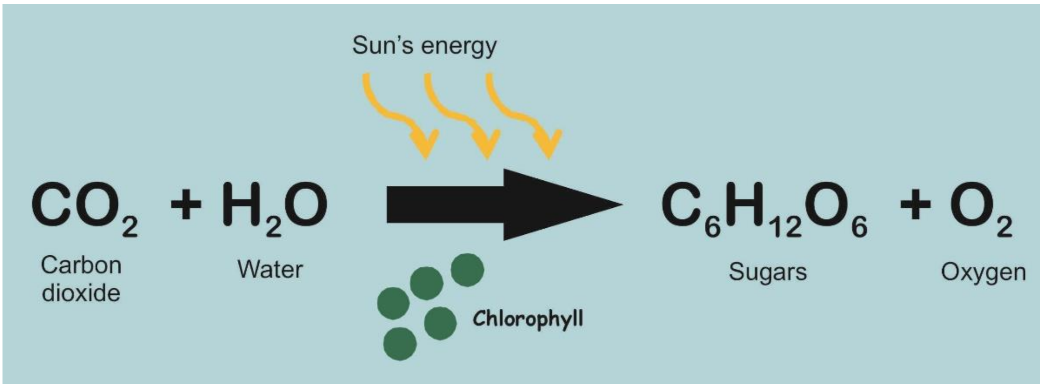
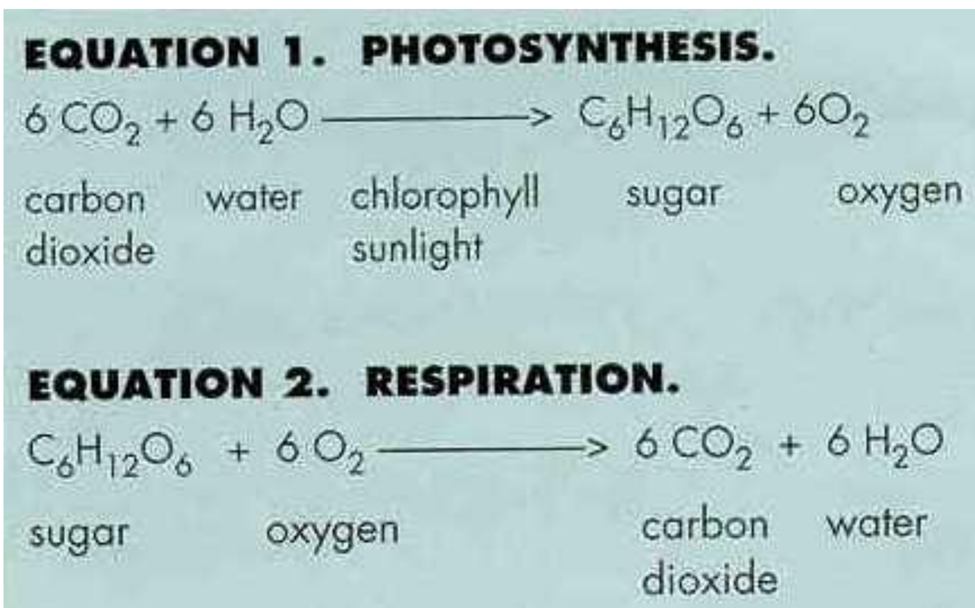
In addition to the animals there are many plant like organisms in the water. Most are photosynthetic storing energy by converting CO_2 and H_2O in the presence of sunlight into sugar and oxygen

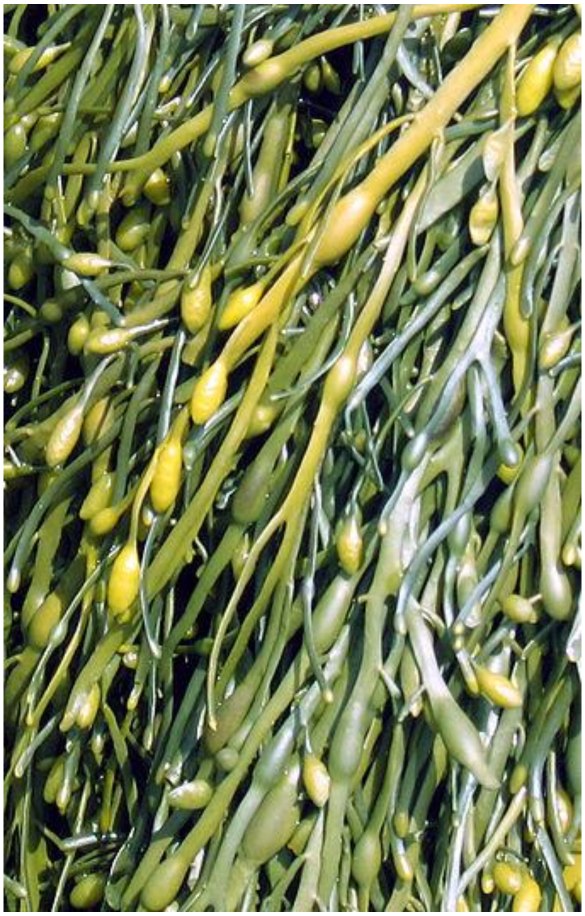


These organism also respire and take in oxygen and produce carbon dioxide.



More oxygen is generally produced than carbon dioxide.

Most of the organisms in the ocean that do this are microscopic protists. Algae, which are photosynthetic organisms may be multicellular, like sea weeds,



and some like kelp may grow a hundred or more feet in length!

They lack true roots, although kelp have “hold fasts” which look like roots, but are not involved in transportation of food and water, but rather are used to attach the organism to a substrate or base.

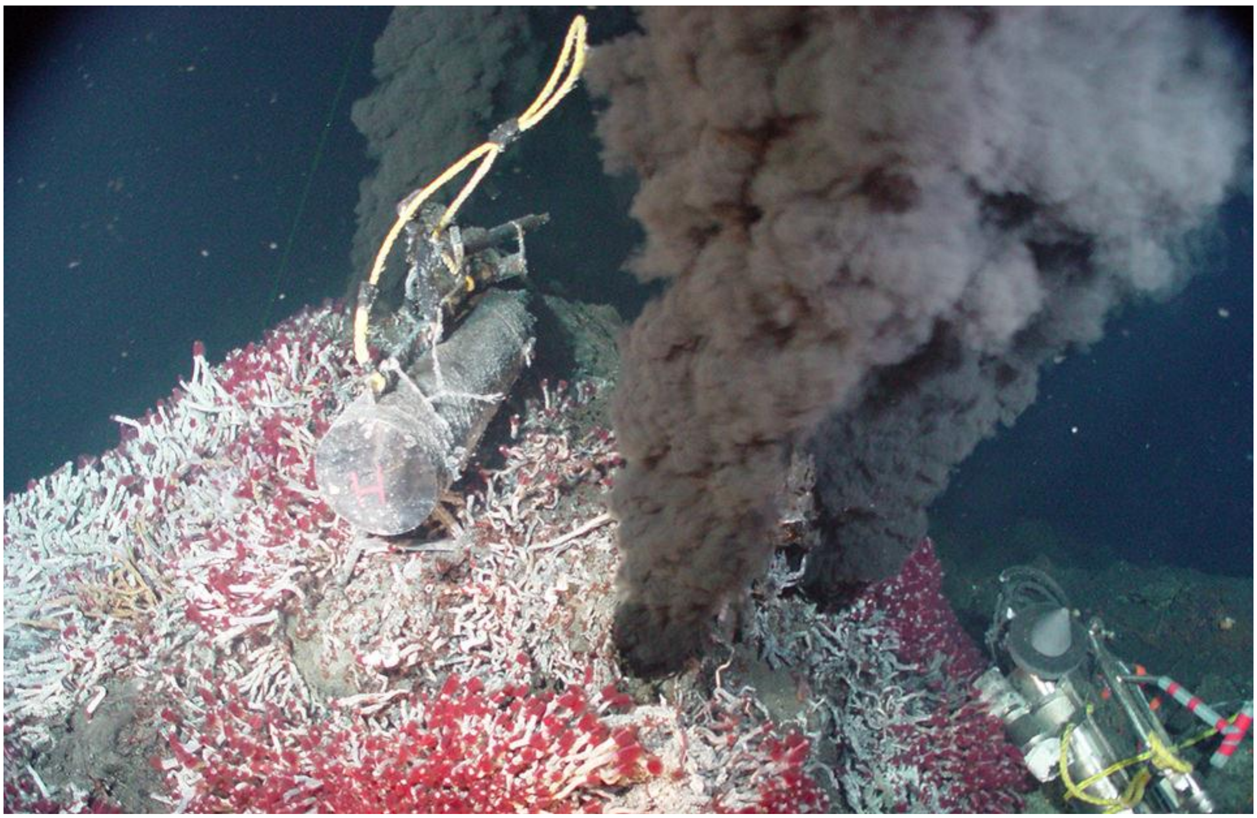
Some organisms live deep in the ocean where light does not penetrate and photosynthesis is not possible. Some organisms are able to produce a carbohydrate through a process called chemosynthesis. In this process one of more carbon sontaining molecules (carbon dioxide or methane)

The organisms that do this are largely bacteria and archaea.

Here 12 molecules of hydrogen sulfide and 6 molecules of carbon dioxide are converted into a carbohydrate along with 6 molecules of water and 12 sulfur atoms.

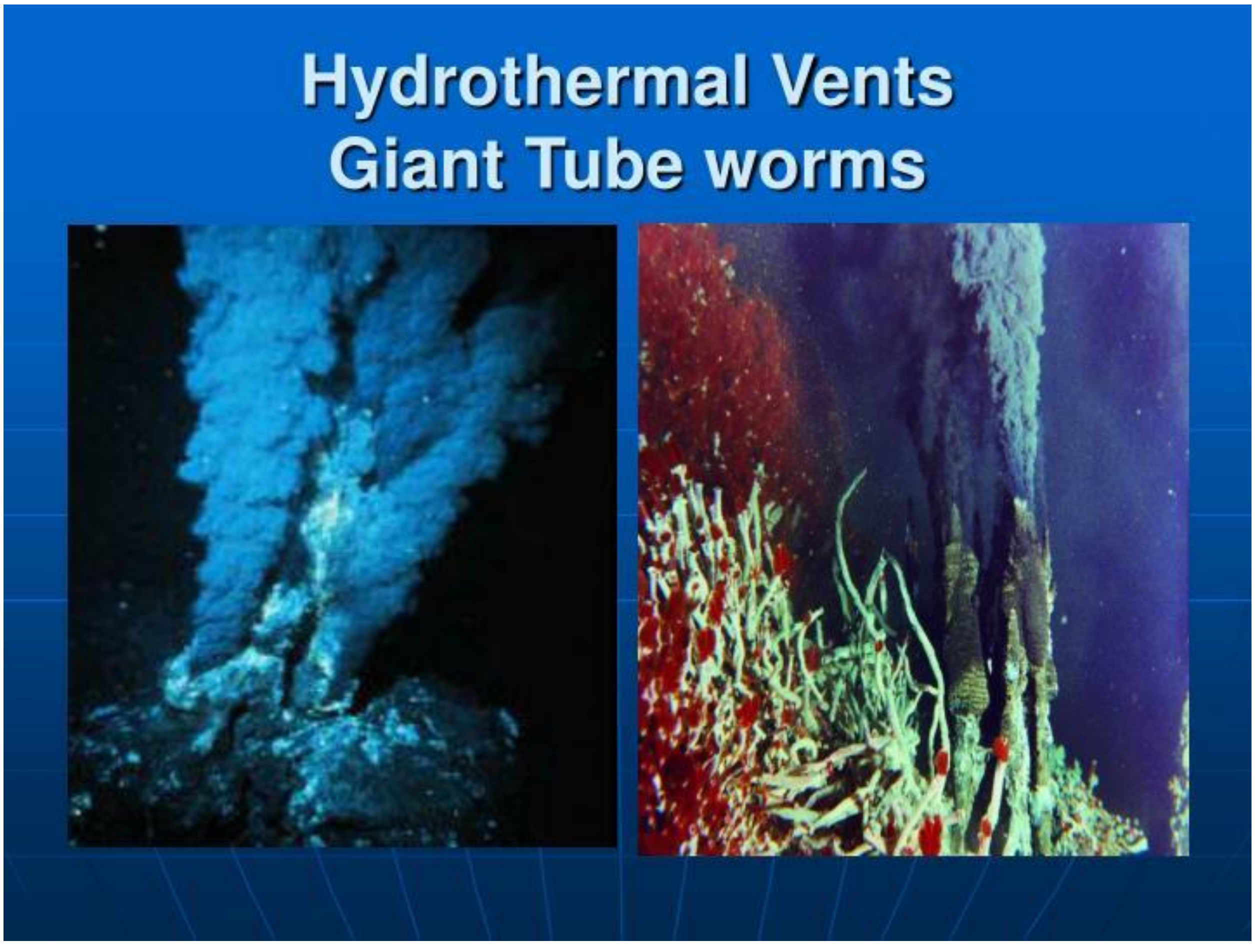
$12H_2S + 6CO_2 \rightarrow C_6H_{12}O_6$ (=carbohydrate) $+ 6H_2O + 12S$

In the depths of the ocean there are “hydrothermal vents” . These are places where geothermally heated water occurs – that is the water is heated by volcanic action. These areas are also known as “black smokers”. An incredible amount of life forms exist in this very heated area which lacks sunlight and often oxygen.



The life forms (along with the photosynthetic forms) are the base of the food chain. All energy needs to be converted into a form that can be used by life forms. The bottom of the food chain consists of those organisms that can manufacture their own “food” from either sunlight by photosynthesis or by some chemical reaction (chemosynthesis). These organisms are called “primary producers” upon which all other life forms are dependent.

In many instances some symbiotic relationships have formed. The giant tube worm (Riftia pachyptila), for example grows as large as 8 feet. They lack a mouth and digestive tract. Within the giant tube worm live bacteria that “make” their food for them by converting chemicals from the hydrothermal vents into organic molecules. The bacteria are given a “safe” place to live within the worm, and get oxygen, carbon dioxide and hydrogen sulphide from the worms “tentacles”.



The food chain starts with those organisms which do not eat, but can manufacture their own food. They are called “Primary Producers” and are at the lowest level of the food chain. Being autotrophs they need only energy and certain minerals to be able to survive. The energy may be light (photosynthesis) or some other source (chemosyntesis). These range in size from one celled organisms to huge plants like Sequoyah trees.

Algae: a group of photo-synthetic organisms that range from unicellular to multicellular

Kelp (a kind of large algae). It is not a true plant. It lacks a true root system

Primary producers are at the bottom of the food chain, but without them, all forms of life above them would cease to exists. The various levels of the food chain are known as “trophic levels”

Heterotrophs

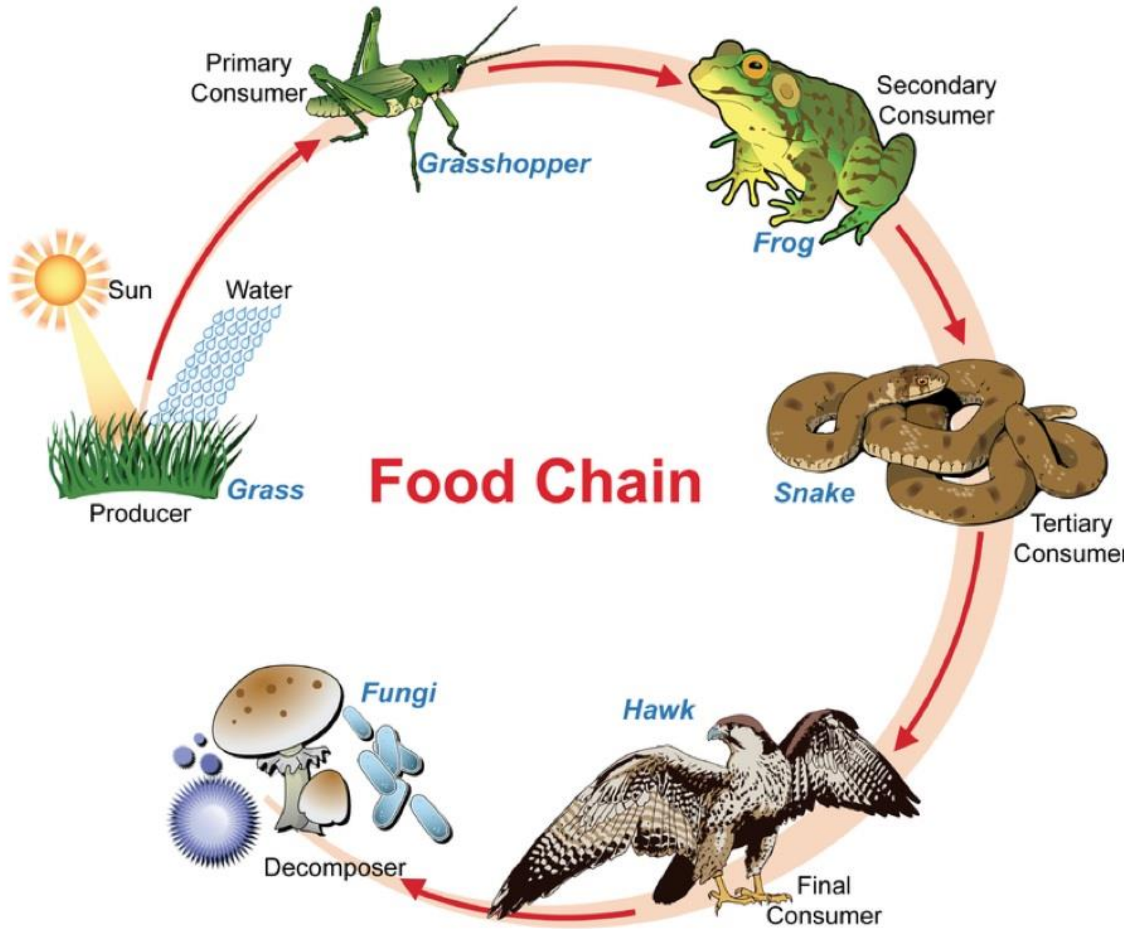
Apex predators (eat level I predators)

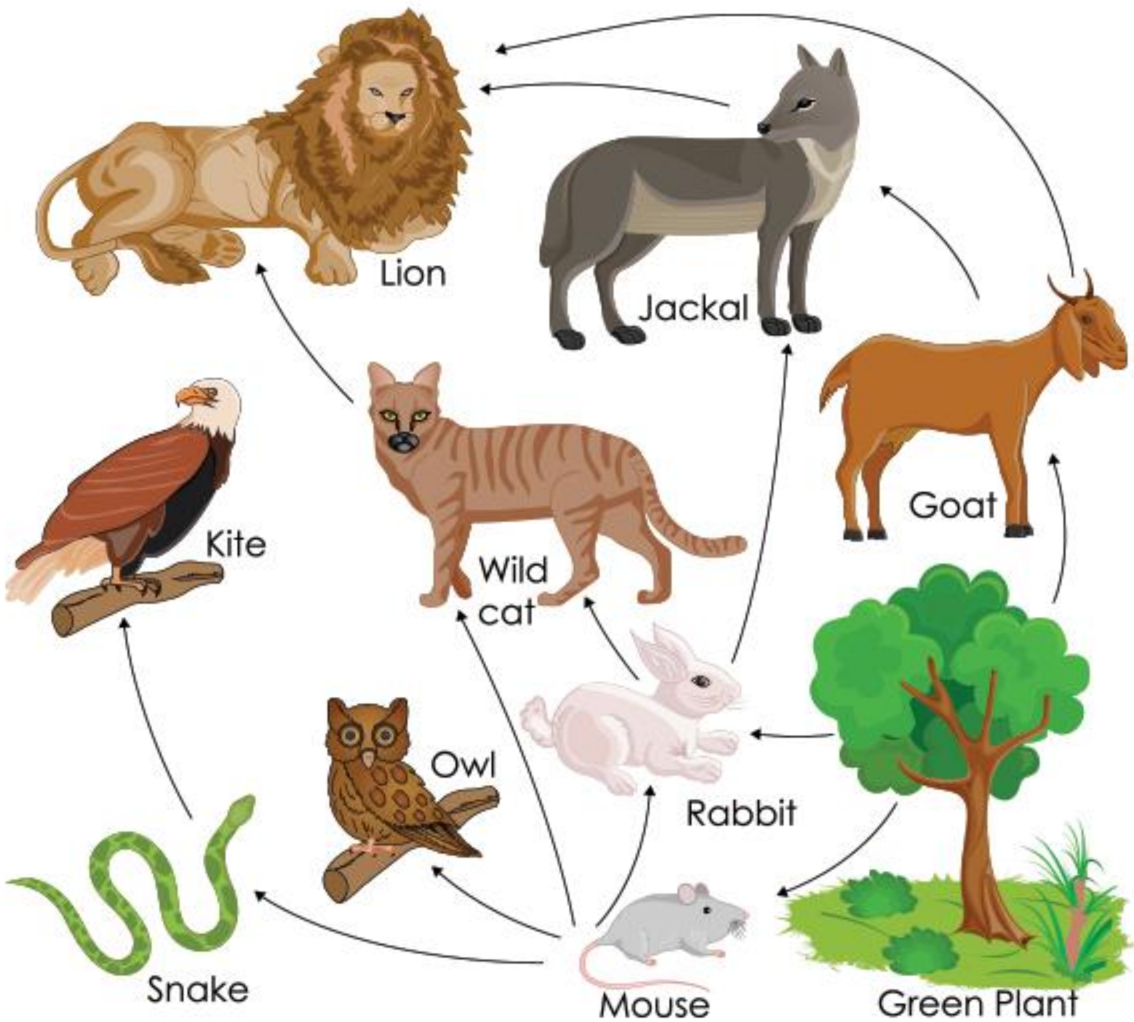
Predators (eat grazers)

Grazers (eat primary producers)

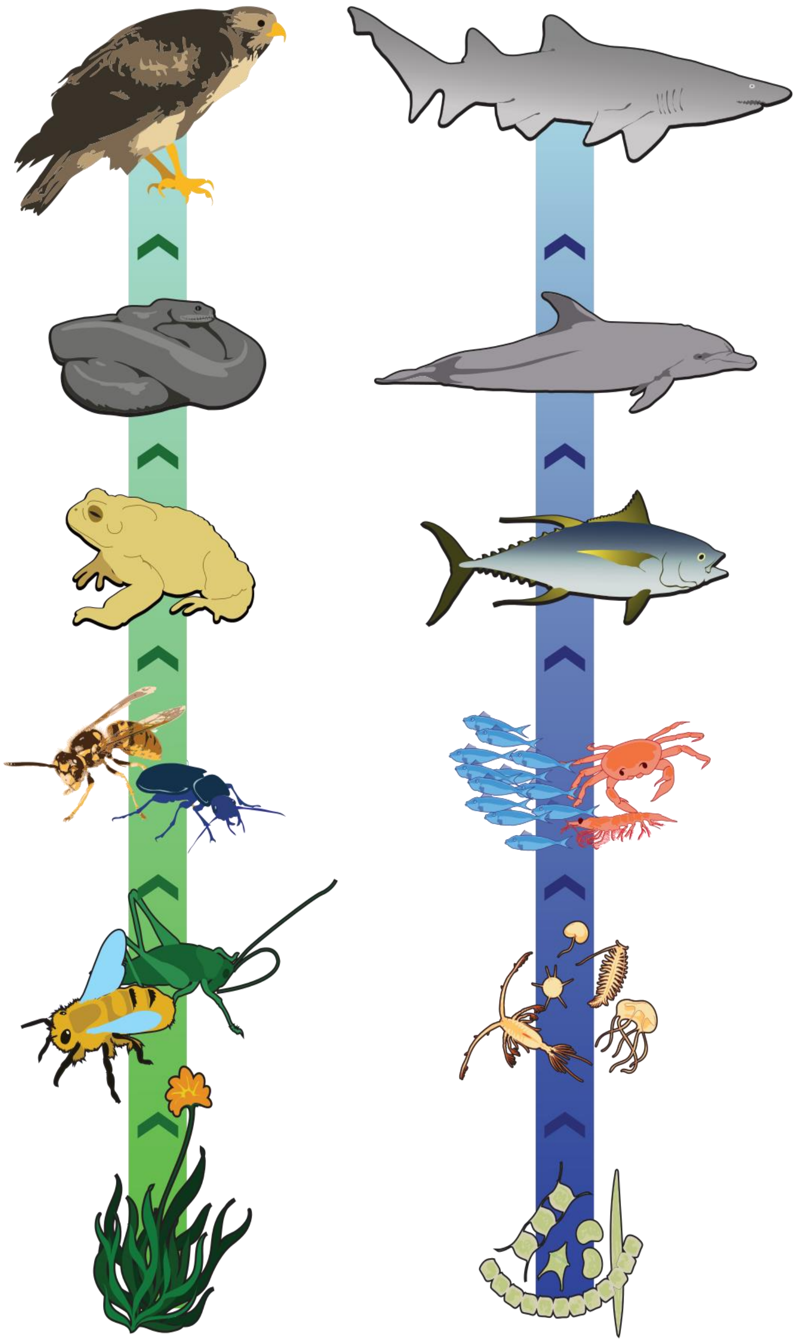
Autotrophs

Primary producers (autotrophs)

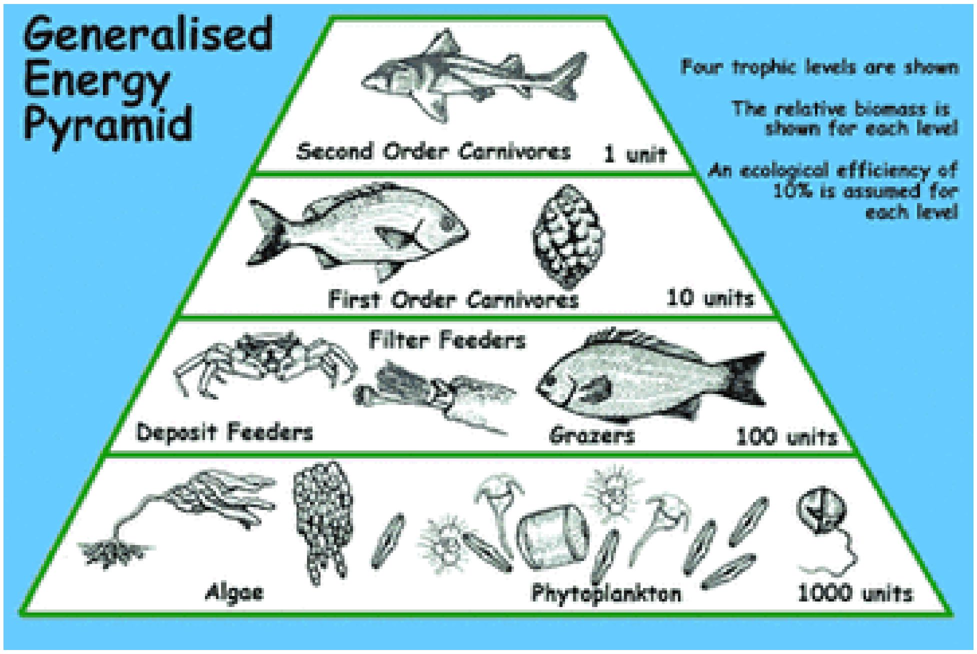

Primary
Consumer
Grasshopper
Secondary
Consumer
Frog
Sun
Water
Grass
Producer
Food Chain
Snake
Tertiary
Consumer
Fungi
Hawk
Decomposer
Final
Consumer



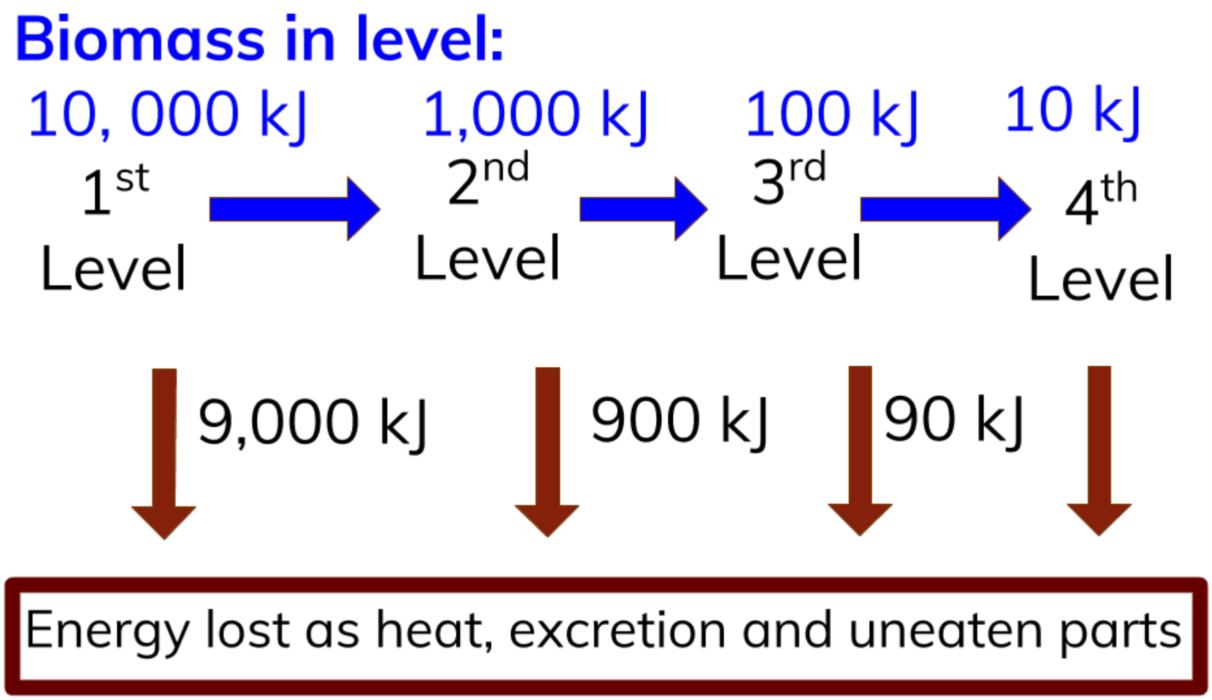
Lion
Jackal
Goat
Kite
Wild
cat
Owl
Rabbit
Snake
Mouse
Green Plant

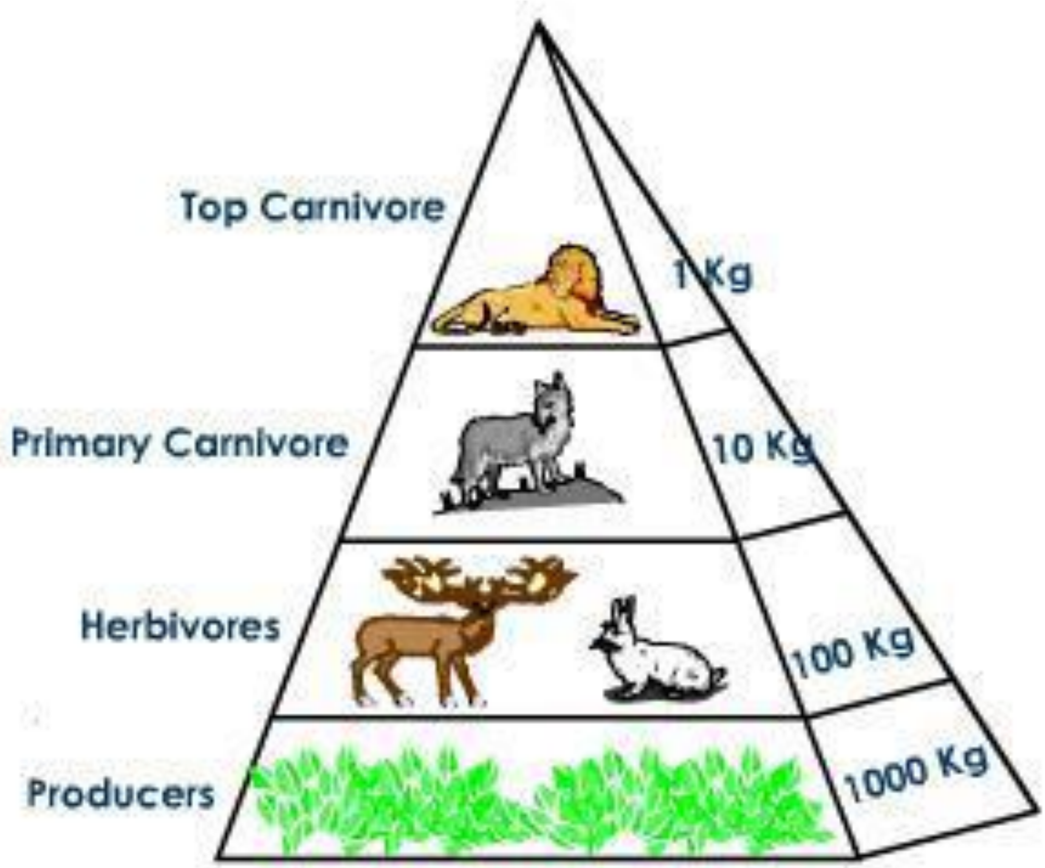


A food chain may have many levels and Is often far more complex than the one pictured here. What is important to note is that upper level consumers are dependent on, and to some degree control the growth of the population of the organism they eat. Changes in the population numbers of any organism can seriously impact the organisms below it and above it. Lower Level organisms may grow out of control while upper level organisms may find that Their food supply is gone.



All heterotrophs need to use energy to search for food, eat it, digest it and excrete non digestible parts. All of this takes energy and about 90% of what is eaten is used for that purpose. Only about 10% on the average is used for maintaining the organism and building tissue etc. So only 10% of what each level eats gets used for its own needs outside of food gathering.


Biomass in level:
10, 000 kJ
1,000 kJ
100 kJ
10 kJ
1st Level
2nd Level
3rd Level
4th Level
9,000 kJ
900 kJ
90 kJ
Energy lost as heat, excretion and uneaten parts



Upright Pyramid of biomass in a Terrestrial Ecosystem

So, almost all energy ultimately comes from the sun. Those organisms that can turn the sun's energy into food are called "primary producers". The do not need to eat. They are able to take carbon dioxide and water and with the energy from the sun, change those into sugar and oxygen. This process is called "photosynthesis". Organisms which cannot photosynthesize (or in rare cases - chemosynthesize - that is use chemical energy to make their own food) have to eat other life forms. So there is a food chain - called trophic levels, starting with the bottom level of primary producers and working up to apex predators.

Carbon dioxide comes into the water from respiration and also because the ocean is able to absorb it from the atmosphere. This is something that becomes significant when we talk later about pollution and climate change.

WHAT KINDS OF THINGS DO WE GET FROM THE OCEAN?

(a) Food.

All kinds of edible material comes from the ocean. The most obvious is probably fish (Pisces) but also shellfish, which are not "fish" at all. In addition to animal life, some algae (including seaweeds) are edible. Sea mammals are also edible and people in different parts of the world eat whales and seals. What people regard as food is part of their "culture"

(b) Minerals.

Salt is one of the most common minerals taken from the ocean. One need only let the water evaporate and the minerals remain. Salt is used for food, but was used as money for the Roman legions. The word "salary" is derived from the Latin word for salt.

Along the shores of South Africa and Nambia there are large numbers of diamonds found. They are formed by pressure deep in the Earth and are moved to the surface through volcanic vents.

Heavy metals known as placers are more often mined along the coasts. These are moved by waves and being heavy than the water, get deposited in pockets and depressions along the coast. Gold has been mined off shore of Nova Scotia; tin ore off Malaysia, Indonesia and Thailand.

Aggregates. These are needed for building materials (concrete etc.) Marine aggregate resources are the second largest off shore extraction industry after hydrocarbons. These aggregates were obtainable from beaches, but with the growth of the tourism industry, beaches are a conflict area. The tourism industry is a greater source of dollars so the extraction of aggregates has moved out onto the continental shelf – half of the surface of which is covered with supplies of aggrgates (sand and gavel). Japan, the major producer, generating about ½ the world's production.
Many other minerals are found that in the ocean as well that are mined.

(c) Energy

Energy comes from the ocean as well. In some places, hydro electric power is derived from turbines driven by tidal movements.

Fuels like oil do not literally come from the ocean, but can be found from the land under the ocean.

(d) Pharmaceutical/Medical materials.

Most currently come from terrestrial sources.
NOAA reports (http://oceanexplorer.noaa.gov/facts/medicinesfromsea.html)

systematic searches for new drugs have shown that marine invertebrates produce more antibiotic, anti-cancer, and anti-inflammatory substances than any group of terrestrial organisms. Particularly promising invertebrate groups include sponges, tunicates, ascidians, bryozoans, octocorals, and some molluscs, annelids, and echinoderms.
Some chemicals produced by marine animals that may be useful in treating human diseases include:

a. Ecteinascidin: Extracted from tunicates; being tested in humans for treatment of breast and ovarian cancers and other solid tumors
b. Discodermalide: Extracted from deep-sea sponges belonging to the genus *Discodermia*; anti-tumor agent
c. Bryostatin: Extracted from the bryozoan, *Bugula neritina*; potential treatment for leukemia and melanoma
d. Pseudopterosins: Extracted from the octocoral (sea whip) *Pseudopterogorgia elisabethae*; anti-inflammatory and analgesic agents that reduce swelling and skin irritation and accelerate wound healing

e. w-conotoxin MVIIA: Extracted from the cone snail, *Conus magnus*; potent pain-killer

A striking feature of this list is that all of the organisms (except the cone snail) are sessile (non-moving) invertebrates. To date, this has been true of most marine invertebrates that produce pharmacologically active substances. Several reasons have been suggested to explain why sessile marine animals are particularly productive of potent chemicals. One possibility is that they use these chemicals to repel predators, because they are basically “sitting ducks.” Another possibility is that since many of these species are filter feeders, they may use powerful chemicals to repel parasites or as antibiotics against disease-causing organisms.

Competition for space may explain why some of these invertebrates produce anti-cancer agents. If two species are competing for the same piece of bottom space, it would be helpful to produce a substance that would attack rapidly dividing cells of the competing organism. Since cancer cells often divide more rapidly than normal cells, the same substance might have anti-cancer properties.

Up to this point we have been talking about the ocean and the ways that it has an impact on people. The way in which the people make use of the ocean and the way the ocean is perceived is all based on questions of "culture".

The nature of culture.

First, we need to think about two kinds of differences: qualitative and quantitative. Quantitative changes indicate changes in amount; qualitative changes indicate changes in kind. In English, quantitative changes are indicated by the comparative and superlative forms of an adjective:

Tall	taller	tallest
Rich	richer	richest
Pale	paler	palest

A change in the nature of something requires a different word. Compare

Sick	sicker	sickest
Sick	sicker	dead

The first shows a quantitative, the second a qualitative one. Being dead is not being extremely sick.

The social sciences deal largely with human societies, but not exclusively. This indicates that societies are not exclusively human. The study of societies is unlike many aspects of science as it occurs in the physical sciences because it is often not possible to experiment the way one can in the physical sciences.

It is possible to organize the world along levels of complexity:

Societies
Organisms
Organ systems
Organs
Tissues
Cells
Bio-molecules
Molecules
Atoms
Subatomic structures

Typically physics deals with the lowest levels, chemistry is above that, biology a bit higher and geology tends to be more or less like biology but with inorganic materials.

We can look at the organization of things as levels of organization:

Sub atomic particles come together to make atoms, which combine to make molecules. Some molecules combine in such a way that they constitute bio molecules. These become sub cellular parts that can become cells which become tissues, that becomes organs and organ systems which make organisms.

At each level of organization some new attribute appears which does not exist at the lower level. So going from molecule to bio-molecule the characteristic of life appears. This is not a new idea. It generally contrasts with something called reductionism – If something is in the whole it must be in the parts. So we could ask under this idea "Are you alive?" If your answer is "yes", then the next question would be "Is your circulatory system alive". If "yes", then "Is your heart alive?" If "yes", then "Is the muscle tissue on your heart alive?" If "yes", then "Are the muscles cells in the muscle tissue alive?" If "yes". "Are the sub cellular parts alive?" If "yes", "Is the DNA in your cells alive?" If "yes", is the carbon in the DNA alive"? Hmmm. If it isn't then, non-organic material combined to make organic material. This is a QUALITATIVE leap rather than simply a quantitative one. In effect, each level can be defined relative to something that appears at that level but not the one below it. There is as additive property involved.

It is also clear though, that what happens at a lower level can also have an effect on what happens at a higher level.

If we take hydrogen and put a lit splint in it, it will flare up.

It will do the same thing if you put a lit splint in oxygen.

If you combine hydrogen and oxygen you get water, and if you put a lit splint in water it does not explode or flare up, but goes out. So water does not behave like the elements which make it up.

At the same time we recognize that different atoms when combined will produce different molecules with different properties. Combining carbon and oxygen makes carbon dioxide not water. So there is something about the things which combine that has some impact on the higher level, but is still qualitatively different from the lower level.

So, while societies all share something in common, they can also be rather different in the same way that all molecules share something in common, but are uniquely different from one another.

In this sense, we can ask what is the "new" attribute that occurs at each level. At the moment our concern is about the level of organisms combining to form societies. We don't have a name for what the new attribute is that appears at that level. But we can say that whatever appears when organisms come together will be different depending on the organisms. When chimps come together in social organization, something "extra-chimp" will appear. The same will happen if the organisms are humans. We can use the term "culture" for the new attribute that appears when humans come together in social organization.

This is one "operational" definition of culture.

However, there are two ways in which "culture" is used. One is something we have just defined – something which is uniquely human, while the other is peculiar to a specific group. These are sometime designated as "Culture" with an upper case letter for the universal meaning and "culture" with a lower case for a specific culture (e.g. Japanese culture, Navajo culture, Swazi culture and so on).

You can compare this with language as well. All human societies have Language (with an upper case "L") but specific societies have specific languages (with a lower case "l"). So German is a different language than Japanese, both are "languages" so they share something in common which allows people to classify them as "Language". Similarly, some group A, has culture A; group B has culture B. A and B are not alike, but they share enough in common to be called "cultures" What they share in common is "Language".

So one definition of culture is "What occurs when humans come together in social organization".

This is a definition of “Culture” (upper case) whereas the specific form it takes in specific groups is “culture” with a lower case.
Culture can have variations in it the way there are different languages. There can be variations in cultures, the way languages have dialects.