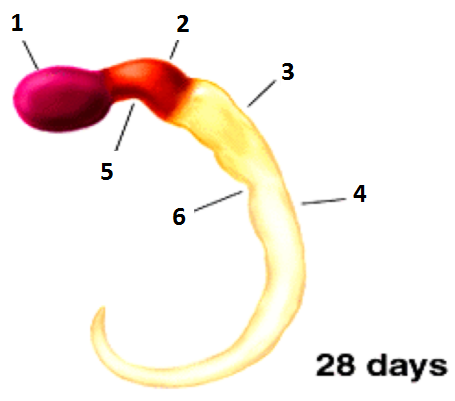
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The composition of blood is monitored by receptors. \_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Development and organization of the nervous system (15 points).**

**(A) Early development of the brain. Identify the numbered structures, and render the name of the structures to the statements. Multiple choice might be possible. (12)**

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**1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**4) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**5) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**6) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Derives from the proliferating caudal part of the neural tube: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Develops at the level of the midbrain: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

From its derivative secondary vesicle the medulla develops: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Derive from the rostral part of the neural tube: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

During further differentiation it divides into two secondary vesicles: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Its concave shape points toward the ventral part of the body: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**(B) Define briefly. (3)**

1. germ layers: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. radial migration: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. ganglion: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**The spinal cord (5 points)**

**Name the numbered parts of the spinal cord.**



**1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**4: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**5: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Parameters characterizing the nervous system (5 points)**

**Give the number and the unit (!).**

Change in the membrane potential, when an action potential is generated: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Extracellular calcium ion concentration: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Number of thoracic spinal cord segments: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Diameter of the perikaryon: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Diameter of the naked axon: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**experimental approaches (10 points).**

**(A) Answer the questions. (4)**

List two advantages of two-photon microscopy against confocal laser microscopy.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What properties make immunohistochemistry a highly usable technique in transmitter-detection?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Define PCR: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the aim of NGS? (What aspect of genome sequencing should be improved?)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(B) What kind of technique would you apply to … (6)**

1. get high-resolution microscopic images with 3D appearance: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. study the level of gene expression in a tissue: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. study membrane particles in replicas: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. detect neuronal paths: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. demonstrate whether two neurons are electrically coupled (by gap junctions): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. image synaptic release in vivo: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_