# Simple Animals

all animals are multicellular

while most animals have complex tissues and organs
some of the simplest, most primitive groups lack them

For us, Simple Animals:

are generally very small

all are aquatic: freshwater or marine

some are poorly known forms that are often found in unusual environments

usually with few or no true tissues

most with only few or no organs or organ systems

the organ systems present are usually primitive and simple

no circulatory system
not respiratory system
most with no nervous system
when present is nerve net
most with no excretory system
when present is protonephridia (flame cells)

→diffusion plays a major role in distributing oxygen, nutrients, carbon dioxide, and wastes

**eg. <u>Placozoa</u>**

one of the simplest kinds of animals

microscopic form barely visible to unaided eye

was $1^{st}$ discovered in 1883 in a marine aquarium

Originally thought it was some kind of larval jellyfish or something

eventually it was determined to be a new life form
    Placozoa → *Trichoplax*

for almost 100 years it was only known from aquariums
    in 1971 was found in plankton in the Pacific Ocean
    in 1980's it was found to be common in oceans

consists of only ~1000 cells,
    no true tissues,
    no true organs

has the least amount of DNA of any animal species

yet all other characteristics place it clearly in the animal kingdom

small disc shaped animal
    there is a dorsal and ventral surface
        ventral surface has cilia for movement

no front or rear → moves in any direction

probably feeds on algae

reproduces both sexually and asexually

**eg. <u>Mesozoa</u>**

small, parasitic, worm-shaped animals

made up of only 20-30 cells

one group is found only in the kidneys of octopi

consist of 2 layers of cells – not true tissues

the only structures resembling organs are the gonads

**eg. <u>Sponges</u>**

a much better known and more common animal group

an ancient group with abundant fossil record

still very simple in structure

no true tissues or organs
- no nervous system
- no digestive system

only a few cells have been specialized for certain functions

→ can force a sponge through sieve and cells will regroup and reform the sponge

all are aquatic, most marine; a few are freshwater

are **sessile** (non motile); but they have motile larvae

often brightly colored: yellows, reds, greens, lavenders

body is a network of canals and passageways

water is pumped through these passageways and the animals filter nutrients from the water currents

## Sponge Anatomy

small openings are pores or **ostia** where water is drawn into the sponge

some sponges have one or more relatively large inner chamber = **spongocoel** or **flagellated chambers**
where food is extracted from the water passing by

These canals and/or spongocoel are lined with **"collar cells" (=choanocytes)**

each collar cell has a **flagellum**
surrounded by a sieve-like **collar** that acts as a strainer

the flagellum beats to draw the water currents into the sponge and then to strain particles through the collar

food is absorbed (phagocytosis) by the collar cell and then sent to other cells in the sponge

water exits the sponge through larger openings = oscula (sing. = **osculum**)

## Support

sponges maintain their shape and keep pores and canals open by supporting structures called **spicules**

these spicules can be made of:

**calcium carbonate**

**silica** → spicules often united to form a rigid network that looks like fiberglass (eg. Venus Flower Basket)

**spongin fibers** (protein) → flexible common commercial sponge and most sponges normally encountered on reefs

## Reproduction

sponges can reproduce asexually and sexually:

Asexually

- budding
- internal buds = gemmules in freshwater sponges
  - =dormant masses of encapsulated cells produced during harsh conditions

## Ecological Interactions

many **commensal** organisms live in or on sponges:

→ protection from predators

eg. 1 specimen, 2M tall had 16,000 shrimp inside

eg. another had >100 species of organisms in and on it

eg. venus flower basket:
used as a wedding gift in SE Asia
typically has a male and female shrimp locked inside
="bonded bliss" or "prisoners of love"

also sponges are used by some animals as **camoflage**

eg. decorator crabs: mobile substrate

eg. some snails and clams have specific species of sponges encrusting their sthells

many sponges have mutualistic associations with bacteria

eg. bacteria live inside the tissue of some sponges
eg. demospongiae 38% of its volume was bacteria
for bacteria food and space
for sponge – it eats the bacteria as needed

eg. some sponges have blue green bacteria or algae that live inside their tissues
microorganisms get protection

sponge gets food

until 90's all sponges were thought to be filter feeding omnivores

now, one is known to be a **predator**

found in Mediterranian caves

lives in stagnant water → not much to filter

has developed a tentacle like appendge covered with velcro like hooks

the hooks snag shrimplike crustacea

other "tentacles" grow around victim and engulf and digest it

Another group of sponges = boring sponges (demospongiae)

live in shells and corals

excavate holes in shells and coral = "bioerosion"

have significant impacts on coral reefs

important in recycling shells and corals

sponges have few predators

→ a few bony fish and hawksbill turtle eat only sponges

sponges are important components of coral reefs

their distribution is mainly limited by proper substrate

corals are their chief competitor for space

sponges produce quite a few chemicals that repel potential predators or other competitors for space

(often brightly colored to warn others)

→ they make a wide range of "biotoxins"

reduce crowding: create "dead zone" around some sponges

## Economic Importance

eg. bath sponges have been used over 4000 years
→ holds up to 35x's its weight in water
takes 5 years to reach marketable size

eg. medicines:
anticancer drugs
drugs that promote wound healing, antiinflammatories

eg. aquarium trade

## <u>eg.  Cnidaria (Jellyfish & Corals)</u>

very abundant group

again, a very ancient group with lots of fossil representatives
(plenty of hard parts – corals)

widespread in marine habitats
→ especially shallow waters, warmer oceans

typically marine but some are freshwater
all but 1 species of fw cnidarians are polyps
but there is one small fw jellyfish *Craspedacusta*

more complex than sponges but still very simple
do have true tissues
→ but only two, not the 4 typical of animals

between the two tissues is a jelly layer
→ very thick in "jellyfish"

only a few very simple organs

often beautiful and graceful forms
sometimes superficially resemble plants and flowers

many are **colonial**
→ groups of individuals usually living together and interconnected eg corals

## Anatomy

**two main body forms:**

**polyp:**

tubular body with tentacles around mouth
usually sessile (attached)

**medusa:**

umbrella shaped with mouth pointing down
often with thick jelly layer between cell layers
free floating, pelagic, motile

predatory

use **stinging cells** with **nematocysts** for feeding and defense

each nematocyst is a coiled tubular thread
thread inside capsule covered by lid
most have a trigger (=cnidocil) –responds to touch
when triggered can fire in a fraction of a second

different kinds of nematocysts:

- some wrap around prey or are sticky
- some with tiny barbs that inject poison
  - most are harmless to humans
  - a few can be very painful (Man-O-War)
  - some are fatal (cubomedusae)

digestive system is a mouth that opens into a saclike cavity

→ incomplete digestive tract

most have various **sensory cells** (light, balance, chemicals) on surface of body

have simple **nerve net** (no CNS) to coordinate movements; no central processing area

## <u>Reproduction</u>

asexual reproduction usually by budding
    if buds remain connected = colonial

in many members of the group there is an **alternation of generations** between
        **polyp** which reproduces **asexually** and the
        **medusae** which reproduces **sexually**

## <u>Ecological Interactions</u>

anemones form interesting mutualistic relationships with other organism

eg. decorator crabs

eg. clown fish (immune to nematocysts)

most corals are mutualistic with zooxanthellae (algae)

# Coral Reefs

sponges and corals are familiar to most people as main components of coral reefs

coral reef communities are the most luxuriant, complex and diverse of all benthic communities

>3000 species of animals alone

corals form the main framework of a reef

also an abundance of clams, snails, worms, fish, eels, sea stars, sea urchins, shrimp, crab, sponges, etc

reef organisms are mainly **benthic animals**
= animals that live in or on a substrate
(don't swim in open ocean)

the most diverse aquatic or marine ecosystems
consists of a diverse array of photosynthetic algae and bacteria and numerous animals

reef organisms require **clear waters** to allow photosynthesis
→ not many nutrients, not too deep
→ depth of active reef is restricted by light penetration

found in warm tropical, shallow waters (to 60M) most reefbuilding corals contain **symbiotic algae** (=zooxanthellae)

| **corals** | **algae** |
|---|---|
| provide $CO_2$ | provide $O_2$ |
| N, P | remove wastes |
| | make organic nutrients |

present in enormous populations
provides a vital energy source for the reef organisms
base of reef food chain
→ require **light** for photosynthesis
→ **depth** of reef community is restricted

because of dependence on **light** reef communities also require clean water
→ low amounts of dissolved materials and few nutrients
→ not at mouth's of large rivers

reef communities are also restricted by water **temperature**
→ occur only in tropical and subtropical seas (±30º latitude) where average water temperature ~20º - 28º C

especially in S Pacific and Indian Oceans

## Reef Structure:

reefs create their own environment:

high diversity

→ lots of competition especially for space & food

algae, sponges and corals are constantly growing over and killing each other

rapid recycling of nutrients (similar to rainforests)

(produce several times more organic material/area than phytoplankton communities)

require a **hard surface** (firm base) on which to start construction

the coral colonies are able to extract calcium carbonate from sea water to form the reef structure

as organisms live and die get build up of coral skeletons, encrusting algae, shells, etc

involve construction and destruction phases:

any exposed surface is quickly attacked by boring organisms especially sponges. worms and clams

waves also break up and destroy old reef material

fine materials settles into crevasses and holes

→ fills spaces

→ cements reef together

the extensive vertical growth of reefs is the result of changes in sea level

→ virtually all modern reefs have grown upward due to recent sea-level rise beginning ~18,000 BP (3-15 M (10-40')/1000yrs)

→ some of the thickness may also be due to subsistence
(especially at atolls and some barrier reefs)

Three general types of reefs:

1. **Fringing Reefs**
   most common type
   surround islands and border continents
   project seaward directly from shore

2. **Barrier Reefs**
   platforms separated from adjacent land mass by a lagoon

   eg. Great Barrier Reef is longest in world ~1000 miles

3. **Atolls**
   at summits of submerged volcanoes (seamounts)
   usually circular or oval with a central lagoon

## <u>Zonation</u>

All three reef types show similarities in profile (vertical zonation)

due mainly to differences in wave energy and water depth

## a. Reef Face

seaward side
inclined from gentle to steep slopes
often with terraces creating more zonation

**10-20M: (30-60')** high energy – help to dissipate wave energy
grooves drain off sand
masses of large dome shaped and columnar corals
large fish

**20-30M: (65-100')** little wave energy
only 25% of surface light reaches heref
more delicately branched corals

**30-40M: (100-130')** gentler slope
very reduced light
sediments accumulate here
corals become patchy

**>50M: (>165')** slope drops off sharply

## b. Reef Crest

highest point of reef front
exposed at low tide, covered by waves at high tide
elkhorn coral and shelf coral

## c. Reef Flat (back reef)

sheltered, lagoon side
highly variable
short to several 100 meters
lowest energy, coral sand
delicate corals, eg. staghorn
becomes shallower and supports sea grasses

## Threats to Reefs:

Coral Reefs are among the most endangered ecosystems in the world

the greatest threats to reefs are from human:

~1/2 of world's population live in coastal regions
    in SE Asia, 70% of population is in coastal areas

todate humans have directly or indirectly caused
    the death of 5-10% of the worlds reefs

at current rates ~60% of worlds reefs could be gone
    in next few decades due to human impacts
    (but excludes effects of global warming and ozone depletion)

all reefs are impacted by human activities
    only reefs in remote areas are generally healthy

Coral Reefs are associated with 109 countries,
    those in 93 countries show significant damage

reefs at highest risk:

| | | |
|---|---|---|
| Japan | Singapore | Taiwan |
| Sri Lanka | India | |
| Indonesia | Asia | |

eg. Phillipines
    only 5% of reefs are pristine
    30% are dead

39% are still healthy

all are areas with dense coastal populations and heavy coastal development

One indication of reef decline is **"coral bleaching"**

→ symbiotic algae die

→ corals lose color (=bleaching)

→ then coral polyps die

## Causes of Coral Reef Decline:

### 1. Sedimentation

by far the greatest impact

increase in suspended silt, clay, dirt

mainly due to deforestation esp. mangroves

due to logging, farming, mining, dredging

from rivers and coastal activity – doesn't have to occur near coast to have and impact

sediment blankets coral reef

initial plume blocks sunlight→reduces photosynthesis

smothers polyps

as they produce mucus to remove it, depletes their energy reserves; makes them more susceptible to disease

impedes larval settling

### 2. Eutrophication

food and nutrients usually limit the growth of most organisms

eg. N & P →plants, algae; organics→ bacteria, heterotrophs

too much food can upset the balance between organisms in the community:

some grow much faster than others and can become toxic eg algae

sometimes a new predator gains upper hand

eg. crown of thorns starfish → can clean out entire reefs when its predators are eliminated

## 3. Shipping and Oil Spills

eg. oil tankers pollute and kill reefs
eg. $1^{st}$ gulf war oil release (10M BBL's) caused extensive damage to reefs in arabian sea
eg. in Mid East a phosphate tanker ran aground on a reef, releasing phosphates into the water and killing 500 $mi^2$ of reef

## 4. Exploiting for Food

reef fishing are prone to overfishing because many are slow growing, long lived fish (K-selected; low natural fertility); when depleated they are slow to repopulate
**blast fishing** → use explosives to kill or stun fish
eg ~1/$6^{th}$ of reefs in Phillipines have been damaged this way since 1945
some use **cyanide** and poisons to fish → kills other organisms as well
**child labor** → in Phillipines 40 ships carry 300 children to reef each day
children pound reef with rocks to scare fish into nets
can destroy up to 1 $km^2$ of reef/day
children killed by needlefish, sharks, barracuda, poisonous snakes, etc
as fish become more scarce, fishermen earn extra income collecting turtles, clams, etc

## 5. Use as Building Material

in Sri Lanka and parts of India entire sections of reef have been removed to make cement
there is no other source of rock nearby

## 6. Collecting

1.5 Million kg's of coral/year is harvested mainly for "shell shops" around the world – most is exported
~1/$3^{rd}$ from the Phillipines
most goes to US gift shops and aquarium shops

live corals were collected and sold in Florida until 1989 when it was outlawed
but some is still traded on black market
shells etc collected by malacologists: prefer killing live specimens rather than dead shells from beach
exotic fish collected from reefs feed a $4 Billion/yr aquarium industry

## 7. Tourism (Ecotourism)

walking on reef and touching it kills polyps and kicks up sediment
many break off souvenirs of live reef
stimulates beach front developments

eg. On S Pacific Island of Palau
they mined an area of reef to build a new airport runway
→ to accommodate an increasing number of tourists coming to see the reef
eg. in Grand Caymans a 525′ cruise ship dropped a 5 ton anchor and dragged its chain across 150M of reef
creating a 3M wide path 150M long
uprooted 8M diameter blocks of coral
destroyed an area 1/2 the size of a football field

## Indirect Human Effects:

## 8. Global Warming

global temperatures are increasing 1/2 – 1 degree every decade
this rate is 100x's faster than natural rate at end of last glaciation
most of this accelerated warming is due to human activities
global warming will
alter weather patterns
cause significant sea level rise
up to 6 cm/decade
reefs can grow up to 10 cm/decade
alter ocean circulation
all of these factors can adversely affect coral reef communities

## 9. Ozone Depletion

will continue into next century

ozone levels decrease .5-5% over the tropics
this causes a 1-10% increase in UV radiation
shallow marine communities are particularly susceptible to damage from this additional radiation

## **Economic Value of Coral Reefs:**

many marine animals produce biologically active compounds

the earliest known use of marine resources was for medical uses:

2700 BC – China – medical text

perhaps 10% of all marine organism could yield medically important compounds

since the greatest marine diversity is in coral reefs, they offer the greatest possibilities for potential uses

Some examples:

1. Sponges

antibiotics, antitumor drugs, antifungal drugs

eg. Acyclovir
from Caribbean sponge
1st antiviral compound approved for human use
fights herpes infections
used since 1982

eg. Vidabarine
may attack AIDS virus

eg. a species of S Pacific sponge produces chemicals that can kill *Candida* → a human pathogen that causes thrush and vaginal infections

2. Corals

antiinflammatories, painkillers for arthritis, antimicrobials

cardiac stimulant from sea anemone

3. Segmented Worms
   eg. Padan – a powerful insecticide produced from a polychaete worm

4. Snails & Other Molluscs
   muscle relaxants, painkillers
   adhesives

5. Bryozoa
   potent anticancer chemicals

6. Tunicates
   antiviral, antitumor
   including possible treatment for malignant melanoma
   → the most dangerous form of skin cancer