

RHYTHMS COURSE

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Content-goals:

- (1) Classical models of brain rhythms
- (2) Basic experimental/analysis techniques for rhythms

Skill-goals:

- (1) Read experimental rhythms papers
- (2) Ask questions and hypothesize at the edge of the field
- (3) Turn experimental results into psuedo-computational models

Assignments:

- Day 1: Papers accompanied by comprehension worksheets
 - Restate
 - Interpret data/figures
- Day 2: Synthesis assignment
 - Extrapolate/hypothesize
 - Pose questions
 - Design model

Tools:

- Qualitative analysis of vector fields in phase plane

By week:

- (1) Introductory week
 - Syllabus
 - Review the neuron
 - Neurons maintain electrical potential difference with environment
 - Different types of ions are conducted in and out through channels, affecting potential

- * Terminology: INWARD vs. OUTWARD, Polarizing vs. Hyperpolarizing
- * Terminology: Conductance
- Some ion channels open and close with voltage
- Neurons interface at synapses
 - * Some open INWARD excitatory channels
 - * Some open OUTWARD inhibitory channels.
- Introduce 2D vector fields
 - The spike: V vs. n
 - STATE determines DIRECTION
- Introduce the frequency domain
 - How to read a power spectrum
 - * What does a sine wave look like in the freq domain?
 - * What does a sum of sine waves look like?
 - * Look at other signal/spectrum pairs
 - How to read a spectrogram
- (2) Gamma 1: What does the data say?
 - Fast-spiking cells are critical.
 - Frequency is connected to inhibition time constant
- (3) Gamma 2: What neural mechanism creates it?
- (4) Gamma 3: What function might it serve?

PART 1: Cortico-thalamic rhythms

- (5) Alpha 1: What does the data say?
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- (6) Alpha 2: What neural mechanisms create it?
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- (7) Beta 1: What does the data say?
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- (8) Beta 2: What neural mechanisms create it?

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PART 2: Hippocampal rhythms

(9) Theta 1: What does the data say?

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(10) Theta 2: What neural mechanisms create it?

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(11) Ripples 1: What does the data say?

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(12) Ripples 2: What neural mechanisms create it?

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(13) Ripples/Theta: What functions are theta and ripples serving

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(14) Projects 1

(15) Projects 2

(16) Projects 3

OLD OUTLINE

16 weeks

1a. Introduction: what are rhythms? 1b. Methods:

Gamma Themes: Synchronous spiking, feedback inhibition 1. 2. 3.

PART 1: Cortico-thalamic rhythms

Alpha Themes: (Negative) attention, central control by thalamus, bursting Papers: Topics: 4. 5.

Beta Themes: Top-down control, laminar architecture 6. 7.

Delta 8.

PART 2: Cortico-hippocampal rhythms

Theta Themes: Nested rhythms, phase coding 9. 10. 11.

SWR Themes: Sequences, plasticity 12. 13.

14-16 Projects

1. REFERENCES