Azim Premji University

Teaching iThink Biology in your classroom

A guide to teaching the Waterscapes chapter

iThink Biology is different from the types of science textbooks we are familiar within India. The content, organization and features of the e-book have been developed with different objectives in mind. We hope that the chapter-wise guides prepared by the iThink Biology team will help a teacher make the best use of the resource in their learning spaces. The following text is a guide to teaching the Western Ghats chapter. Please read through the section on *how to read iThink Biology* before using this resource.

Table of contents

Introductory notes

- The book has been written in an informal and conversational style of English and important or difficult concepts have been linked to the glossary or elaborated in detail within the text.
- The book is hosted on a website (ithinkbiology.in), so the reader will require a computer, mobile or tablet to access it. An internet connection will be required to access the different pages of the website, as well as the different interactive features of the book such as weblinks, glossary terms, video interviews, and downloadable research papers.
- Several exercises in the book may require students to step out of their classroom and observe their surroundings, such as a city area, water bodies or a garden. The possibility of such an engagement can be important to meet the learning objectives of the book.

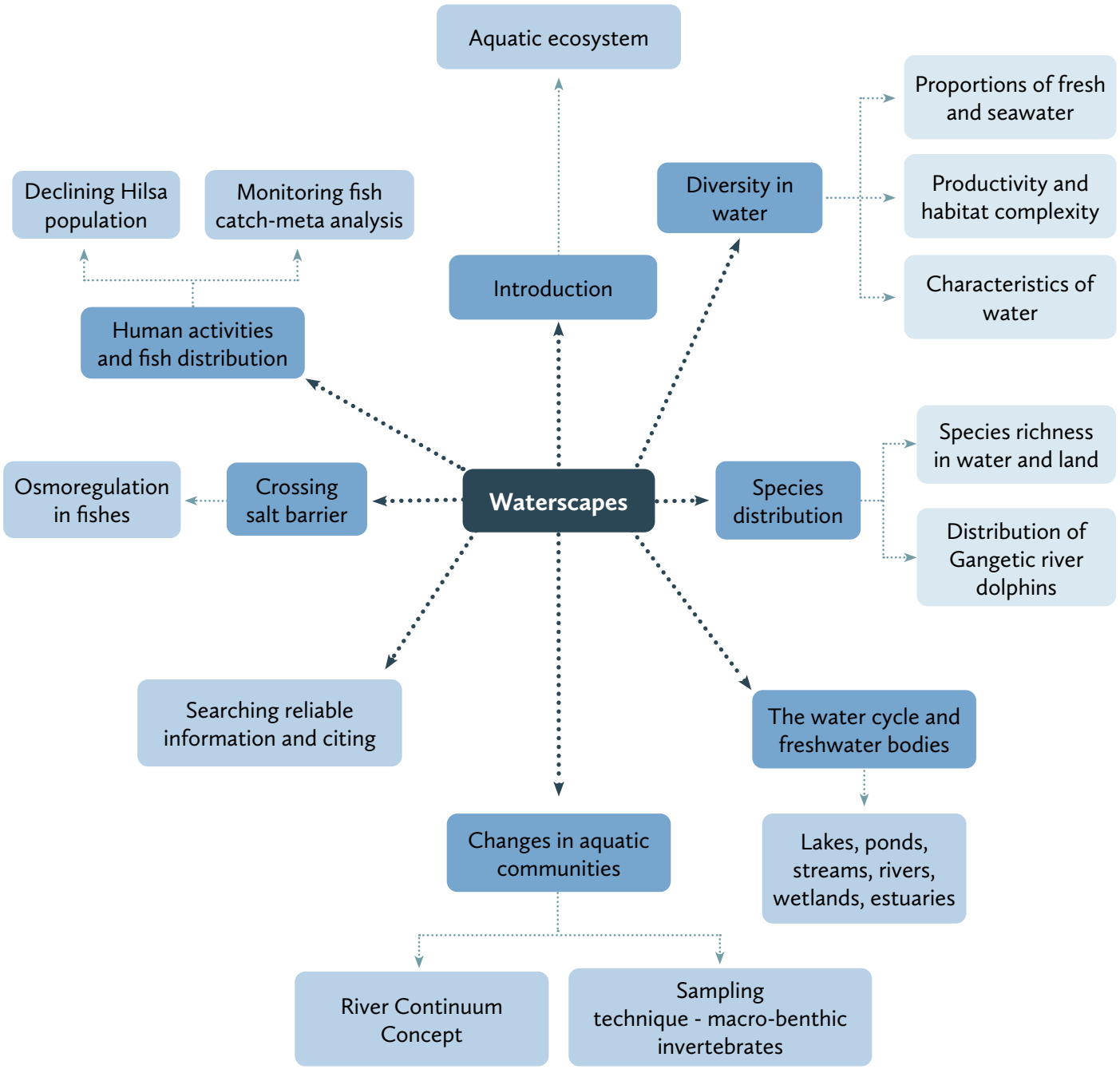
Content Mapping

This table will help you map parts of your syllabus to the content and capacity-building approach in iThink Biology. In the first column, you will find units and topics from your syllabus and the subsequent columns contain the sections, subsections, and concepts from our book iThink Biology. By using this table, you can easily identify the relevant concepts from the book that align with your syllabus.

Existing syllabi	Corresponding Topics in iThink Biology			
Subject, Topic	**Headings/ Sections**	**Subsection**	**Concepts explored**	**Capacities**
Aquatic biology, Introduction	Introduction	Introduction to aquatic ecosystem	Fauna and floral diversity in water	Reading and Interpreting
Research methodology, Data interpretation	Why does land harbour more diversity than water?	Proportions of fresh and seawater	Interpretation of graphs	Scientific process, Quantitative skills
Aquatic biology, Ecology, productivity, measurement of productivity		Productivity	Net primary productivity of oceans	Scientific process
Ecology, niche, biodiversity		Habitat complexity	Niche, biodiversity in oceans	Reading and Interpreting
Aquatic biology, Physical characteristics of water		Characteristics of water	Density and viscosity of water	Reading and Interpreting
Animal diversity, Ecology, species richness	Why do organisms live where they do?	Biodiversity in water and land	Species richness in aquatic and terrestrial ecosystem	Reading and Interpreting
Ecology, species distribution Diversity of Chordates, zoogeography		Reasons for species distribution in the environment	Species distribution, Gangetic River dolphins	Reading and Interpreting
Ecology, hydrological cycle	The water cycle and freshwater bodies	Water cycle	Natural water cycle	Reading and Interpreting
Aquatic biology, aquatic biomes		Freshwater habitats	Lakes, ponds, streams, rivers, wetlands, estuaries	Reading and Interpreting
Aquatic biology, biological communities in water, Physico-chemical environment		River Continuum Concept (RCC)	Changes in river as it moves from the headwaters to the mouth, Limitations to RCC,	Scientific process, Scientific tools
Aquatic biology, freshwater biology	Changes in aquatic communities in a river	Studying changes in biotic and abiotic factors in a stretch of river	Change in Ganga in Himalaya, sampling	Scientific process
Research methodology, data collection and analysis **Animal diversity,** identification key for macroinvertebrates		Sampling aquatic macro-benthic invertebrate communities in a stream	Identification key for macroinvertebrates in rivers, data analysis	Scientific tools

Existing syllabi	Corresponding Topics in iThink Biology			
Subject, Topic	**Headings/ Sections**	**Subsection**	**Concepts explored**	**Capacities**
Aquatic biology, Brackish water (Hilsa), **Ethology**	Has human activity altered fish distribution?	Declining hilsa populations	Dams and barrages, impact of Farakka barrage on fisher community	Bridging science, society and the environment
Aquatic biology, Brackish water (Hilsa), **Research methodology,** data collection and analysis		Monitoring fish catch over decades	Long-term study, meta-analysis, documentation	Reading and Interpreting, Quantitative skills
Aquatic biology, marine ecosystem, **Animal Diversity**, Osmoregulation in fishes	Crossing the salt barrier	Osmoregulation in anadromous fish	Osmosis, osmolarity	Reading and Interpreting, Scientific tools
Research Methodology, Usage of search engine tools for retrieving research/review papers		Locating information	An exercise on searching, filtering, and citing; Advanced search techniques	Reading and Interpreting, Scientific tools

Concepts introduced in the chapter



Capacities developed in this chapter

You will notice that every chapter has a set of questions appearing at the beginning of the chapter. These describe the content (indicated by the questions) related to the capacity (indicated by the icon).

In this guide, we have followed different subsections from the iThink Biology book. We have suggested different activities that are focussed on understanding different concepts given in the book.

Notes for Instructors

In this document, we provide some suggestions for instructors on how to get students to engage with the critical thinking questions that are present throughout the chapter. We have provided the answers, suggested activities and learning objectives for each critical thinking question. It would be ideal to use these questions along with the book chapter but do adopt these questions and activities to related topics in your curriculum. We hope that this document encourages you to create similar critical thinking questions for the concepts in your course syllabus.

In our experience, there is much value in group work conducted between students. If a student can be accompanied by even one other student while attempting some of the exercises, it will make a difference to their learning experience.

If you do conduct these exercises in groups, ensure that the group sizes are not too large (not more than 5 students per group) so that all the students participate in the discussions. Students tend to be curious but having a few pre-prepared questions and hints to promote conversation in groups might be helpful. A wrap-up discussion to combine and connect the individual group learnings is essential to ensure learning objectives are achieved. Do keep some extra time while conducting group work since they tend to run longer than the time estimated.

A2.1 Introduction
A2.2 Why does land harbour more diversity than water?

Note: We have combined the activities for topics A2.1 and A2.2 to provide a cohesive understanding of the related topics.

Bridging science, society and the environment; Scientific tools

Question

Can you identify any plants or animals found in aquatic ecosystems?

Hint

Look in your vicinity for a waterbody and observe flora and fauna associated with it.

Suggested Activity

Suggested time: *2 hours*

Part -1

This activity can be done individually or in groups of 2-3. Teachers can plan a short field trip to any nearby water body (river, lake, pond, etc.).

Students must spend at least an hour near the water resource and observe different plants and organisms. They will document their observations during the trip.

If possible, sketch your observations or click photographs of organisms. Make a list of the organisms you recognise. If you do not recognise an organism, observe it, and make a list of its features and try to search for it online or take help from your teachers.

Note: Diversity can be found surrounding the water bodies, rather than just inside them. You will find many organisms such as birds, butterflies, dragonflies, etc. near the water body.

Teachers may provide the given list of questions to the students that will help them make different observations.

Question	Description
What type of water body did you visit?	
What is the colour of water?	
Does the water look clear or murky or polluted?	
Does the water look greenish? If yes, what could be the reason for that?	
Are there any plants growing inside the water?	
Are there any plants floating on the water?	
What types of plants are present around the water body?	
Can you see any organisms on the surface of the water? If yes, describe what kind of organisms you see.	
Can you see organisms inside the water?	
What types of organisms are present surrounding the water body?	
Compare the diversity of organisms found inside the water and in the surrounding area.	
Other observations	

Take a bucket or tray with you and take the water from the aquatic body in it.
Now make the following observations:

- What is the colour of water now?
- What kind of organisms are there in the water?

Draw images of all the organisms that you observed along with its description.

Name of the Organism	Description	Image

Part -2

- Collect some water from the water body in a vial and bring it to the laboratory.
- Using a dropper, put two drops of water on a slide and put a coverslip on it. Observe the slide under the microscope and note down your observations.
- Take notes and make drawings of the organisms you see under the microscope. Notice if you can distinguish between phytoplankton and zooplankton.
- Collect some tap water also and observe it under a microscope.
- Compare the life you find in the tap water and water from your sampling site.
- Draw images of all the organisms that you observed along with its description.

Name of the Organism	Description	Image	Location (sampling site/ tap water)

Note:

- *Do not unnecessarily handle or kill and collect organisms. As far as possible, record your observations on field by taking photographs of such organisms. The purpose of this activity is to familiarise students with aquatic organisms.*
- *Examine the plants and their leaves nearby carefully, organisms may be hidden underneath them.*
- *Very small organisms may be found in the water body, look closely at the movement of such organisms.*
- *Even if students are not able to recognise every microscopic organism, they could note down the different types of organisms they have observed. This will help them appreciate the diversity of organisms found in a water body.*

What does this question make students do?

Students become familiar with the common organisms found in water bodies. This question will help students to learn observational skills. Students will be able to connect with nature and appreciate the diversity of organisms found in a water body.

Suggestion :

As you walk near the water body and make your observations, you could create a podcast about your experience.

A2.3 Why do organisms live where they do?

Quantitative skills

Question

How to represent a given data set graphically?

Hint

Create pie charts and bar graphs and analyse them.

Suggested Activity

Suggested time: *1 hour*

The following table shows the numbers of species of selected taxa that live in marine, freshwater or terrestrial habitats. Use this data to create graphs, and interpret them to answer the following questions:

Taxon	Marine	Freshwater	Terrestrial
Molluscs (gastropods, bivalves, copepods)	61800	6400	30000
Arthropods (insects, arachnids)	3400	105000	10000000
Arthropods (crustaceans)	65000	12000	5000
Chordates (fishes)	15000	15000	0
Chordates (mammals, tunicates and other vertebrates)	3625	7100	25000
Fungi	1000	1000	1000000
Photosynthetic organisms (plants and algae)	10100	2600	280000

Source: ithinkbiology.in (Note: In the above table, greater than and less than symbols have been removed to create graphs).

Using the above data, create the following graphs:

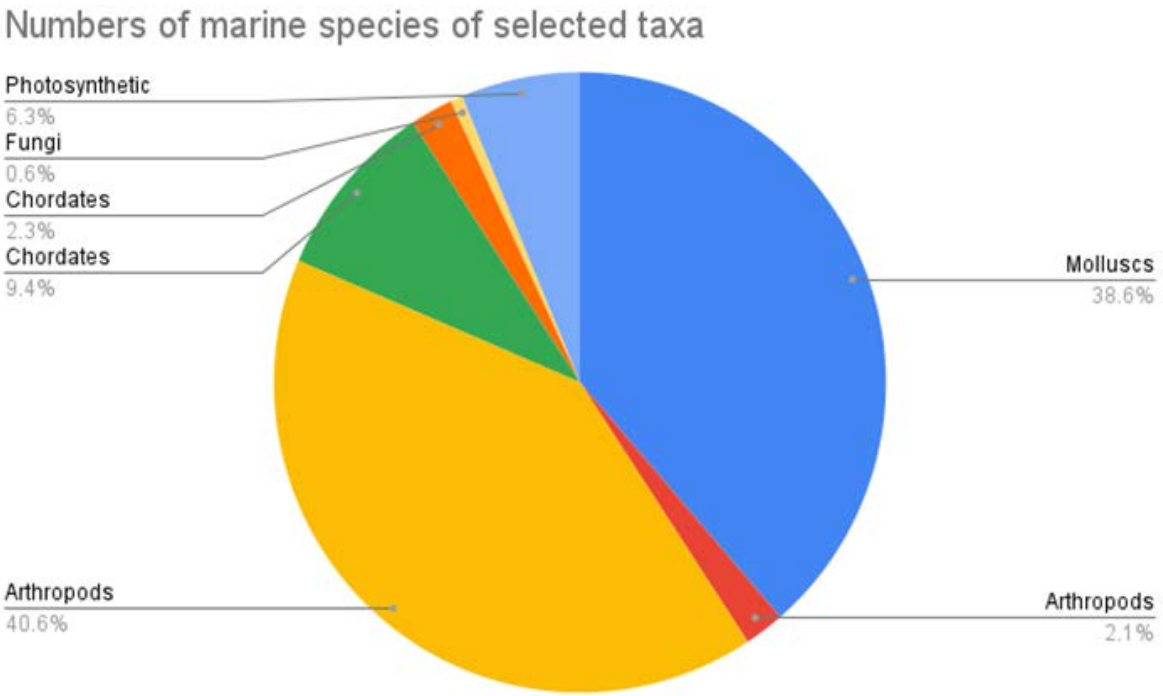
a. Create a pie chart for marine organisms for the given taxa.
b. Create a bar graph for marine organisms for the given taxa.
c. Create a pie chart for freshwater organisms for the given taxa.
d. Create a bar graph for freshwater organisms for the given taxa.
e. Create a pie chart for terrestrial organisms for the given taxa.

f. Create a bar graph for terrestrial organisms for the given taxa.
g. Create a stacked bar graph for different taxa found in different habitats.

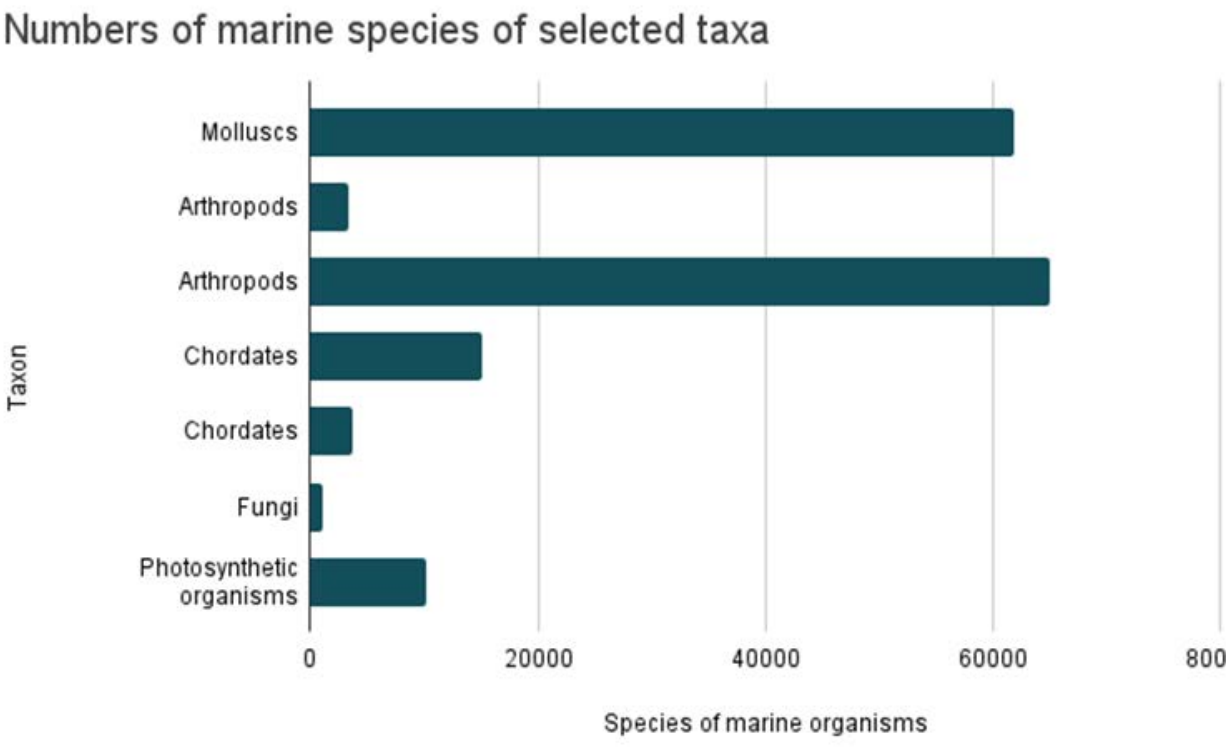
Note: To create pie charts, use percentages.

We have provided some graphs for your reference.

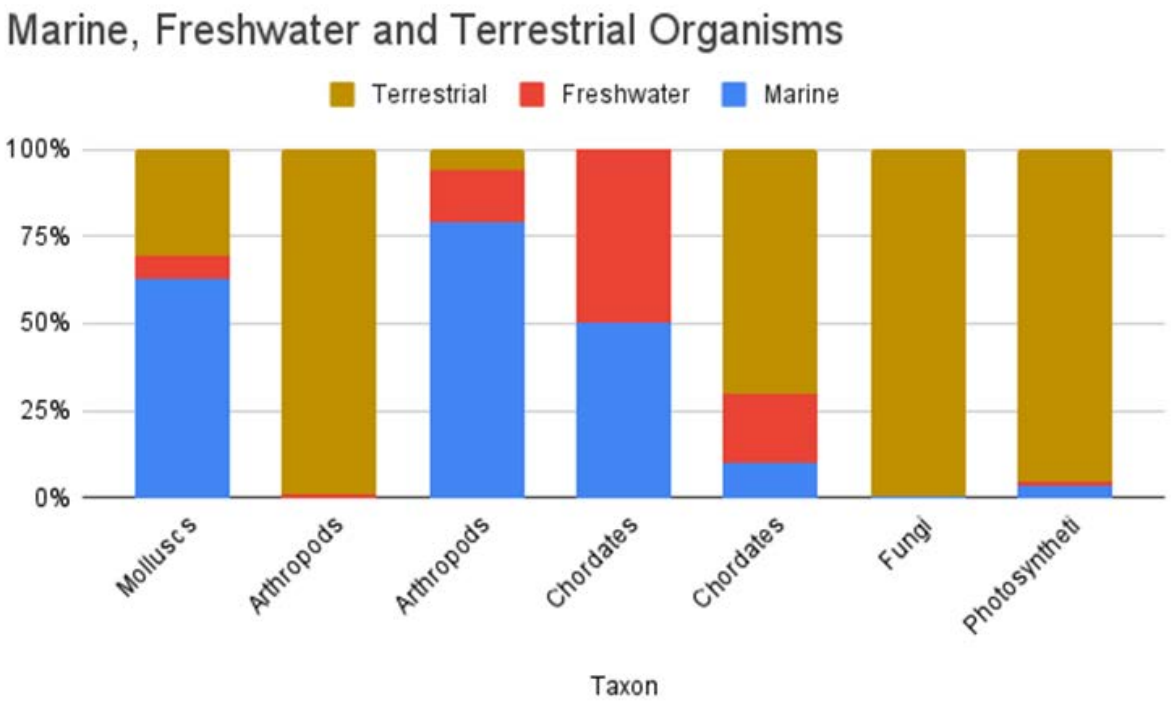
a. Pie chart for marine organisms for the given taxa.



b. Bar graph for marine organisms for the given taxa.



c. Stacked bar graph for different taxa found in different habitats



Answer the following questions:

- Which is a better representation of data for marine organisms - a pie chart or a bar graph?
- Which is a better representation of data for freshwater organisms - a pie chart or a bar graph?
- Which is a better representation of data for terrestrial organisms - a pie chart or a bar graph?
- Look at three bar graphs/ pie charts closely for organisms found in different habitats. Are you able to make a comparison by looking at individual graphs?
- Study the stacked bar graph you created for organisms of three different habitats. Is it easy to compare data for different species?

What does this question make students do?

This exercise aims to introduce students to data visualisation. They will learn to represent data in different ways and to choose the best-suited representation as per the data.

Scientific process, Scientific tools

Question

What type of diversity is found in different sources of water?

Hint

Study different types of water resources for water quality.

Suggested Activity

Suggested time: *1 hour*

This activity can be performed in a laboratory setting in groups of 3-5.

Ask students to collect water samples from different locations, such as

- Local water bodies nearby,
- Puddles,
- Sewage water,
- Tap water,
- Drinking water.

Observe each water sample under a microscope and examine the microscopic diversity. Additionally, notice the macroscopic diversity in the water samples collected outdoors.

Test different water samples for pH, biological oxygen demand (BOD) and chemical oxygen demand (COD).

To determine the pH of different water samples, follow the protocol given here:

https://vlab.amrita.edu/index.php?sub=3&brch=272&sim=1414&cnt=2

To determine the BOD of different water samples, follow the protocol given here:

https://vlab.amrita.edu/index.php?sub=3&brch=272&sim=1430&cnt=2

To determine the pH of different water samples, follow the protocol given here:

https://vlab.amrita.edu/index.php?sub=3&brch=272&sim=1413&cnt=2

If time is a constraint, then different groups can perform experiments to measure different parameters and compile the results at the end. Analyse the results and find out which of the collected samples is most polluted.

Compare the diversity of different water samples with their pollution levels.

What does this question make students do?

This question will encourage students to learn laboratory techniques. They will understand the relationship between polluted water and the diversity of organisms found in it.

A2.4 The water cycle and freshwater bodies

Reading and interpreting

Question

What is a hydrological cycle and how is it affected by climate change?

Hint

Think of different processes: evaporation, transpiration, precipitation, and condensation.

Suggested Activity

Suggested time: *1-hour*

Video: *https://youtu.be/jFjI6y46QRk*

Teachers can use this video to instil a basic understanding of the hydrological cycle in students.
After watching the video, ask students to draw their version of the water cycle.

Discuss the following questions with the students:

a. **What are the three major processes involved in the water cycle?**

Hint:

Major processes involved in the water cycle are:

- *Evaporation*- it is the process of change of a liquid into a gas. In the water cycle, the liquid water present in water bodies evaporates into water vapour. This process is driven by the sun and is also influenced by wind, temperature, and the density of the water body.
- *Condensation*- it is the process by which vapour changes to a liquid. In the water cycle, water vapours present in the atmosphere cool down and become liquid.
- *Precipitation*- it is any liquid or solid water that condenses in the atmosphere and falls back onto earth. For example, rain, hail, and snow.
- Other processes involved in the water cycle include transpiration, runoff, snowmelt, and evapotranspiration.

b. **How is water moved and stored in the lithosphere, atmosphere, and hydrosphere?**

Hint:

Watch the video and write down the answer in your own words.

c. How are humans a part of the water cycle?

Hint:

Humans use water bodies for domestic, agricultural, and industrial purposes. They manipulate the water flow by building dams for hydroelectric power and other activities.

Suggested video: *https://www.youtube.com/watch?v=-2-9U1UEnRU*

d. How human activities have affected the water cycle?

Hint:

Human activities affect the water cycle in numerous ways. For example, deforestation leads to reduced transpiration, which in turn leads to less precipitation. Deforestation also contributes to increased soil erosion on the banks of streams and rivers. Burning of fossil fuels causes increased temperatures which further accelerate the melting of glaciers and polar ice caps leading to flooding in some places. In agricultural lands, irrigation washes off fertilisers and pesticides into water bodies, thus affecting the water cycle.

e. With the increasing global warming, what will happen to the water cycle if the rate of evaporation increases?

Hint:

Evaporation is one of the major processes driving the water cycle. An increase in global warming speeds up evaporation. This will have erratic effects causing heavy rains in some parts of the world and extreme droughts in other parts.

What does this question make students do?

This question will provide students with the knowledge of water cycle. They will understand how human activities affect the water cycle.

Suggested video:

Watch this wonderful educational and engaging documentary on freshwater by Sir David Attenborough. Learn about the organism's dependent on freshwater bodies and their interactions. You will understand how freshwater ecosystems are changing due to human activities and their impact on organisms.

https://www.youtube.com/watch?v=R2DU85qLfJQ

A2.5 Changes in aquatic communities in a river

Bridging science, society and the environment

Question

How much do you know about aquatic organisms e.g., fishes?

Hint

Record your prior knowledge about fish before attempting this activity.

Suggested Activity

Suggested time: *2 hours*

Take students to visit a nearby fish market to learn more about different types of seafood.

Look at different fishes and try to recognise them. If you do not know the name of a fish, ask the vendor.

Ask the following questions to the vendor/ fisher:

Note: You can add more questions to this list.

Interview Questions	Responses
Which fish is most commonly eaten and why?	
Which fishes are seasonal, and which are found year around?	
What strategies do fishers use to catch fish?	
How many fishes does the vendor/ fisherperson know?	
Do they catch fish at a particular time of the day? Why?	
What changes have they observed in fish distribution over time?	
Are there any fishes that they find and choose not to sell?	
What other organisms do they commonly see while catching fish?	
What other seafood is there apart from fish?	

Furthermore, try to learn about different fishes from the vendor.

- Learn the names of different fishes and their identifying features.
- Learn about the habitat of the fish. Are they freshwater or seawater fish?
- Are they caught from natural resources or fish farms?

Draw the images of fishes that you found in the fish market.

Name of the fish	Distinguishing features	Habitat of the fish	Image

What does this question make students do?

This question will help students to learn about different types of fish and other seaweeds. They will learn more about fishing and changes in aquatic communities due to the overexploitation of fish.

Suggested reading:

Read this article to learn about different types of fishes:
https://www.currentconservation.org/fish-face/

A2.6 Has human activity altered fish distribution?

Bridging science, society and the environment

Question

How have rivers and fish changed over the course of time?

Hint

To understand the changes in aquatic communities, talk to people who have been dependent on rivers and have seen the changes in their lifetime.

Suggested Activity

To learn about how aquatic ecosystems have changed over time, make a short documentary/video using your phone or camera.

To make a documentary, take people belonging to three different age groups:

- Your grandparents,
- Your parents,
- Your peers.

Talk to them and learn how their lives have been dependent on water from rivers or lakes or any other water body.

Some suggested questions that you can ask are:

- How is your life dependent on a water body?
- What are the different ways in which people use this habitat?
- What flora and fauna have you observed?
- How has the water body changed over the course of your lifetime?
- How has the habitat surrounding the river changed?
- How have flora and fauna changed around the water body?

Document their experiences and create a short video.

Note:

- *If making a video is not possible, write a report about your experience.*
- *There is a possibility that people you interview might not have a connection with rivers or lakes nearby. Don't be discouraged, look from other perspectives, and understand how urbanisation has changed the way people live.*

What does this question make students do?

This question will help students to bridge the gap between science and art. Students will learn how humans have been dependent on a water source and how that water body has changed over time due to urbanisation and industrialization.

A2.7 Crossing the salt barrier

Reading and interpreting

Question

What are the different adaptations in plants and animals to survive in water?

Hint

Think about how plants and animals found in aquatic environments are different from organisms found in terrestrial environments.

Suggested Activity

***Suggested time**: 1 hour*

Different organisms require different environmental conditions for their growth and development. Various adaptations improve the ability of an organism to survive and reproduce in a particular environment.

For this activity, teachers can provide a list of aquatic plants and animals to the students. Students can work in a group of 2-3 and each group will be given one plant and one animal to find the adaptations to live in an aquatic environment.

Name of the plant	Adaptations
Wolffia (Duckweed)	
Pistia spp.	
Water *lilies*	
Vallisneria	
Bladderwort	

Name of the plant	Adaptations
Fishes	
Dolphins	
Crabs	
Manatees	
Octopuses	

Once the students fill in their responses, discuss the following questions in the class:

- Do all plants have similar adaptations?
- What are the similarities and differences between the adaptations of different aquatic plants?
- What common adaptations do the aquatic animals share?
- Do all animals have streamlined bodies and gills to survive underwater?

- How do different adaptations help different organisms survive in the water?
- What are the similarities and differences between aquatic and terrestrial organisms?

What does this question make students do?

Students will learn about different types of adaptations found in aquatic organisms. They will understand that different aquatic organisms may have different types of adaptations to survive.

Suggested video:

Given the changing climate and water scarcity around the globe, we often wonder what if all the seawater could be converted to freshwater, that would solve the problems of humans. Watch this 5-minute video to understand the repercussions of this idea:

https://www.youtube.com/watch?v=LEo81a2w07Q

Reading and interpreting, Scientific tools

Question

How to search research papers on Google Scholar?

Hint

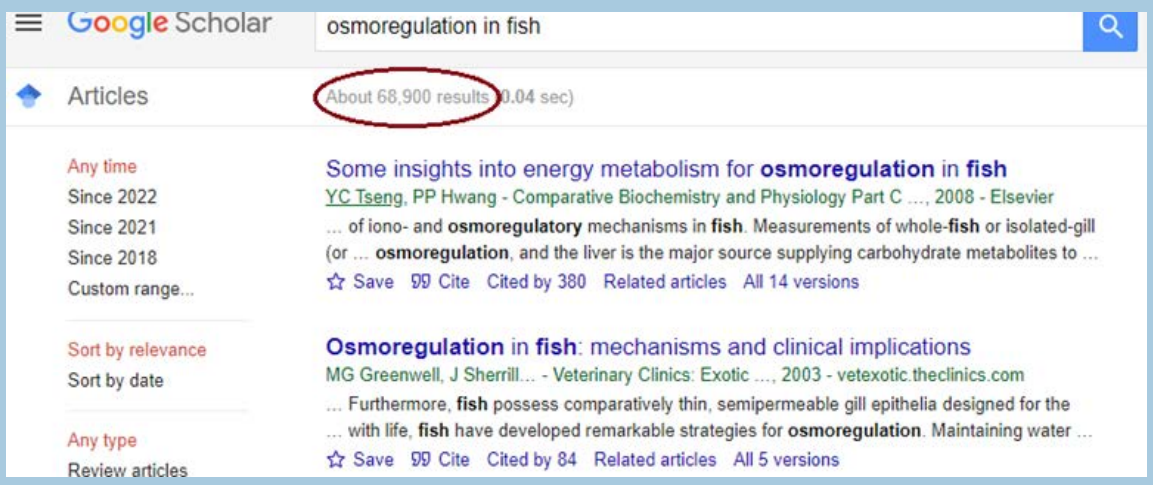
Think about different websites that you use to search for information. Are those sources reliable?

Suggested Activity

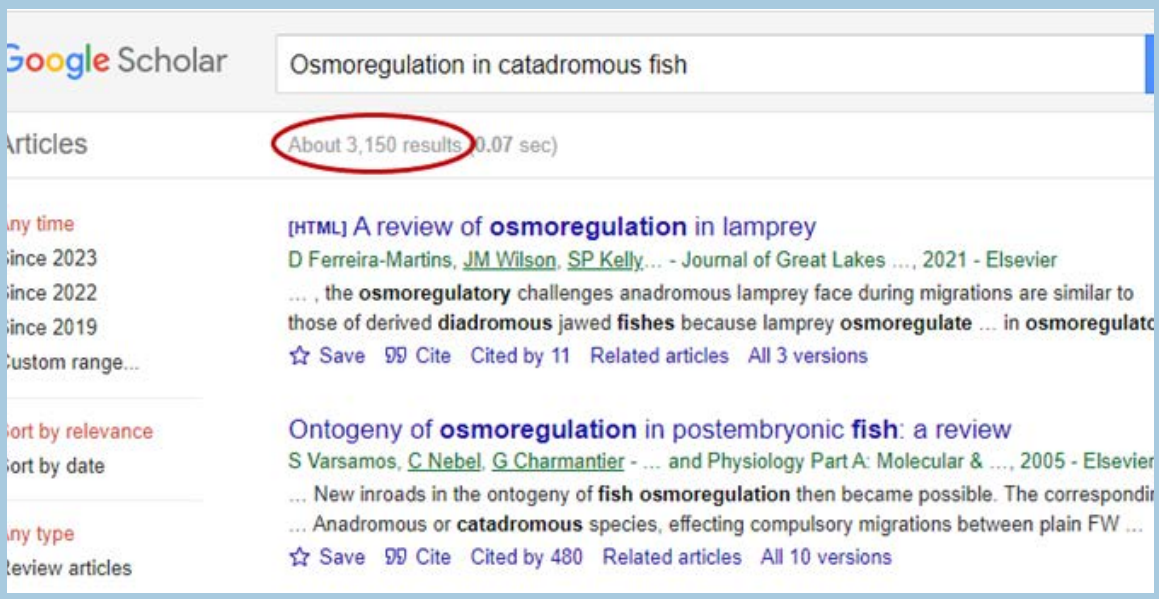
Teachers can teach students how to search for research papers on Google Scholar step by step.

a. Open Google Scholar.

b. For this activity, we are taking the example of 'Osmoregulation in fishes.' Type it in the search box of google scholar. Notice how many results it shows.



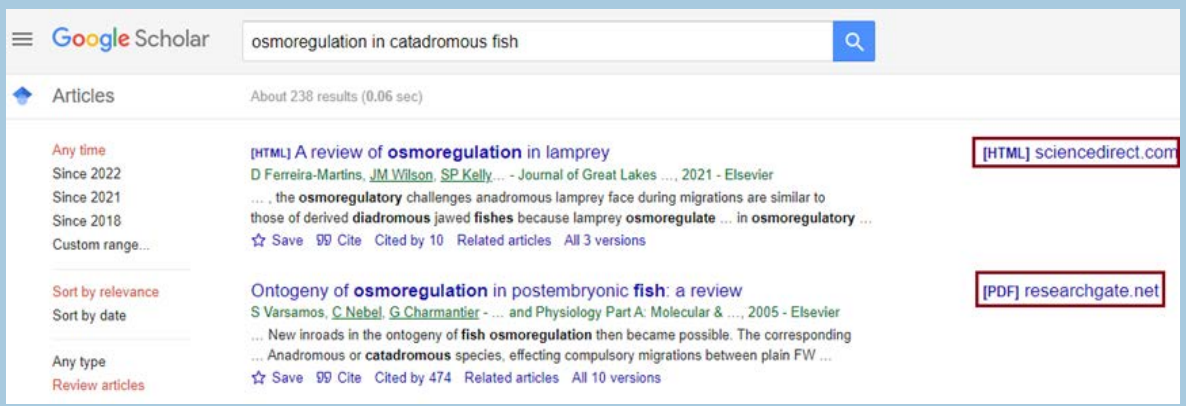
c. Try typing 'Osmoregulation in catadromous fish'. Notice how many results it shows.



Note: With more specific keywords, the results will be less generic.

d. Notice on the left side of the above image,
   - 'Any time' is written, which allows to sort results for a particular year. For example, if you need articles from the year 2021, you can click on 'Since 2021.' You can also use a 'custom range' if you need articles from particular years.
   - Papers can be sorted either by date or relevance.
   - If you do not want research articles and only need review articles, then click on 'Review articles.'

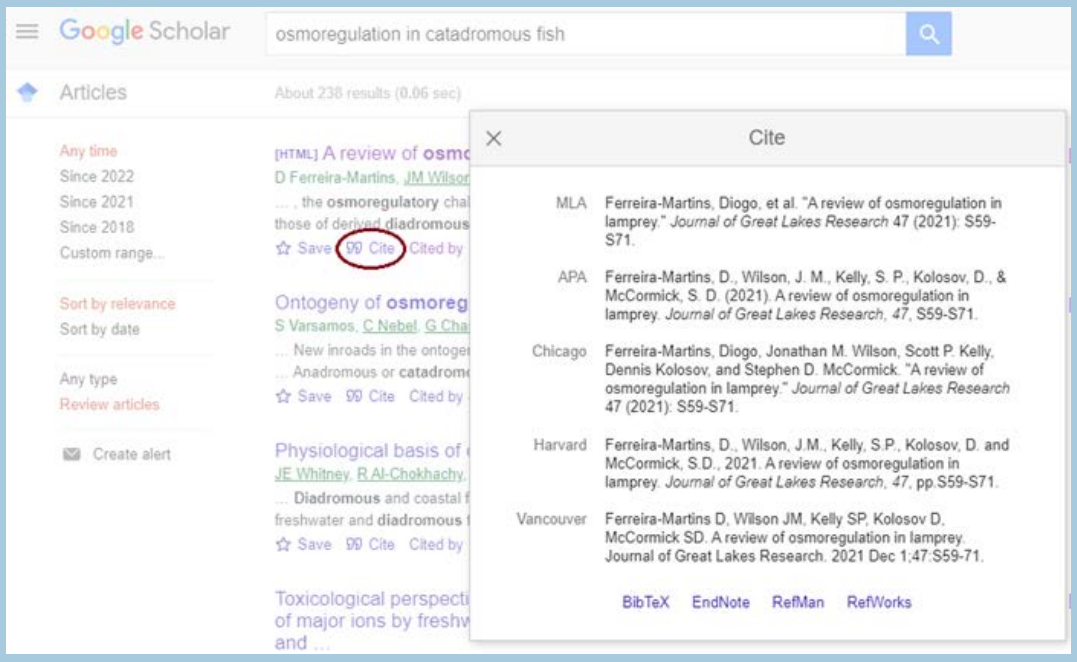
e. Look on the right side of each article, if a link to a PDF is given, then the article is freely available.



f. Below each article, notice it is mentioned as 'cited by.' This will tell you how many researchers have cited the article. Once you click on the 'cited by' it will open all the articles that have cited the main article you were looking at. This is important as these articles could be similar to the articles you are searching for. Thus, if you found a research article that you want to read, look for articles that have cited it.

g. Clicking on 'related articles' will produce all the articles that are related to the original article irrespective of its citation.

h. Notice the 'cite' below an article, click on this to find different styles of citing articles.



i. Clicking on a particular article will take you to its journal where the paper is published. You will find the names of all the authors with their affiliations. You will also find the e-mail address for the corresponding author.

Use the above steps to find papers by yourselves. Learn more information about searching on Google Scholar by clicking on the link. You will find the information under the subheading 'Locating information.'

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