

## EDUCATOR GUIDE

# Building the skeleton of your shark skull

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



**Time to complete:** 40-60 min

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

**Bloom's levels:** 1, 2, 3, 4 & 5

**Description:** In this module, your students will identify the skeletal cartilages that make up the cranium and jaws of the spiny dogfish shark (*Squalus acanthias*) and figure out how they fit together by building a 3D model of the skull.

**Materials needed:**

- [SA01 Student Guide & Notebook](#)
- [Dogfish Shark Skull Kit v1.0 or higher](#)
- “Office scissors” to cut out branchial arches

**Systems:**

- Skeletal

**Core concepts:**

- Structure & function

**Competencies:**

- Observation
- Legacy of racism in anatomy

**Module ID:** [SA01](#)

**Module version:** 1.2

**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](#).

## 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

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## Purchasing Kits

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

# Pedagogical schema

## Section 1. What is the anatomical orientation of the chondrocranium and brain?

**Learning objective** **Identify (Bloom's Level 1 - Remember)** the chondrocranium and brain and **interpret (Bloom's Level 2 - Understand)** their orientation and position relative to one another.

**Activity** Observe models of the shark braincase and brain and fill in blanks on an anatomical conceptual image

**Self-assessment** Compare fill-in-the-blank responses with possible responses in the student guide

**Systems** **Skeletal**

**Core concepts** **Structure & function**

**Competencies** **Observation**

## Section 2. What are the cartilages of the shark splanchnocranium and how do they articulate?

**Learning objective** **Identify (Bloom's Level 1 - Remember)** the cartilages of the shark jaws by **matching (Bloom's Level 1 - Remember)** 3D models to 2D representations, **choose (Bloom's Level 3 - Apply)** their proper orientation by trial and error, and **solve (Bloom's Level 3 - Apply)** how the cartilages of the shark cranium and jaws attach and articulate with one another by **building (Bloom's Level 3 - Apply)** a 3D model.

**Activity** Assemble 3D model of shark jaws made from 3D printed and paper pieces

**Self-assessment** Compare 3D model with images in student guide

**Systems** **Skeletal**

**Core concepts** **Structure & function**

**Competencies** **Legacy of racism in anatomy**

## Section 3. How are sharks able to protrude their jaws?

**Learning objective** **Explain (Bloom's Level 4/5 - Analyze/Evaluate)** how sharks are able to protrude their jaws by observing an articulated and mobile model of a shark skull.

**Activity** Observe model of shark cranial skeleton and write short answers

**Self-assessment** Compare written responses with possible responses in the student guide

**Systems** **Skeletal**

**Core concepts** **Structure & function**

**Competencies** **Observation**

## Answer key

### Section 3. How is it possible for sharks to protrude their jaws away from the rest of their skull during feeding?

#### How is it possible for sharks to protrude their jaws away from the rest of their skull during feeding?

- The upper jaws are only connected to the chondrocranium at one point (on each side) and this articulation is formed by ligaments. This frees the upper and lower jaw to move together as a single unit.
- The mandibular and hyoid arches connect to the chondrocranium at only two points on each side (palatoquadrate and hyomandibula) via ligaments. By only having two articulation points that are both flexible, the jaws can move relative to the chondrocranium.
- The mandibular and hyoid arches are formed by nine separate cartilages, joined together by ligaments. The more separate parts a system has, the more ways in which it can move.

# Updates

## Version 1.1

- Moved self-assessment for open-ended questions from the Student to Educator Guide.

## Version 1.2

- Updated images relating to the stand assembly and stand base to include both the box-integrated stand base (kit versions  $\leq 1.1$ ) and the standalone stand base (kit version 1.2+).