PHYLUM ECHINODERMATA

CLASS

ASTEROIDEA
Starfish

OPHIUROIDEA
Brittle Star

ECHINOIDEA
Sea urchins

HOLOTHUROIDEA
Sea Cucumbers

CRINOIDEA
Feather Star

Flattened central body with five or more projecting arms.
Under each arm lie delicate cylindrical tube feet with sucker tips.

Five or more slender brittle arms arise from central round body.

Body encased in a hard shell, the test. Tubefeet protrude through pores in shell. Long protective spines project from test.

Sausage-shaped. Branched feeding tentacles at the front of the body.

Tiny, round bodies with short hook-like limbs. Handsome crown of feather-like appendages.
PHYLUM: ECHINODERMATA

STARFISH, SEA URCHIN, BRITTLE STAR, SEA CUCUMBER AND FEATHER STAR

As their name implies (*ekhinos* = hedgehog + *derma* = skin), they have spicules or spines on their skins. This feature is developed to varying degrees in the different groups.

**CHARACTERISTICS**

Echinoderms have

- a penta- (five) radial symmetry.
- cylindrical feet with suckered tips that operate hydrostatically.
- no head or eyes.
- the ability to move in any direction.
- a spiny shell made up of patterned skeletal plates. These are ‘joined’ with elastic threads that lie just below the surface, enabling the plates to continually grow.
- Echinoderms do not moult.
- The surface of the body opposite to that bearing the mouth (the arboreal side) is highly textured, bumpy surface, sometimes with spines.
CLASS: ASTEROIDEA

スターfish

Habitat
Rocky shores and subtidally on both rocks and sand.

Description
- Five relatively stout, tapering arms radiating from a central disc. In some starfish the rays and the disc merge together.
- There is a sense organ at the tip of each arm that can ‘taste’ food and it is sensitive to light.
- Rows of tiny hydrostatically operated tube feet in a groove in each arm.
- The mouth is situated centrally on the under surface, while the anus is on the upper side.

Feeding
Most starfish in South Africa are herbivores and feed on algae. Some species are mobile scavengers or predators such as the spiny starfish. They feed on a variety of animals including mussels, crabs and sponges.

Spiny starfish pry open mussels by exerting a strong continuous pull with their suckered tube feet. They feed by extruding their stomach through the mouth and food is digested outside the body.

Predators
Reef fish e.g. the Red roman.

Did you know?
The crown-of-thorns starfish is 50 cm in diameter, has from 9 to 23 arms and spines, which are venomous and painful to human beings. The female can bear between 12 and 24 million eggs in the annual breeding season. Voracious consumer of coral polyps, this starfish can eat large amounts of coral and population explosions on the Great Barrier Reef have left great areas of damaged reef.
CLASS: OPHIUROIDEA

BRITTLE STAR

Habitat
Usually found hiding in crevices or under rocks in rock pools as well as subtidally.

Description
- They have circular bodies with five slender arms. Trapped arms break off easily, but can regenerate.
- The brittle arms are covered with small scaly plates called ossicles with a pair of tube feet at each joint of the ossicles.
- The mouth lies on the lower surface of the body and is surrounded by five toothed jaws.
- Brittle stars are usually brown, black or striped.
- They are the most mobile of the echinoderms and move by writhing their arms.

Feeding
Omnivorous. They feed on small animals and decaying plant matter (detritus). They use their tube feet to catch suspended food material in the water, or to pick food off the bottom. They lack an anus and wastes are regurgitated through the mouth.

Predators
Reef fish.

Did you know?
The most striking brittle star is the basket star (Gorgon's head), which can be up to 50 cm across and has 10 branching arms with numerous writhing tendrils.
CLASS: ECHINOIDEA

 SEA URCHIN

Habitat
During the day sea urchins in the intertidal zone tend to hide in holes or crevices in deep rock pools out of direct sunlight. Some live in sand.

Description (Figure 1)
- Globular or flattened body encased in a shell (test) covered with spines.
- The spines move on a ball and socket joint and can be moved in any direction.
- There are five double rows of tube feet and different types of minute defensive nippers/pincers (pedicellariae) scattered over the body.
- The mouth is situated centrally on the under side (oral) and the anus is on the upper surface (aboral).
- The mouth has five massive teeth used to scrape the rock-face and to fragment algae. They form part of a complex structure called Aristotle’s lantern.

Feeding
Most rocky-shore urchins are grazers, but the more flattened sand-dwelling forms, like the pansy shell, feed on detritus.

Predators
Reef fish, starfish and rock lobsters.

Figure 1 The diagram shows the test of the sea urchin.

Figure 2 A section through a sea urchin

Figure 3 A section of the shell showing tube feet and pedicellaria with nippers/ pincers
CLASS: HOLUTHUROIDEA

SEA CUCUMBER

Habitat
In South African waters sea cucumbers are normally found either under stones in rock pools or lying camouflaged against the base of the rocks.

Description
- Sea cucumbers have lost the star-shaped symmetry.
- They have elongate, sausage-shaped bodies with soft leathery skins.
- They lie on their sides.
- The mouth is situated at one end and is surrounded by 8-30 finger-like, branched or shield-shaped retractable feeding tentacles. The anus lies at the other end on the aboral surface.
- There are up to five bands of tube feet that run the length of the body.

Feeding
Sea cucumbers use their sticky tentacles to capture plankton or to gather detritus from the seabed.

Predators
Fish eats them, e.g. parrot fish and crabs. Most are rather unpalatable. Some release a poison when disturbed.

Did you know?
- In some areas of the world sea cucumbers are considered a delicacy.
- When disturbed, some species eject sticky threads from the anus, while others will disgorge part or all of the gut, which they subsequently regenerate.
CLASS: CRINOIDEA

Oldest living class of echinoderms. There are 5,000 fossil forms and only 620 living species.

FEATHER STAR

Habitat
Found under rocks or in crevices subtidally. In tropical waters they range from the shallows to deep sea.

Description
- Unlike the other echinoderms, their mouth faces upwards.
- Small soft bodies surrounded by 10 or more feathery upraised arms.
- The gonads are in the pinnules of the arms closest to the body.
- Feather stars are essentially sedentary (sitting). They hold onto the surface of rocks with small claws (cirri). They can crawl using their cirri or swim using their arms.

Feeding
Feather stars are nocturnal filter feeders. Feed on zooplankton or phytoplankton. Food is trapped by the arms and passed along grooves to the mouth on the upper surface.

Predators
Reef fish e.g. Roman.

Did you know?
These animals have been around for 350 million years. Some fossil species achieved a length of 20 metres.
Quick Review

1. What characteristic does the phyla name: Echinodermata refer to?

   ______________________________________________________________

2. Identify the following animal and label parts a - c.

   ______________________________________________________________

   a. ________________________  
   b. ________________________ 
   c. ________________________

3. What is the function of the different parts?
   a.___________________________________________________________
   b.____________________________________________________________
   c. ____________________________________________________________

4. Give 2 interesting facts about each of the following animals.

   A._____________________
   B._____________________________
   A.___________________________________________________________________________________
   ____________________________________________
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   ___________________________________________________________________________________
   B.___________________________________________________________________________________
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PHYLUM: CHORDATA
SUBPHYLUM: UROCHORDATA

Most chordates are vertebrates (animals with backbones). The urochordata lack a backbone, but possess the three distinguishing chordate characteristics shown in diagram below: notochord, tubular nerve cord, and pharyngeal gill slits.

CLASS: ASCIDIACEA

SEA SQUIRTS (TUNICATES)

The simple looking sea squirts are in fact highly advanced animals. They belong to the Urochordata and are a close relative of the vertebrates. Their larval stage looks like a tadpole and possess the three distinguishing chordate characteristics (See diagram on the next page).

Red bait is the best-known sea squirt along our coast.

Habitat
Ascidians are found under rocks or ledges in the lower balanoid zone. Red bait grows where it is exposed to wave action just below or above the low tide mark.

Description
- These animals have the habit of squirting jets of water, hence the name sea squirt.
- They are sessile creatures with a tough barrel-shaped body and a pair of turret-like siphons.
- They are encased in a 'tunic', hence the name tunicate. The tunic is made of cellulose, a chemical normally found only in plants.
- They remain permanently attached to rocks.
- Colonial ascidians look like brightly coloured jelly with patterns of holes on the surface.
Feeding
They are filter feeders. Water is sucked through one siphon into a large pharynx where it passes through tiny holes in the wall into the body cavity and is squirted out through the other siphon. Oxygen and food are obtained from the water in the pharynx which leads on into the stomach.

Predators
Red bait forms a large part of the omnivorous diet of some species of fish, for example Galjoen and Fransmadam.

Figure: Microscopic photographs of Colonial Ascidians (b and c are clusters of ascidians with their own inhalant siphon and a common exhalent siphon in the middle)

Did you know?
Ascidians are the only animals that can manufacture cellulose.
Certain African tribes collect sea squirts for food and anglers use them for bait.
THE TWO OCEANS AQUARIUM MICROSCOPE

Introduction

Early in the seventeenth century, Galileo Galilei placed two glass lenses in a cylinder to enlarge his view of an insect. He was able to describe the stunning geometric patterns of a tiny eye. A nineteenth century cartoonist has illustrated the startling impact that microscopic observations made in London.

Today with far more advanced microscopes than those of the seventeenth century we are able to introduce visitors at the Two Oceans Aquarium to the wealth of life, the fragility and beauty of the microscopic world.

COLLECTION OF MICROSCOPE SPECIMENS

Holdfasts, the root systems of sea plants, are brought to the aquarium regularly. The holdfasts are kept in seawater in the room behind the microscope and air and water is kept trickling through them.

- Using a strong knife cut out the central stem of the holdfast and then cut into workable pieces. Put the pieces into a bucket with an 'air stone' and running water as you work.
- Separate each root 'branch' shaking out the dust, sand and whatever is holding on into a further bucket of water. Use an old toothbrush to clean out anything still clinging to the holdfast. Collect all the residues from the kelp segments in turn and allow it to settle. Shake all the segments vigorously to get the best results.
- Decant the collected sludge, sand and specimens through a hand net. The green nets have larger holes and white nets have finer holes. Place the green net into the white net and pour the water and sludge through the nets and into a bucket. Shake the nets vigorously as you pour.
- Remove as much sand and solid items as is possible.
- Carefully place a teaspoonful of the residues and water into a flat dish (coffee tin lid or a similar container) and, with a light above, go through it with a spatula or flat slightly curved probe, separating and recovering as many animals as possible. A large syringe attached to a length of air hose can be used as a pipette to gently suck up the smaller animals and place them into a suitable container.
- After examination under the microscope record the findings and list them on the public notice board ‘What’s on Today’ (on the wall next to the microscope).
A simple guide to the new OLYMPUS microscope in the HI-TEC exhibit

<table>
<thead>
<tr>
<th>Microscope parts</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Sub-stage condenser.</td>
<td>This allows you to adjust the intensity of the light passing through an object.</td>
</tr>
<tr>
<td>(2) Focus knobs (Coarse adjustment knobs)</td>
<td>These are the large double knobs on the rack used to FOCUS the image.</td>
</tr>
<tr>
<td>(3) Objectives / Lens (0.67 – 4X magnification)</td>
<td>Magnifies (enlarges) the image.</td>
</tr>
<tr>
<td>(4) Zoom knobs</td>
<td>These are located on the sides of the eyepieces and are used to control the magnification.</td>
</tr>
<tr>
<td>(5) Light source</td>
<td>Illuminates (brightens) the object</td>
</tr>
</tbody>
</table>

The OLYMPUS microscope (Model SZ 61) has a camera (also known as an adaptor), which picks up the image and displays it onto two television screens.

Magnification of animals on the TV monitors:
Small television      Range ≈ x37 – x285
Large television      Range ≈ x70 – x 535
HOW TO OPERATE THE MICROSCOPE

**Step 1** - Before switching on the microscope first ensure that the light switch on the sub-stage condenser (1) is turned to the lowest position. Then switch on the microscope.

**Step 2** – Lower the arm of the microscope to its lowest position. Turn the zoom knob (4) towards you to its lowest position at 0.67X.

**Step 3** – Move the microscope over a specimen pot/ bowl so that it is positioned under the objectives / lens (3). Raise or lower the arm of the microscope to secure a clear image on the large television screen. **This has the same function as the focus knobs (2).**

**Step 4** – Making sure that the image you wish to enlarge is in the centre and in clear focus, adjust the zoom knob (4) to enlarge the image.

**THE AIM IS TO FOCUS FIRST ONTO AN AREA TO BE ENLARGED, PLACE IT IN THE CENTRE OF YOUR VIEW AND THEN ADJUST THE ZOOM TO ENLARGE THE IMAGE.**

Note each time you increase the magnification the image goes out of focus. Refocus by repeating step 3.

**TIPS:** Using the light from the sub-stage condenser allows you to view any semi-transparent or transparent specimen such as crayfish larvae with far greater clarity. It highlights specks of floating debris or mucous in the water or helps when searching for items such as strings of eggs.

The camera and microscope are fitted to a column allowing you to pivot in one major and one minor movement over the specimen dishes.

**THIS EQUIPMENT IS EXTREMELY VALUABLE AND GREAT CARE MUST BE TAKEN WHEN USING IT. ONLY TRAINED, CONFIDENT STAFF CAN DEMONSTRATE TO THE VISITORS. IF ANY PART OF THE EQUIPMENT APPEARS NOT TO BE FUNCTIONING CORRECTLY (LIGHT SWITCHES OR THE CONTROLS), PLEASE CALL FOR THE FLOOR MANAGER.**

The following points are extremely important to ensure that the specimens are kept alive for as long as possible.

1. The combination of lights and the small volume of water in the dishes mean that the water becomes warm very quickly. Therefore, **every hour or so the water in the specimen dishes must be replaced by fresh, cold seawater.**

2. Never place your fingers (or allow the public to do so) into the specimen dishes.

3. The best way to stimulate the various animals (especially after changing the water) is to squirt a **small amount** of brine shrimp or mineral-rich water from the bottom of the tanks.
using the syringe in the dish. At times it is possible to agitate the water by squirting the residues at the bottom of the dishes and to push the sediment around a bit.

4. Try not to move the animals with the metal probes as they are easily injured (especially the sea cucumbers). This is with the exception of the sea urchin, which can be very gently turned over to expose the mouth.

5. Use the microscope to show the public the **most 'invisible' areas** - for example zoom into the rough growth on kelp to find Bryozoa and the natural growth around the dishes to show the hydroids.

**Detailed microscope procedures will be at the microscope area.**

**REFERENCES**


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**Module 4 - Marine Invertebrates** was compiled by Antoinette Swart MSc (Stell); HED (UNISA); H Dipl. Bibl. (UNISA).