



Aalto University
School of Science

NBE-E4140 Neurophysics

Teachers: Ari Koskelainen and Risto Ilmoniemi

Place: Seminar room F336, Rakentajanaukio 2 C, 3rd floor (Health Technology House)

Learning outcomes

After the course, the student

- knows the physical basis of mechanisms with which one can influence brain tissue and cells
- can critically read advanced literature and find out where the border between the known and the unknown
- can differentiate between important and less important research questions
- can make a research plan to expand our knowledge at the border of the unknown

Themes

Influencing tissue properties in degenerative brain diseases

- 1) Direct electric current
- 2) Heat treatment
- 3) Ultrasound
- 4) Indirect neural stimulation with transcranial magnetic stimulation (TMS)
- 5) Your choice of topic

Organization of the course

- The course consists of team work.
- Teams will consist of 4–5 members.
- Each team will focus on one theme and will act as opponents for another team on some other theme.
- You can find the themes and the tasks for the teams in Materials under the title "Course content".
- The detailed schedule will be agreed on in the first session.

Tasks for the theme groups, 1

The group shall, based on a literature search and analysis,

- identify 4–5 important sub-topics / research questions on their theme;
- select at least 20 key scientific articles (“papers”) on their theme
 - 5 on each physics-based subtopic
- send teachers an explanation why these articles were selected;
- meet with the teachers to discuss the articles that were found and how the group should proceed towards the research plan;
- write a research plan based on their understanding of the articles and the ideas on how to study the unknown (see below).

Tasks for the theme groups, 2

Each group member shall (collaborating with the other group members)

- be assigned 5 articles. One of these 5 shall be a review article, while the 4 other papers shall be original research papers;
- write about each of the 4 research papers assigned to her/him
 - a one-sentence summary;
 - a description of the boundary of the known and unknown based on the paper;
 - one or more ideas of how one could study the unknown.
- evaluate contributions (significance of own contribution to group work, own learning, quality of own ideas, quality of the contribution of the other group members).

Tasks for the theme groups, 3

The members of the group shall

- give the papers (with summaries) to the opponent group at least 2 weeks before the final seminar;
- give an oral presentation (30 minutes divided between group members).

Tasks for the opponent groups

The group shall

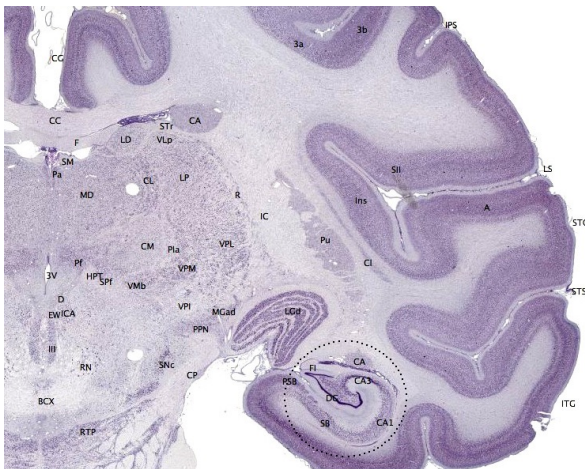
- act as opponent in the final seminar
 - evaluating the summary, description of the boundary and ideas provided by the theme group
 - commenting and asking questions about the presentations
 - taking questions from the audience and leading the discussion.

Evaluation and grading

- Final grading: 1–5 for passed course
- Evaluation:
 - Self-evaluation (1–5; describe each point with 1–3 sentences)
 - significance of own contribution to group work,
 - own learning,
 - quality of own ideas.
 - Team member evaluation (1–5)
 - quality and quantity of the contribution of the other group members
 - The content and quality of the written or oral presentations will be evaluated by the teachers.

Possible targets:

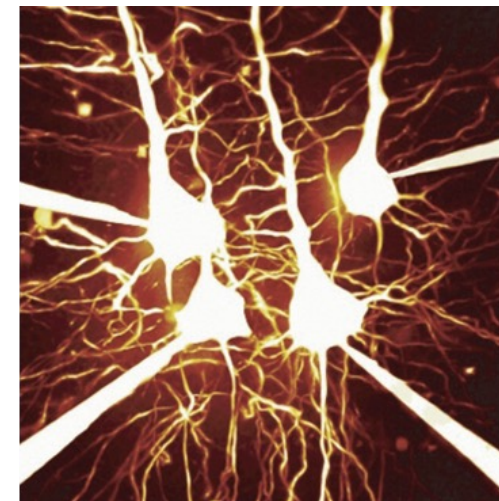
- Structural aspects: skull, brain, neurons, glial cells, targets in cells (soma, axon, dendrites, synapses, ...)
- Emphasis on physical principles



Stained Macaque brain slice



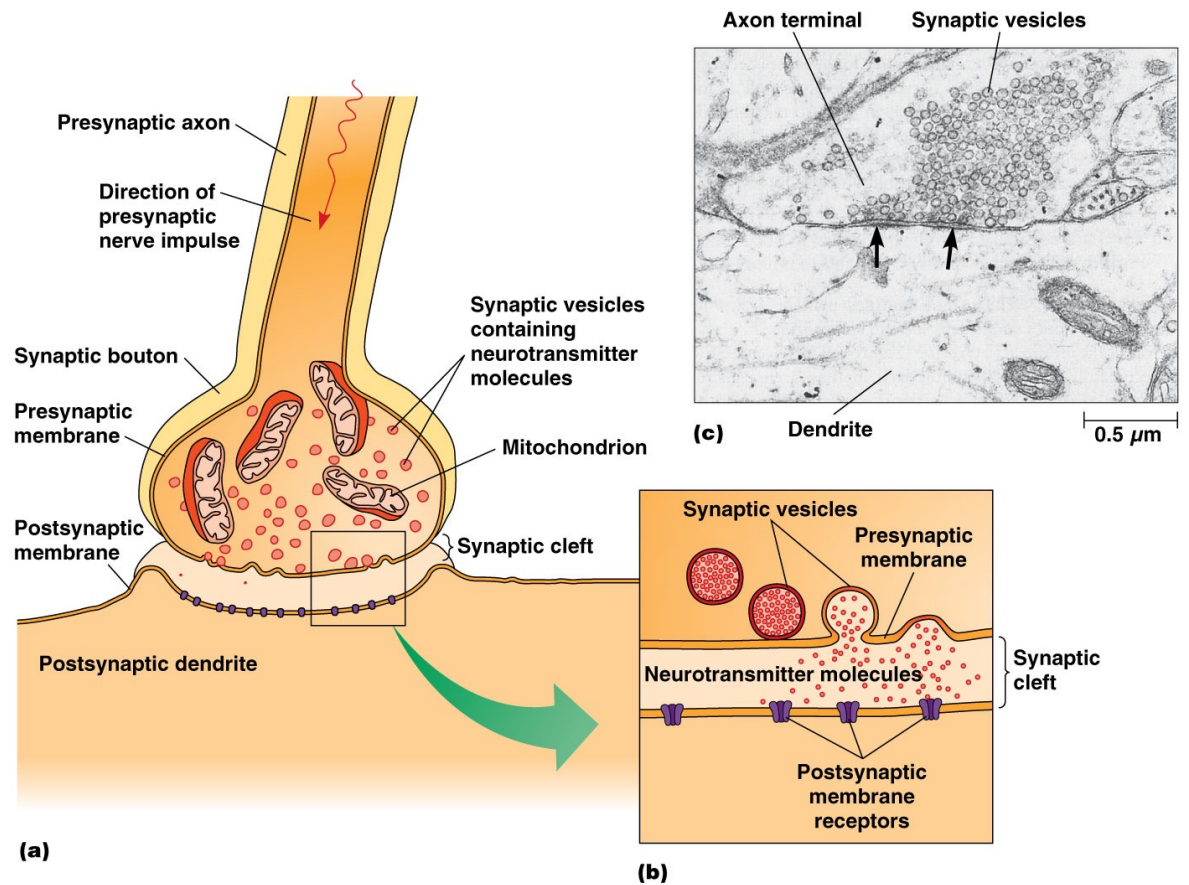
Simulated rat brain



Pyramidal neurons (cortex)

Possible targets, continued:

- Gene expression
- Presynaptic and post-synaptic mechanisms
- Harmful/poisonous molecules or structures
- Emphasis on physical principles



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Schedule 1

- **Thursday, March 10**
 - Theme groups are formed
 - Themes are selected
 - Literature survey will be started (use, e.g., Google, PubMed, aalto.finna.fi)
- **Thursday, March 17**
 - Brainstorming on research questions (teachers will be helping)
 - in theme groups
 - You will get instructions for the research plan
 - You shall make proposals for sub-topics / research questions
 - will be discussed and analyzed with the teachers
 - individual sub-topics / research questions will be decided

Schedule 2

- **Mm dd**
 - You shall make preliminary proposals on articles to be focused on
 - will be discussed and analyzed with the teachers
- **Mm dd**
 - You shall make proposals and give reasons for the choice of the 20 (5 per person) articles
 - will be discussed and analyzed with the teachers
 - articles will be decided
- **Mm dd**
 - Analysis of research ideas and discussions with teachers
- **From Mm dd Mm dd**
 - Team work on the topics
 - When needed, you can be in contact with the teachers by e-mail

Schedule 3

- **Mm dd**
 - How to give scientific presentations
 - You shall have a draft on your research plan
 - should be sent to the teachers latest on Friday, April 24 by 16:00
 - will be discussed and analyzed with the teachers
- **Thursday, May dd**
 - Possibility for meeting with teachers
- **Thursday, May dd**
 - Oral presentations + discussions led by opponents

Groups

Electric current

Maria Koponen, Senni Selkama

Heat treatment

Matilda Makkonen, Joonas Laurinoja, Jonne Annevirta, Eevi Rimmi

Ultrasound

Wenli Fu, Anni Ranta-Lassila, Peyman Moolawi, Samantha Wachter

Indirect neural stimulation with transcranial magnetic stimulation (TMS)

Your choice of topic

Search articles on your theme

<https://scholar.google.fi/>

<https://www.ncbi.nlm.nih.gov/pubmed/>

You can find full papers at <https://aalto.finna.fi/>

–First sign in, then insert the name of the journal, go to the appropriate volume, issue, and article