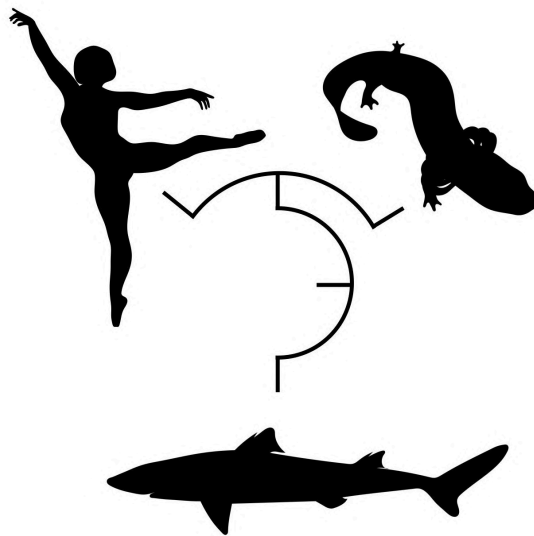


## EDUCATOR GUIDE

# Mapping the functional evolution of cranial nerves

**Text and images by** Aaron M Olsen, PhD



**Time to complete:** 50-70 min

**Age level:** Grades 11-12 or College

**Bloom's levels:** 2 & 5

**Description:** In this module your students will compare and classify the shark cranial nerves and explain the functional evolution of some of the cranial nerves in vertebrates more broadly.

**Materials needed:**

- [SA04 Student Guide & Notebook v1.0](#)
- **OPTIONAL** [Dogfish Shark Skull Kit v1.0](#) **OR** [Dogfish Neuroanatomy Kit v1.0](#)

**Systems:**

- Nervous
- Sensory
- Skeletal

**Core concepts:**

- Development
- Evolution
- Humans are vertebrates
- Structure & function

**Competencies:**

- Data integration
- Depiction of anatomy
- Scientific communication
- Scientific reasoning
- Tree thinking

**Module ID:** [SA04](#)

**Module version:** 1.1

**Module sequence (suggested):**

[SA02](#) → [SA03](#) → [SA01](#) → [SA05](#) → [SA04](#)

# How to use and edit this module

This is an open-source active learning module created by [3D Anatomy Studios](#) and licensed under [CC NC-BY-SA](#) for use with the [Dogfish Shark Skull Kit](#) or [Dogfish Neuroanatomy Kit](#).

## Module Structure

This module has an **Educator Guide**, a **Student Guide**, and a **Student Notebook** and is divided into one or more sections, each with a number, a motivating question as its heading, and a learning objective.

## Educator Guide

The **Educator Guide** is intended for educators and contains a pedagogical schema for the module to help implement the module in a course (e.g., learning objectives, target Bloom's level and competencies, core concepts), an answer key for certain prompts/questions in the **Student Notebook**, and module updates.

## Student Guide

The **Student Guide** is intended for students to read as they complete the module's activities and can be read on a device or printed out.

## Student Notebook

The **Student Notebook** contains worksheets or diagrams on which students can write or draw as a part of the module's activities. The **Student Notebook** can be printed out or filled in using a digital tablet.

## Sharing and Editing

The CC NC-BY-SA license allows you to share and edit this module as long as you (1) do not sell the module or module derivatives ("NC"), (2) attribute the author(s) of all the content, including preserving text and graphic attributions ("BY"), and (3) share the module under the same license ("SA"). You can edit this module by copying the current Google Doc of this module (accessible at [3danatomystudios.com/guides/SA00](https://3danatomystudios.com/guides/SA00)) and editing that copy.

## Purchasing Kits

To purchase kits, please visit [3danatomystudios.com/shop/dogfish-skull-kit](https://3danatomystudios.com/shop/dogfish-skull-kit).

# Pedagogical schema

## Section 1. How are the shark cranial nerves different or similar to one another?

**Learning objective** **Compare and classify (Bloom's Level 2 - Understand)** the shark cranial nerves by creating a Venn diagram if provided with a conceptual diagram of all the cranial nerves and related information (e.g., name, target, sensory/motor).

**Activity** Create a Venn diagram

**Self-assessment** Compare completed diagram with possible diagram in the student guide

**Systems** **Nervous** **Sensory** **Skeletal**

**Core concepts** **Development** **Evolution** **Humans are vertebrates**

**Competencies** **Depiction of anatomy**

## Section 2. What cranial nerves and functions are ancestral versus derived in vertebrates?

**Learning objective** **Explain (Bloom's Level 5 - Evaluate)** some of the apomorphies and synapomorphies in cranial nerve anatomy if presented with an evolutionary tree with a dogfish shark, common mudpuppy, and human

**Activity** Infer the trait changes on an evolutionary tree

**Self-assessment** Compare completed evolutionary tree diagram with one possible correct diagram in the student guide

**Systems** **Nervous**

**Core concepts** **Evolution** **Humans are vertebrates** **Structure & function**

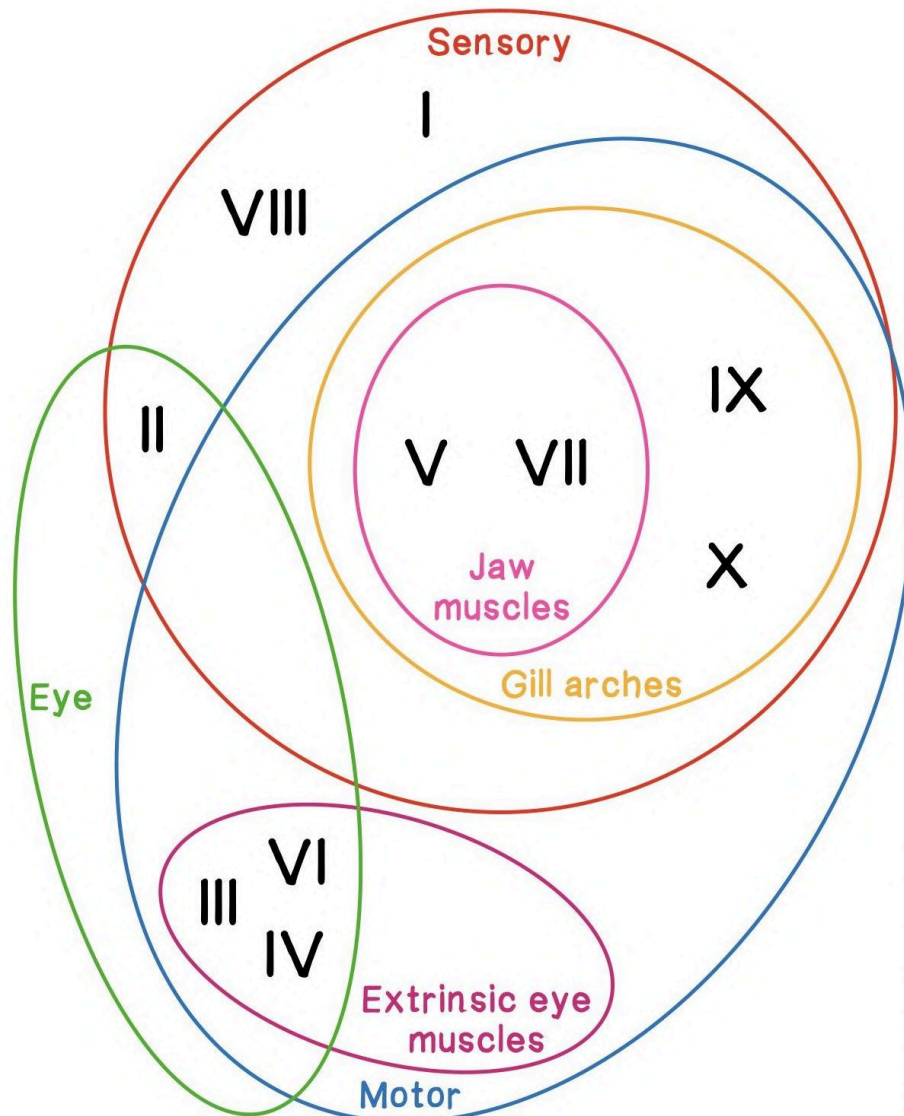
**Competencies** **Data integration** **Scientific communication**

**Scientific reasoning** **Tree thinking**

## Answer key

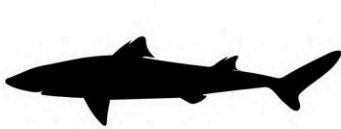
### Section 1. How are the shark cranial nerves different or similar to one another?

Create a Venn diagram of the shark cranial nerves following the instructions in the guide. The image below shows one possible Venn diagram.



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## Section 2. What cranial nerves and functions are ancestral versus derived in vertebrates?



**Dogfish shark**

- ▶ Mechanical and electrical sensation by lateral lines
- ▶ Protrusion of upper and lower jaws by CN V
- ▶ Retraction and elevation of upper and lower jaws by CN VII
- ▶ Vestibular sensation via CN VIII
- ▶ Transports food using suction and fluid transport, no muscular tongue



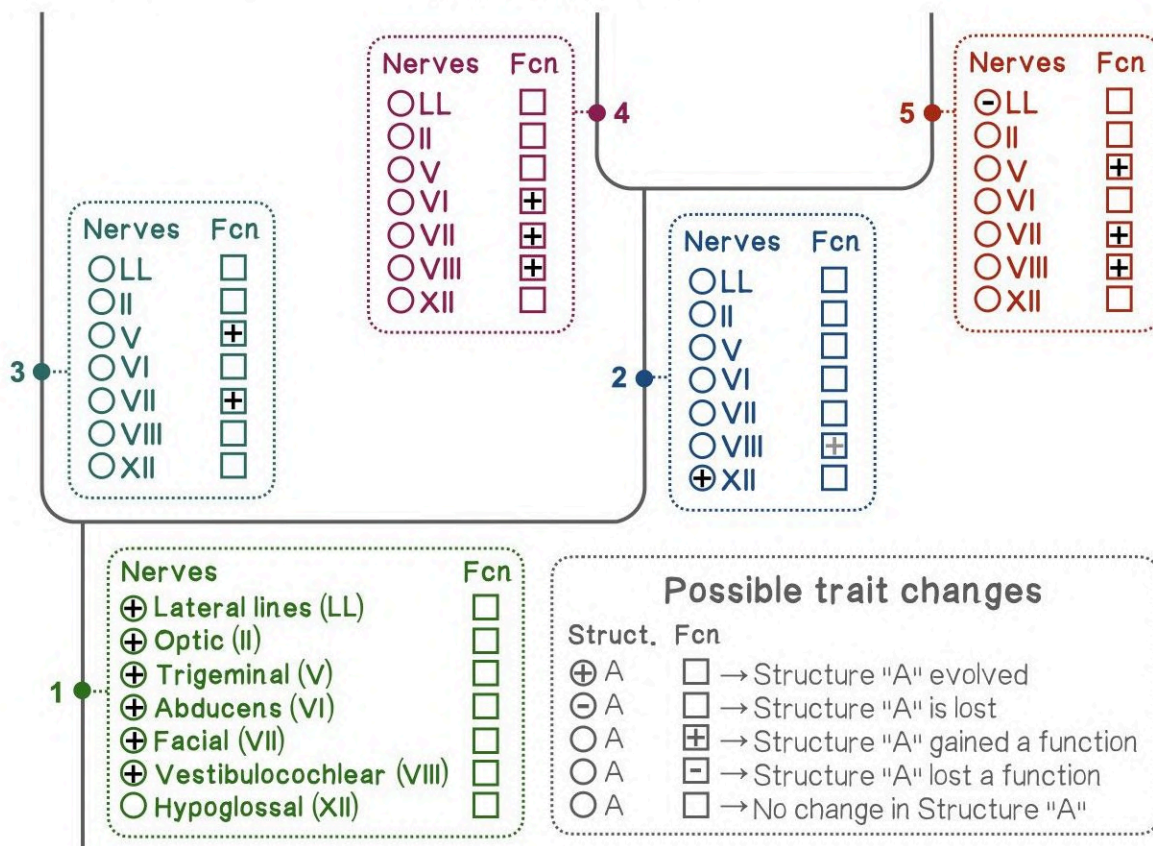
**Common mudpuppy**

- ▶ Mechanical and electrical sensation by lateral lines
- ▶ Depressor mandibulae m. innervated by CN VII
- ▶ Vestibular sensation and some aerial sound detection by CN VIII
- ▶ Retractor bulbi m. innervated by CN VI
- ▶ Partly muscular tongue with motor innervation by hypoglossal spinal nerve



**Human**

- ▶ No lateral lines
- ▶ Facial expression muscles innervated by CN VII
- ▶ Vestibular and cochlear sound sensation by CN VIII
- ▶ Muscular tongue with motor innervation from hypoglossal cranial nerve, taste and sensation from CNs V, VII, and IX



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**If you were to construct a narrative about your completed evolutionary tree on the previous page, what would be the main points around which you would construct that narrative? List at least three brief takeaways as bullet points below.**

- Each taxon/lineage has specializations depending on their particular ecological or behavioral needs
- No one taxon/lineage is necessarily more complex or specialized as a whole than another, each just has a different suite of traits
- If an ancestral trait is already well suited to a new context, it is conserved and there is little evolutionary change (e.g., the optic n.)
- If a cranial nerve is specific to a particular context, it will likely be lost or modified when that context changes through evolution (e.g., the lateral line)
- The transition from an aquatic to a terrestrial ecology was a major driver of evolutionary changes in the cranial nerves of vertebrates and responsible for most of the changes in the tree.

# Updates

## Version 1.1

- Moved completed graphic and open-ended self-assessment from the Student to Educator Guide.