Comparing Animal Nervous Systems

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How do animal nervous systems differ?

• Compare them
• Ask:
  – What does a nervous system need to do?
  – How does a particular animal’s nervous system do this?
Nervous System

- Input
  - Sensory neurons
- Decision-making
  - Interneurons
- Output
  - Motor neurons
What kinds of animals are there?

- Nine “traditional” taxonomic phyla:
  - Porifera - sponges
  - Cnidaria - jellyfish
  - Platyhelminthes - flatworms
  - Nematoda - roundworms
  - Annelida - segmented worms
  - Arthropoda - crustaceans, arachnids, insects
  - Mollusca - squid, etc.
  - Echinodermata - starfish, sea urchins
  - Chordata - includes vertebrates
What to ask about each phylum?

• What kinds of sensory input?
• What kinds of decision making?
• What kinds of response?
What kinds of sensory input?

• Light - photons
• Chemicals - (food/poison/mate) molecules
• Sound/touch - pressure waves
Light:

- Photoreceptors (lightbulb wingding)
- Simple light detectors:
  - eye-cups
  - ocelli
  - omatidia
  - eyes
Chemicals:

- Chemoreceptors
  - Food - (webding banana)
  - Poison - (webding bomb)
  - Mate - (webding heart)
Chemicals:

• Chemoreceptors
  – Simpler animals: localized in several places on animal’s surface
  – More complex animals: concentrated at head
    • (e.g. smell/taste @ nose/mouth)
Sound/touch:

• Pressure waves
  – Air - moving air molecules
  – Water - moving water molecules
  – Touch - physical contact (predator/prey/mate)
Sound/touch

- Mechanoreceptors (hand/speaker wingdings)
- Usually contain cilia that trigger when moved
- Simpler animals:
  - Distributed throughout surface
- More complex animals:
  - Surface (e.g. skin)
  - Localized (e.g. lateral line, ears)
Decision making:

• Choosing an appropriate response:
  – E.g. fight/flight/mating/homeostasis

• Requires interneurons:
  – Direct the sensory input to the output
Interneurons

• Simpler animals - not present
• More complex animals:
  – Central nervous system:
    • Brain - located at the front (head)
    • Spinal cord - runs down the center, branches off where needed
Rapid Response

• Motor neurons:
  – Trigger response - (usu. Movement)
For each animal:

- Identify the sensory neurons:
  - Photoreceptors (lightbulb wingding)
  - Chemoreceptors (banana/bomb/heart wingding)
  - Mechanoreceptors (hand/speaker wingdings)
• Common name: moon jellyfish
• Species: Aurelia
• Phylum: Cnidaria
- Common name: moon jellyfish
- Species: Aurelia
- Phylum: Cnidaria
• Common name: planarian
• Species: dugesia
• Phylum: platyhelminthes
- Common name: planarian
- Species: dugesia
- Phylum: platyhelminthes
• Common name:  C. elegans (a roundworm)
• Species:  C. elegans
• Phylum:  Nematoda
• Common name:  C. elegans (a roundworm)
• Species:  C. elegans
• Phylum:  Nematoda
- **Common name:** Earthworm
- **Species:** Lumbricus
- **Phylum:** Annelida
- Common name: Earthworm
- Species: Lumbricus
- Phylum: Annelida
• Common name: Crayfish
• Species: Procambarus
• Phylum: Arthropoda (crustaceans)
- Common name: Crayfish
- Species: Procambarus
- Phylum: Arthropoda (crustaceans)
- Common name: Garden spider
- Species: Argiope
- Phylum: Arthropoda (arachnida)
- Common name: Garden spider
- Species: Argiope
- Phylum: Arthropoda (arachnida)
• Common name: Garden spider
• Species: Argiope
• Phylum: Arthropoda (arachnida)
• Common name: Garden spider
• Species: Argiope
• Phylum: Arthropoda (arachnida)
- Common name: Garden spider
- Species: Argiope
- Phylum: Arthropoda (arachnida)
• Common name: Garden spider
• Species: Argiope
• Phylum: Arthropoda (arachnida)
• Common name: grasshopper
• Species: romalea
• Phylum: Arthropoda (insects)
• Common name: grasshopper
• Species: romalea
• Phylum: Arthropoda (insects)
- Common name: Squid
- Species: Lolliguncula
- Phylum: Mollusca
• Common name: Squid
• Species: Lolliguncula
• Phylum: Mollusca
• Common name: Starfish
• Species: Asterias
• Phylum: Echinodermata
• Common name: Starfish
• Species: Asterias
• Phylum: Echinodermata

Fig. 6. Nervous system of a starfish: $a$, central nerve ring that surrounds the mouth; $b$, peripheral nerves of the arms. (After Loeb.)
- Common name: Frog
- Species: Rana pipiens
- Phylum: Chordata
• Common name: Frog
• Species: Rana pipiens
• Phylum: Chordata
For further reading:

• Campbell Biology, 6th edition (2002)
  – Ch. 33 Invertebrates (p.646-77)
  – Ch. 34 Vertebrate Evolution and Diversity (p.678-717)
  – Ch. 48 Nervous Systems (p.1038-51)
  – Ch. 49 Sensory and Motor Mechanisms (p.1057-84)