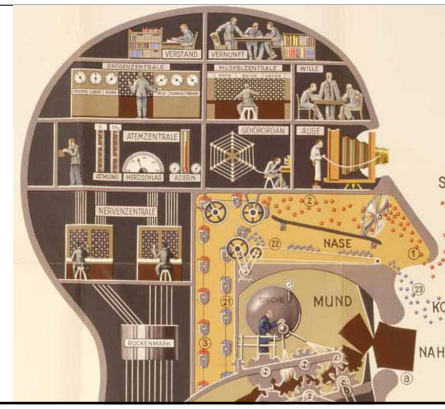
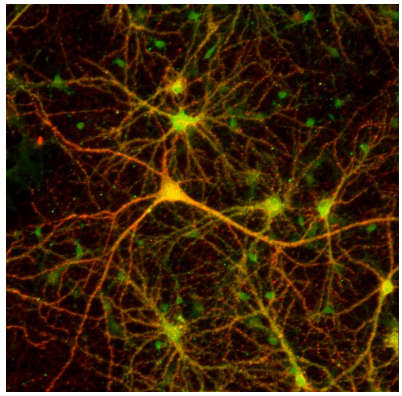
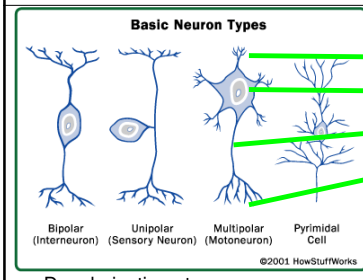
Neurobiology

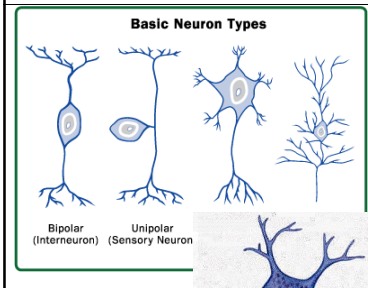
What do we know and how is it relevant to studying behavior?



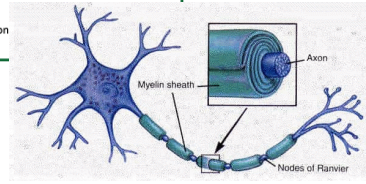


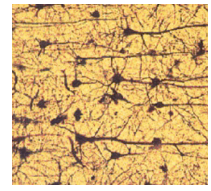


- Depolarisation at synapse or sensory cell
- Electrically sensitive ion channels (let Na^+ in) – more depolarisation
- Signal travels through axon and synapse releases vesicles of neurotransmitter



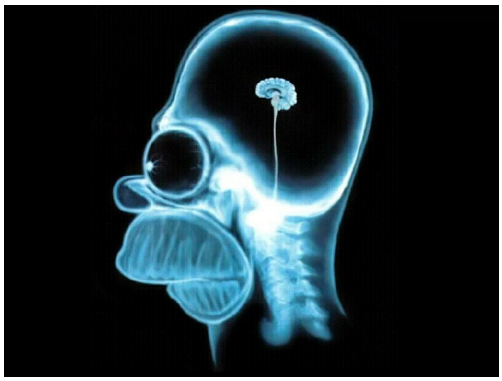
Myelin sheath



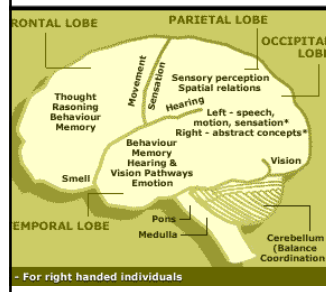


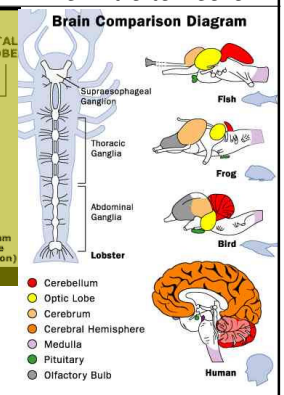
- Axons send digital signals → stronger signals coded as higher frequency (FM!)
- Neurons assembled into networks with input and output
- Brains and ganglia are high concentrations of neurons but also supporting cells

Brief intro to neuro



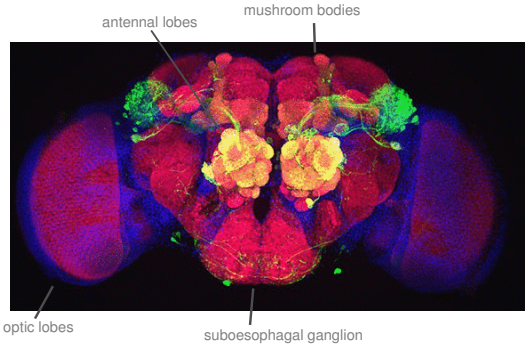
Brief intro to neuro



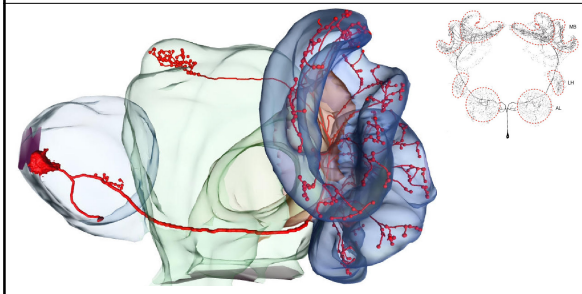


- From lesion studies: which parts of the brain do what

Brief intro to neuro

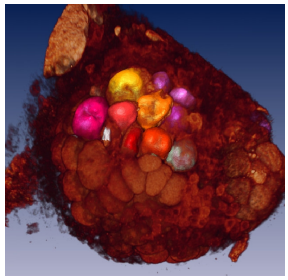


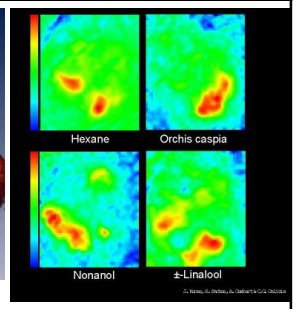
Brief intro to neuro



- From cell staining methods: location and connections of individual neurons

Brief intro to neuro





- From calcium imaging: when are which parts active

Brief intro to neuro

- Functions of many brain areas known
- Large neurons mapped
- Some networks, mostly for sensory input, understood
- Lots of research on stages of memory formation and molecular mechanisms involved

Neurobiology

To understand why animals do what they do

- Behavioral ecology: studies selection pressures, function
- Neurobiology: mechanisms determine constraints
  - brain size and computing capacity
  - energy limitations
  - structural limitations

Energy and material costs

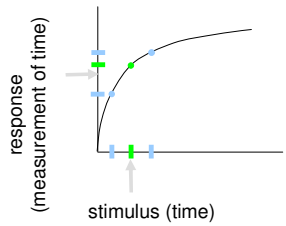
Is behavior limited by computing costs?

- High metabolic cost of neural tissue and of signals themselves (Na^+/K^+ pump)
- Some evidence for circuit design to optimize energy efficiency (Laughlin)
- Flies selected for learning ability have lower competitive ability (Mery & Kawecki)

Optimal foraging

Risk sensitivity or sensory limitation?

- In a choice between a time-variable and time-constant option, animals usually choose the time-variable one
- This can be explained by a sensory limitation: less sensitivity for larger values



Whos: Kacelnik, Bateson

Mechanisms of computing

Specialization as response to neural limitations

(Is a jack-of-all-trades always a master of none?)

- Bernays: dietary specialization makes insects more efficient
- Chittka et al.: flower constancy may make foraging bees more efficient
- Why? - working memory limits & uploading costs
  - absolute limits on memory capacity

Brain size

Does brain size predict behavioral complexity?

(Does relative brain size predict this?)

- Humans: brain is 2% of body mass, 10^{11} neurons, 1.4 kg;
- Bumble bees: 0.4%, 10^6, 1 mg
- Brains can grow by adding neurons or neurons increasing in size or neurons adding more connections

Brain size

Does brain size predict behavioral complexity?

(Does relative brain size predict this?)

- Larger bees have larger brains – mostly for sensory input? (but larger ants don't necessarily)
- In insects, some brain parts increase in volume with experience (probably without neurogenesis), and larger bees may be better learners
- Primates with larger group size have larger neocortices relative to rest of brain

Does brain size predict behavioral complexity?

(Does relative brain size predict this?)

- What is behavioral complexity?