NAME _____

LECTURE GOALS:

- ☐ Have a general overview of the evolution of brains.
- ☐ Appreciate that they are all build on similar cellular components.
- ☐ Among animals, homology and analogy can be drawn across brain centers.
- ☐ *"Every single psychological problem has a biological cause. This is not a philosophical position. This is a fact. Every mental event comes from the brain."* Erik Kandel
- ☐ General understanding of hormone signaling systems.
- ☐ Follow the history of our understanding of hormonal actions.

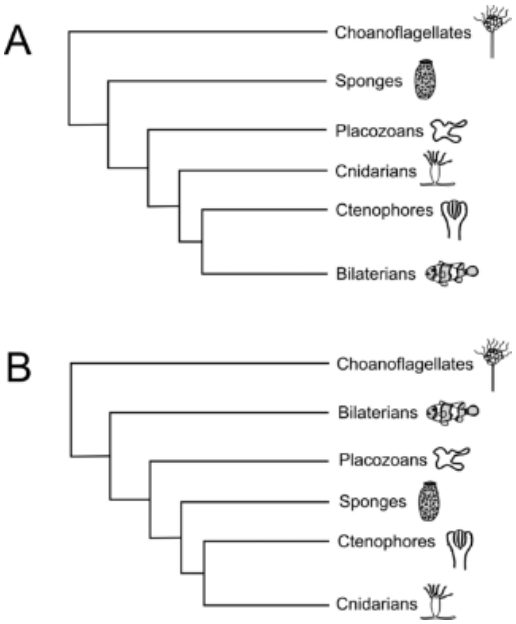
LECTURE OUTLINE

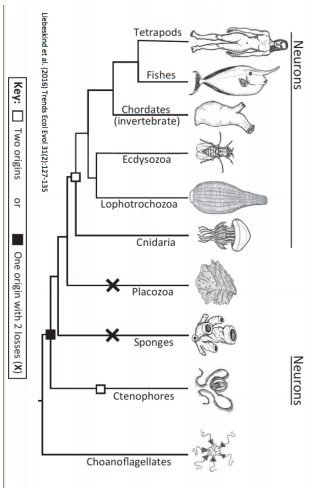
1. Neurons in all animals are composed of similar molecular components (e.g. Ion channels, G-proteins, Pumps, Transporters, Transmitters)
2. Neurons pass information and perform 'computation' through summation of "synaptic input".
3. At chemical synapses neurotransmitters transfer "information" across the synapse to specific receptors on the post-synaptic cell.
4. The post-synaptic response is either excitatory (depolarizing) or inhibitory (hyperpolarizing).
5. There are also electrical synapses that directly "couple" two (or more) neurons.
6. The probability that the post-synaptic cell will fire an action potential depends on the strength of the synapse. Though note that not all neurons use action potentials.
7. Nervous systems are organized in 3 parts: 1) receiving 2) integration 3) response.
8. Nervous systems function as circuits (e.g. Excitatory circuits, Negative feedback circuits, CPGs).
9. Neurons may have evolved more than once.
10. Absolute brain size scales positively with body mass.
11. Relative brain size scales negatively with body mass.
12. Big brains do not always have more computational power in all realms.
13. Nervous system of animals have evolved that best solved problems faced by ancestors.
14. The concept of "Umwelt" describes an organism's "subjective universe".
15. Nervous systems are under selective pressure to produce adaptive behaviors efficiently.
    a. Streamline neuron number
    b. Reduce connection length
    c. Local processing
16. Even "simple" nervous systems accomplish amazing behaviors.
    a. Example jellyfish eyes
    b. Example octopus brains
17. Neuroethology is the field concerned with studying how specific nervous systems orchestrate specific evolutionarily adaptive behaviors and how these nervous systems evolved.
18. Neurons are organized into circuits.
19. Central Pattern Generators, the circuits that mediate rhythmic behaviors
    a. can produce complex output from simple input (intrinsic activity),
    b. can sustain activity without continued input (stable),
    c. can be modified (modulation).
20. Local circuits are organized into larger systems in a somewhat modular fashion.
21. Neural circuits can be modified on longer timescales as well: "plasticity".
22. Analogous brain regions can be identified across broad phylogenetic comparisons.

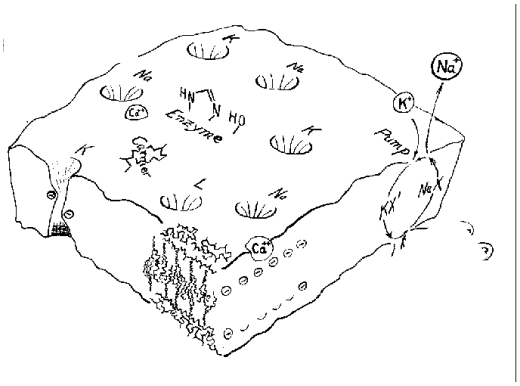
23. At a gross anatomical level, vertebrate brains show clear homology.
24. At a functional level, vertebrate brains demonstrate homology. STOPPED HERE 2018
25. ~~Hormones are simply a signaling system that functions at a distance through the circulatory system (note: animals without "blood stream" use hormone signaling too).~~
    i. ~~Intecrine~~
    ii. ~~Autocrine~~
    iii. ~~Paracrine~~
    iv. ~~Allocrine~~
26. ~~Hormones are produced and "secreted" by "endocrine glands" (or tissues)~~
    ~~*Endon* = within & *Krinein* = to release~~
27. ~~*Hormone* means "to excite" but they may also inhibit as they coordinate physiology allowing the animal to respond to internal and external environmental cues.~~
28. ~~Hormone are grouped in 4 classes~~
    a. ~~Small molecules (e.g. monoamines, serotonin)~~
    b. ~~Peptide (e.g. oxytocin, vassopressin)~~
    c. ~~Protein (e.g. growth hormone)~~
    d. ~~Lipid based (e.g. prostaglandins & steroids)~~
29. ~~Generally a cell makes only 1 type of Hormone~~
30. ~~Endocrine systems are: (a) Ductless (usually) (b)Have rich blood supply (though can travel in lymph, (c) Secreted to blood stream (d) Travel throughout the body (often bound to binding proteins) (e) H~~**~~ave specific receptors, but not 1:1.~~**
31. ~~Interaction with receptors starts a cascade of events leading to changed cellular function through either~~
    a. ~~A second messenger systems~~
    b. ~~A "genomic response"~~
32. ~~Receptor density, placement and type allow for seasonal & environmental regulation of hormonal function.~~
33. ~~Hormones change the probability that a behavior will occur in response to a stimulus, they do not cause behaviors.~~
34. ~~The organizational/activational hypothesis for hormone function describes the early in utero function of hormone action particularly in relation to sexual differentiation. (William Young; Frank Beach)~~

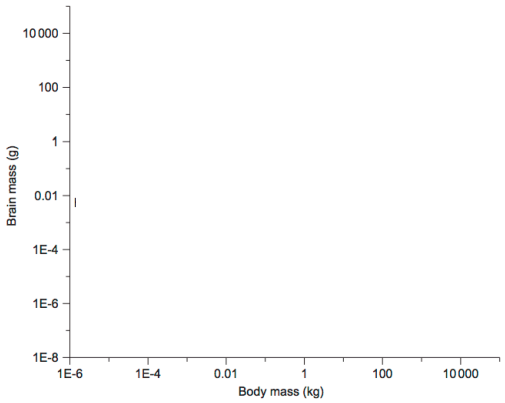
HELPFUL FIGURES & NOTES:

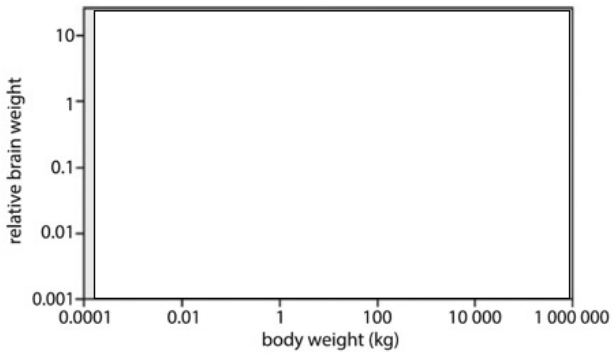
(All PowerPoint files will be available on the courses server after lecture. The subset of figures and notes here are meant to assist your note taking or studying.)

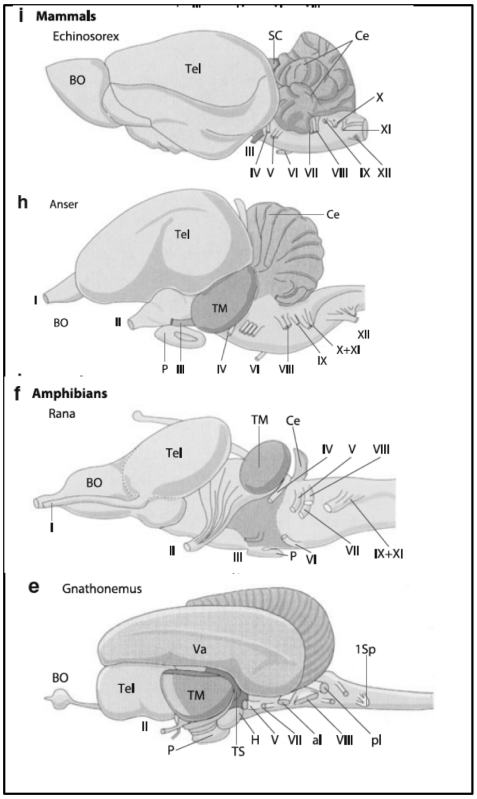








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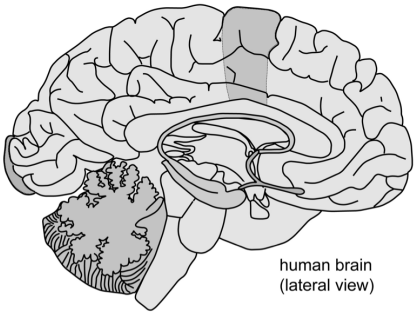
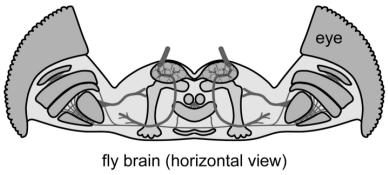
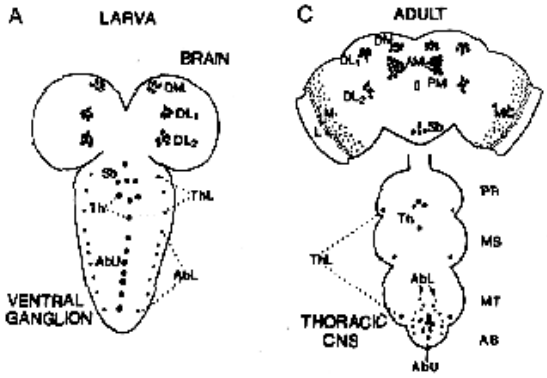

human brain
(lateral view)


eye
fly brain (horizontal view)

A. Prokop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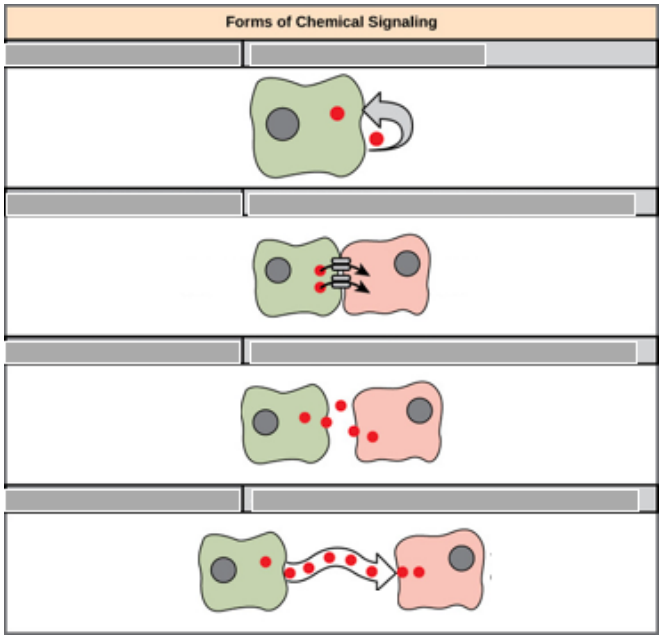
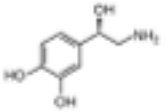
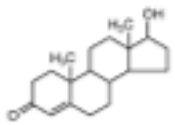
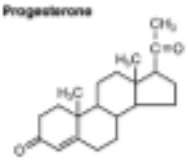
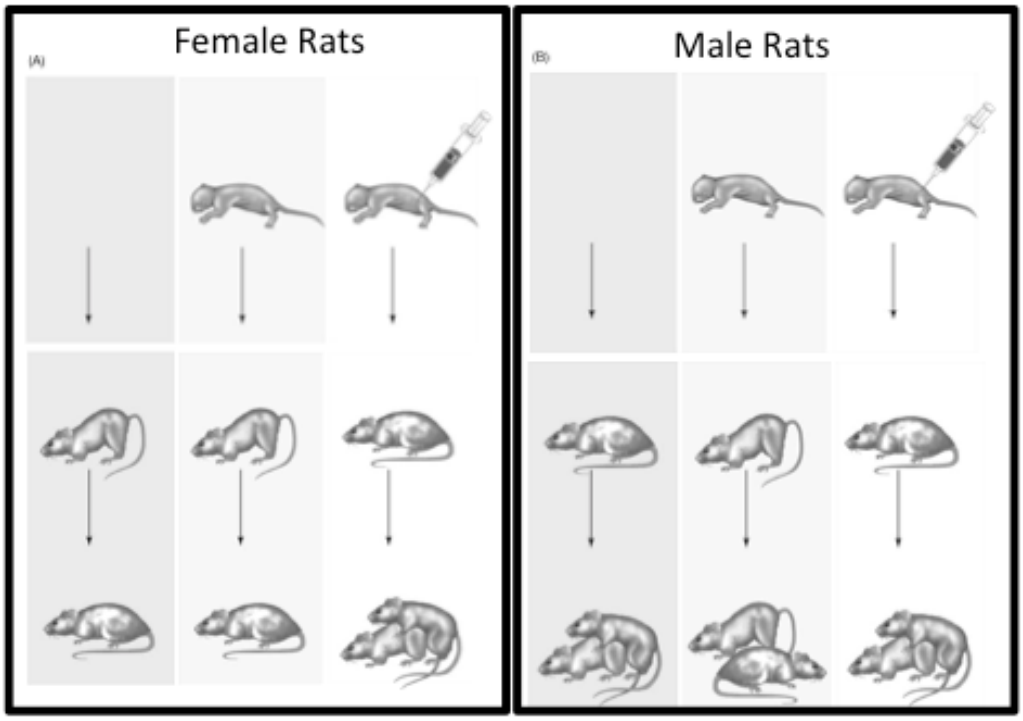


Hormone Class	Components	Example(s)
		Norepinephrine 
		Oxytocin 
		Human Growth Hormone 
		Testosterone  Progesterone 



This diagram (once you fill in the details) represents the early studies that lead to the now somewhat dated theory of the "organizational and activational function of hormones". It is covered in the IntroBio text book. I will not cover this experiment in detail in lecture.

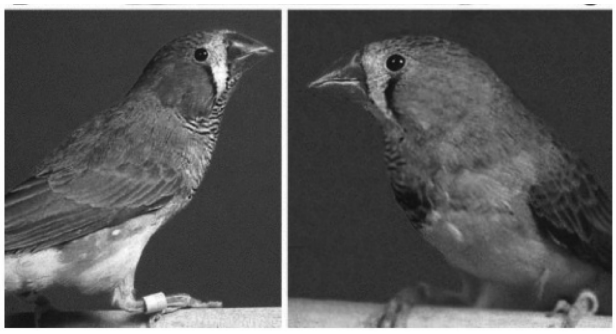


Fig. 1. Zebra finch gynandromorph (*A*) with male plumage on its right side (*B*) and female plumage on its left side (*C*). A few black male feathers can be seen on the left breast in *A*.

Also a genetic influence required for hormonal "organization"

VOCABULARY:
(Practice writing interesting, informative sentences that include, and capture the meaning of, 4-5 words from this list. To simply memorize a definition, is not sufficient.)

Neuron
Nervous system
Action potential
Analog signal
Ion channel
Chemical Synapse
Electrical Synapse
CPG
Modulation
Plasticity
Nerve net/ring
cephalization
Brain
Immediate early gene

Absolute brain size
Relative brain size
Umwelt
Homologous
Analogous
Evolutionary Constraint
Deep Homology

Hormone
Autocrine
Paracrine
Endocrine
Allocrine
Genomic Response
Activational
Organizational

PRACTICE EXAM QUESTIONS:

1. Know which channels open when during and action potential.
2. Understand synaptic transmission (look back at intro bio).
3. Describe 3 ways that you could strengthen or weaken a synapse.
4. In what way has the evolution of nervous systems been "constrained"?
5. If clams and octopus are both mollusks, why do their nervous systems look so different?
6. How does the concept of "deep homology" solve apparent "homoplasies"?
7. Explain the similarities and differences between neuronal signaling with neurotransmitters and hormonal signaling.

8.Give an example of a hormone that is a peptide, lipid derivative, amino acid derivative.

READING FOR TODAY :

Byers Chapter 3
Ryan and Wilczynski Chapter 3
Roth G., and Dicke, U. (2013) Evolution of Nervous Systems and Brains. Neurosciences - From Molecule to Behavior: A University Textbook, eds: C.G. Galizia, P.-M. Lledo, Springer-Verlag Berlin Heidelberg

READING FOR TUESDAY:

Ryan and Wilczynski Chapter 4
Cantina & Remple 2005 Asymptotic prey profitability drives star-nosed moles to the foraging speed limit 433:519.