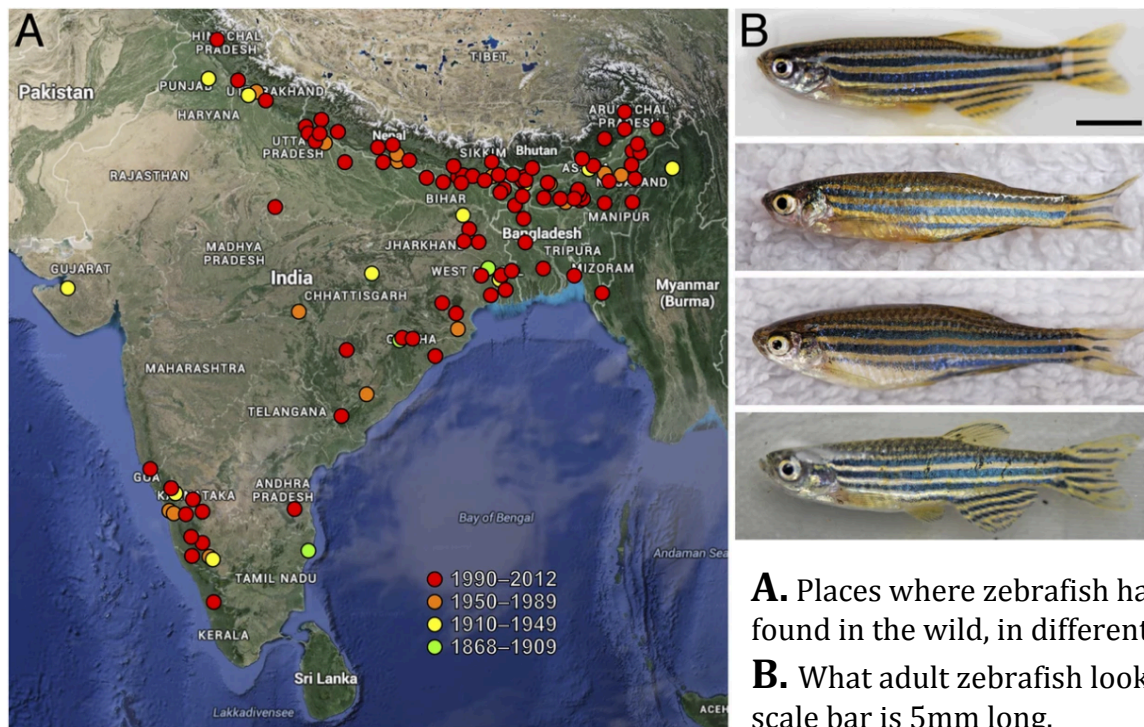


Exploring the cellular make-up of an organism

In this activity, you will explore the anatomy of a zebrafish using an online virtual atlas. This atlas is used by many scientists who use the zebrafish as a genetic model organism to understand how a vertebrate embryo develops into an adult animal.

A zebrafish (the scientific name is *Danio rerio*) is a small freshwater fish from the southeastern region of the Himalayas, including the Ganges river of India.



A. Places where zebrafish have been found in the wild, in different years.

B. What adult zebrafish look like. The scale bar is 5mm long.

For more information about zebrafish and their natural habitat, you can visit <https://www.otago.ac.nz/zebrafish/zebrafish/naturalenvironment.html>

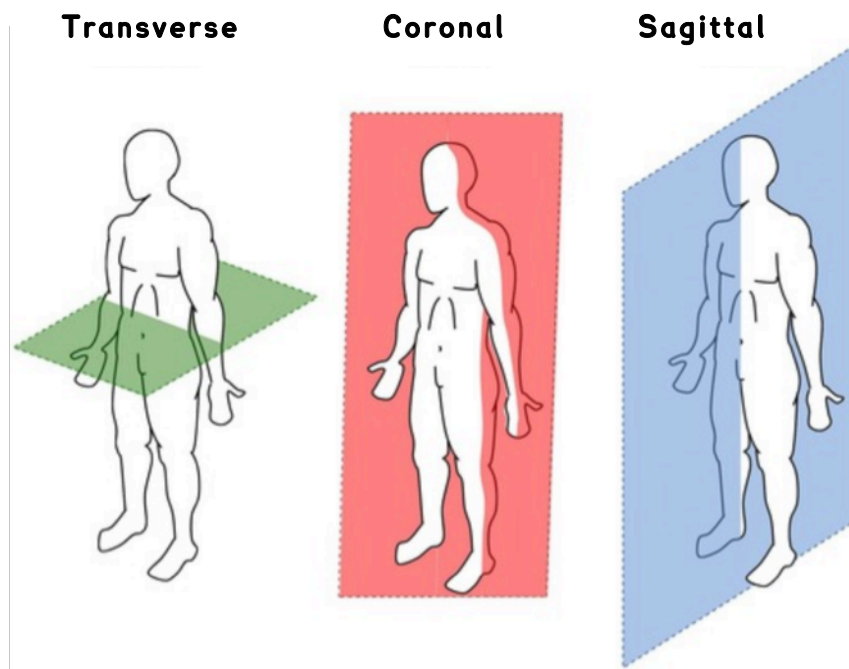
In a laboratory, it is possible to breed many thousand zebrafish in fish tanks. Because scientists can control when the adult males and females are kept together and fertilize the eggs, the development of embryos can be examined based on how many hours or days have passed since fertilization. These times are recorded as hours post-fertilization (hpf), days post-fertilization (dpf) and, for adult fish, months post-fertilization (mpf).

To understand how the tissues and organs in the zebrafish develop, scientists have taken embryos, juvenile and adult fish and put them into a chemical that kills the fish and preserves the cells. The fish is then cut up into very thin slices, about one hundredth of a millimetre thick and those slices (sections) are put onto microscope slides and stained with dyes to make the cells of the organism visible.

When you visit the zebrafish atlas at <http://bio-atlas.psu.edu/zf/progress.php>, you will see the ages of the zebrafish that have been sectioned in the left hand column of the table. You will also see columns with the headings **Coronal**, **Sagittal** and **Transverse**. These words describe the *plane of sectioning*.

Imagine you are filleting a fish (perhaps you have even done this yourself); when you take off a fillet from one side of the fish, that requires cutting on a **sagittal** plane. Or, if you cut across the fish, to separate the head-end from the tail-end, that would be a **transverse** cut. The other plane of section is **coronal**. In this case, imagine you cut the fish so that the dorsal (top) side of the fish is separated from the ventral (bottom) side of the fish.

Anatomists use the same terms to describe the plane of medical images taken of the human body.



Now visit the zebrafish atlas page: <http://bio-atlas.psu.edu/zf/progress.php>

You will see something that looks like this:

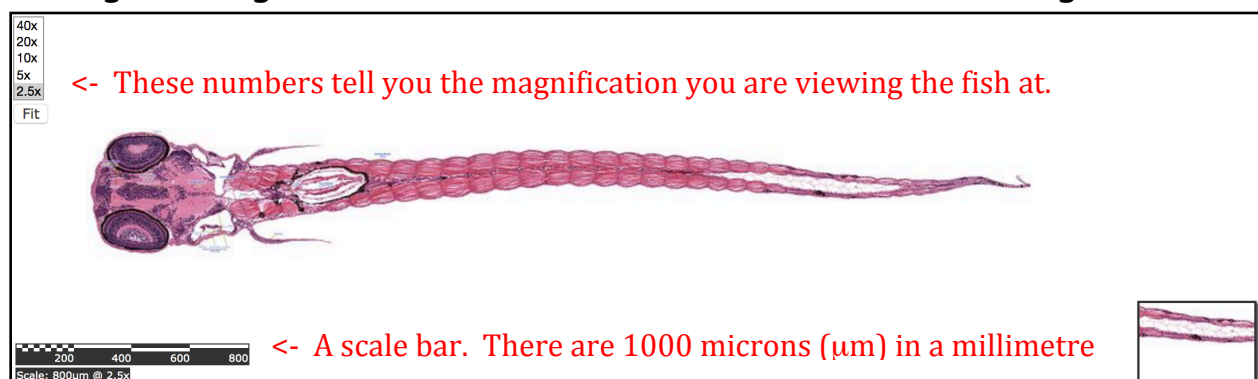
Zebrafish Atlas Slides

There are currently **555** slides in the zebrafish atlas.

Ages	Coronal (dorsal to ventral)	Sagittal (left to right)	Transverse (rostral to caudal)
24hpf (1.9mm)			
30hpf (2.5mm)			
36hpf (2.7mm)			
42hpf (2.9mm)			
48hpf (3.1mm)	1 2 3 4 5	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
60hpf (3.3mm)			
3dpf (3.5mm)	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
4dpf (3.7mm)	1 2 3 4 5 6 7 8 9 10 11 12 13 14	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
5dpf (3.9mm)	1 2 3 4 5 6 7 8 9 10 11 12 13 14	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
6dpf (4.2mm)	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
7-13dpf (4.5mm)	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
14-20dpf (6.2mm)		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	
21-29dpf (7.8mm)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Each of the small blue squares is a link to a section through a zebrafish. The boxes on the pink background are the sections that have been labeled, so that when you click on these, there will be information on the slide about what tissues and organs of the zebrafish you are looking at.

First, let's look at coronal section 6 of the 4-day post-fertilization embryo. Can you find that section? It should look something like this:



You can explore the tissues of the fish by zooming with a higher magnification and dragging the image around to look at different areas. For example, when you zoom in to 40x magnification you will be able to read the labels for the Eye and parts of the brain (the front, middle and back part of the brain are called the telencephalon, diencephalon and mesencephalon!). Can you find the ear and pectoral fin of the fish?

An important thing to notice is that the entire body of the fish - all the different tissues and organs - are made up of cells. Cells have different shapes, sizes and functions in the body. Sometimes they are long and skinny, such as the muscle cells along the body, sometimes they are round and sometimes they are almost rectangular and stacked together, like bricks, to make a layer.

Look carefully at some other 4dpf sections to see how different organs are made up of arrangements of different types of cells. Coronal section 8 and sagittal section 11 have a few other organs labeled. The transverse section 15 includes the fish heart with blood cells (erythrocytes) in it.

Explore other sections to see what organs you can find (remember, on the website table, only sections in the pink rectangles are labeled).

Compare the tissues of zebrafish of different ages. Can you identify some differences between the structure of the eye at 48hpf (coronal section 3), 4dpf (coronal section 8) and 21-29dpf (coronal section 13).

In your workbook, describe your observations on how the fish eye changes as it develops.

Does the eye at different ages have the same number of cell layers?

Did the eye grow - what is your evidence?

If you believe it grew, how do you think that happens?

Do we grow by our cells growing bigger or increasing in number?

Using the scale bar, estimate the diameter of a typical eye cell. How many cells do you think there would be in one cubic millimetre of eye tissue?