

Dissecting an Echinoderm— the Starfish

BACKGROUND

Starfish, like all echinoderms, live only in marine environments. The starfish's spiny-skinned exterior is made up of plates and spines of calcium carbonate that the animal extracts from sea water. In this laboratory you will dissect the starfish and observe how a starfish's body is adapted to life in a marine habitat.

OBJECTIVES

- Dissect a preserved starfish.
- Identify the major internal and external structures of a starfish.
- Observe how a starfish is adapted to a marine habitat.

MATERIALS

Stereoscopic dissecting microscope or hand lens	Dissecting tray	Preserved starfish
Microscope slide	Dissecting scissors	
Coverslip	Probe	
	Forceps	

PROCEDURE A

THE STARFISH'S EXTERNAL ANATOMY

1. Obtain all the materials listed for this dissection and place them at your work area. Place the starfish in the dissecting tray.
2. Locate the dorsal (top) and ventral (bottom) parts of the starfish as shown in **a**.
3. Use the information in the table below and **a** to identify the external anatomy of the preserved starfish.

a. External anatomy of a starfish

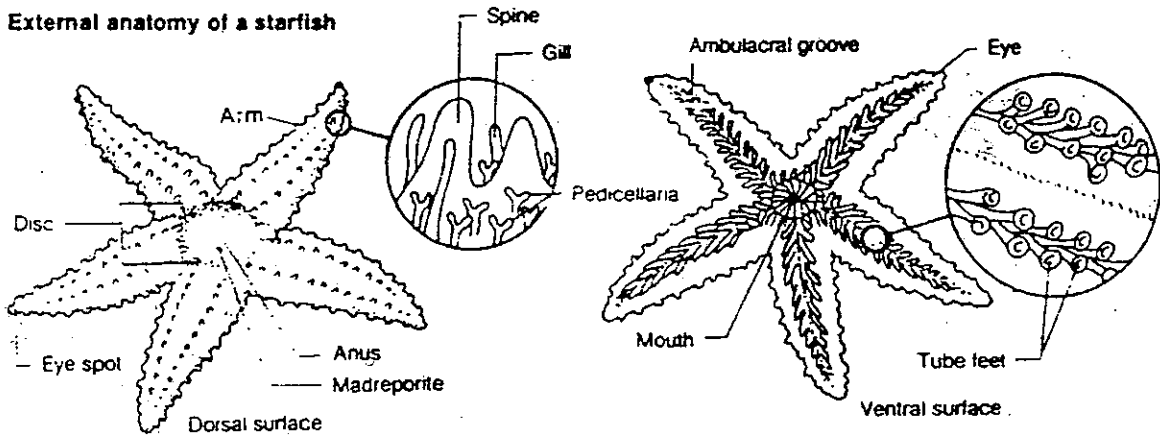
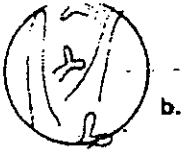


Table The external parts of a starfish

Dorsal surface	Ventral surface
Arm—one of the usually five rays	Ambulacral groove—trench running through the center of each ray
Disc—central raised portion from which arms radiate	Eye—red spot at the tip of each ray
Madreporite—small, buttonlike plate on the disc	Mouth—opening in center of disc surrounded by protective spines
Anus—small opening on disc opposite the madreporite	
Gills—delicate projections of tissues	
Pedicellaria—tiny pincers	
Spine—hard, blunt projection rising through skin from platelike skeleton	



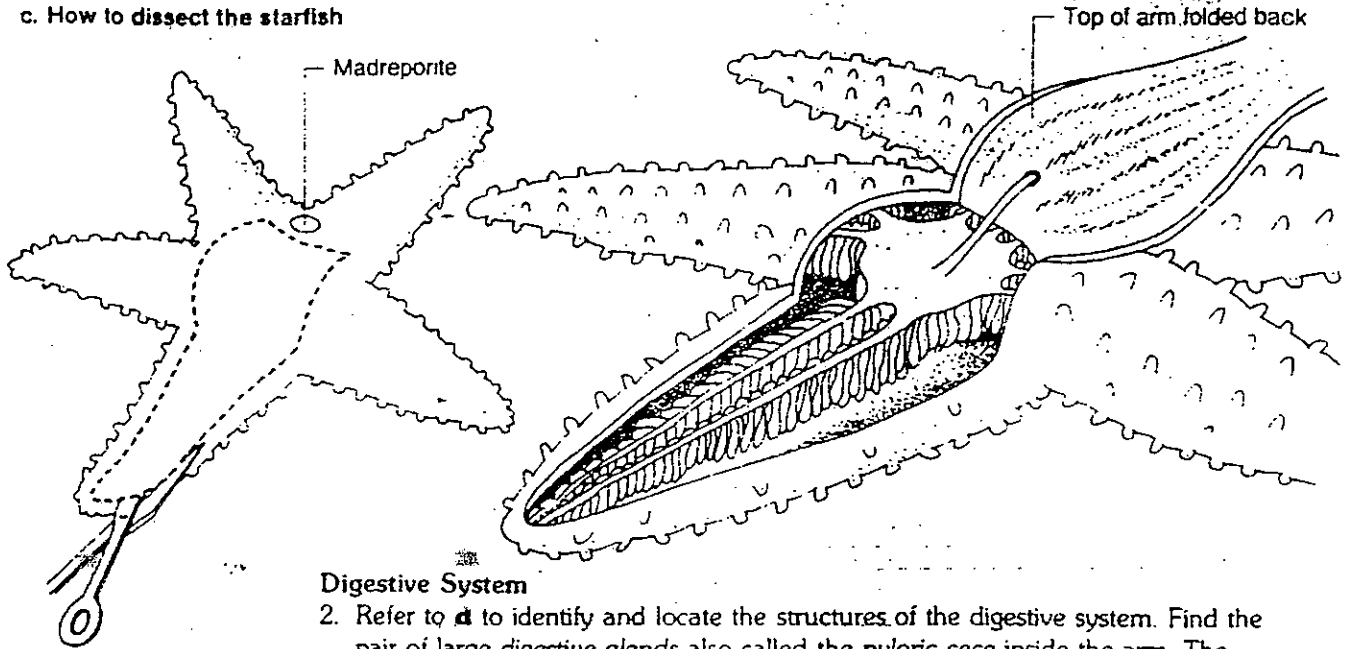
PROCEDURE B

4. Examine the skin of the starfish using a stereomicroscope or hand lens. Look for the *spines*, *skin gills*, and *pedicellaria*. Take a scraping from the skin surface to make a wet mount of these structures. Observe and sketch your observations in circle **b** to the left.

INTERNAL ANATOMY OF THE STARFISH

1. Place the starfish dorsal side up in the dissecting tray. Cut the upper side of one arm and the disc stopping just short of the madreporite as shown in **c**. Start at the tip of the arm and peel and tease away the flap you just cut free.

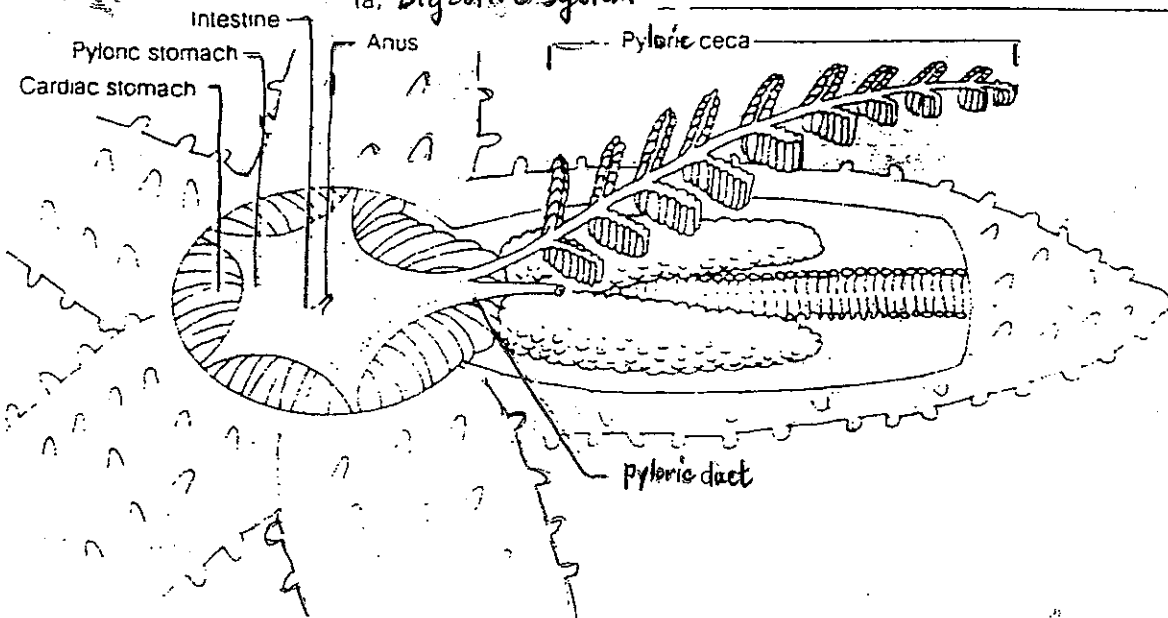
c. How to dissect the starfish



Digestive System

2. Refer to **d** to identify and locate the structures of the digestive system. Find the pair of large digestive glands also called the *pyloric ceca* inside the arm. The ducts of each gland join at the base of the arm to form the *pyloric duct* that enters the *pyloric stomach*. Locate the *mouth* and short *esophagus* leading directly to the starfish's two stomachs: the *cardiac stomach* and the *pyloric stomach*. From the stomach, a short narrow *intestine* leads to the *anus*. During feeding the cardiac stomach comes out of the mouth and floods the prey with enzymes from the digestive glands. Cut out and remove the digestive glands at their base. How many pyloric ceca or digestive glands are present in each arm?

(a) Digestive system



d. The starfish's digestive system

(P2)

Dissecting an Echinoderm—the Starfish (Continued)

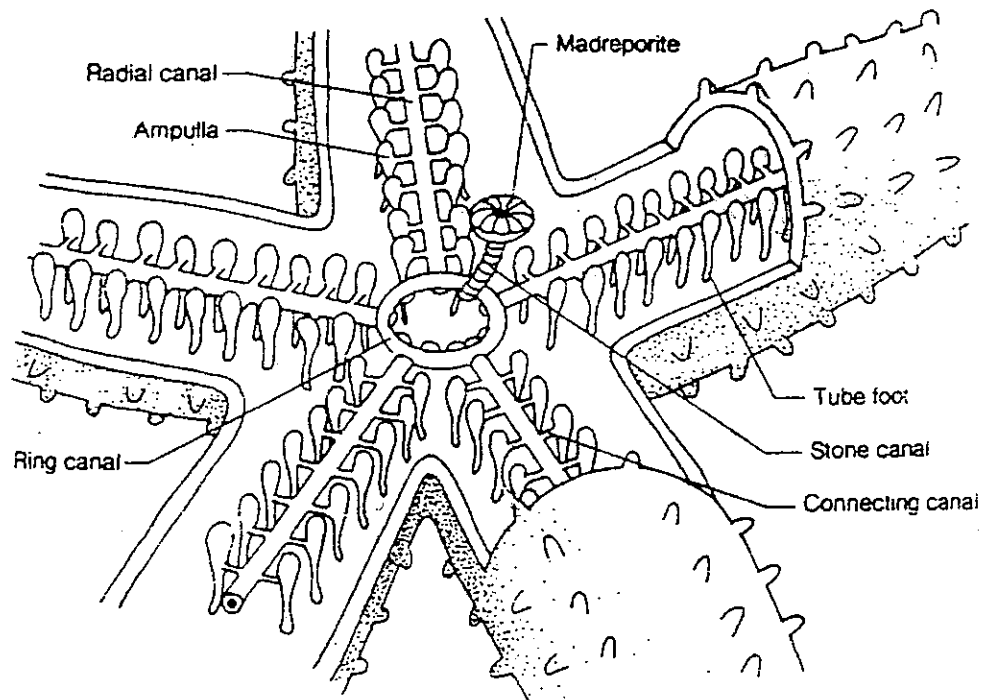
Reproductive System

3. A starfish is either male or female. If the starfish was collected during breeding season the arms will be filled with the *gonads*. The gonads of the male and female starfish look similar. One way to tell the gonads apart is on the basis of color. The male *testes* are usually grey and the female *ovaries* are usually orange. The color may be difficult to distinguish in a preserved specimen.

Water Vascular System

4. Carefully remove all organs of the digestive system and reproductive system in order to expose the water vascular system shown in **e**. Seawater enters this system through the *madreporite* that connects through a *stone canal* with the *ring canal*. A *radial canal*, located on top of the *ambulacral groove* distributes water through the arm. Connecting canals pass outward from the radial canal to the bulb-like *ampullas*. Each ampulla connects with a *tube foot* that passes through the body and projects from the *ambulacral groove* on the ventral side of the body. The starfish moves and exerts force through the use of suction at the end of the tube feet. How many rows of tube feet are found lining each ambulacral groove?

(b)



e. The starfish's water vascular system

5. Dispose of your dissected starfish in the manner described by your teacher. Clean up your work area and wash your equipment after you have completed the dissection.

ALYSIS

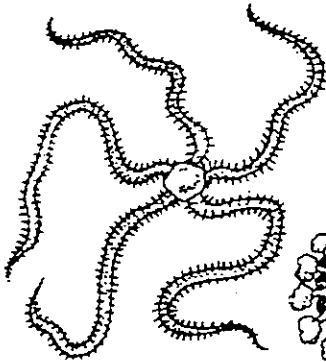
1. List two adaptations of the starfish that suit it well to its life in shallow, marine waters.

2. How does the skeleton of a starfish differ from your skeleton?

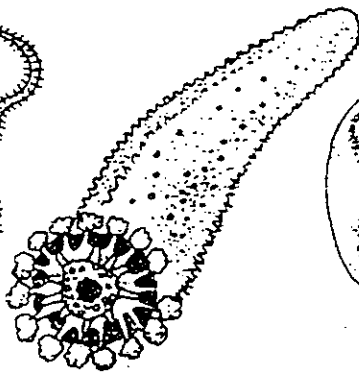
3. Name three traits of the starfish that place it in the phylum Echinodermata.

GOING FURTHER

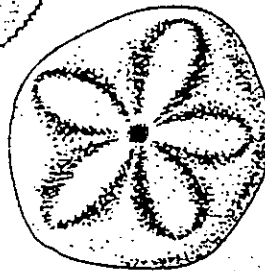
Look at preserved specimens of a brittle star, sea cucumber, sand dollar and sea urchin. Study the external anatomy of each specimen. How are all these echinoderms similar?



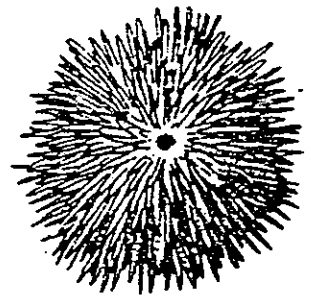
Brittle star



Sea cucumber



Sand dollar



Sea urchin

P4

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EXTERNAL AND INTERNAL STRUCTURE OF THE STARFISH

Starfish and the other members of the phylum Echinodermata are known for their spiny skin. These marine animals are radially symmetrical as adults, but their larvae are bilaterally symmetrical. This suggests a closer relationship to some more advanced animals than earlier biologists thought.

OBJECTIVE

- To observe the unique features that help starfish survive in their marine environment.

MATERIALS

hand lens or dissecting microscope
compound microscope
slides and coverslips

medicine dropper
scissors
dissecting pan

living starfish, if available
preserved starfish

PROCEDURE AND OBSERVATIONS

1. If possible, observe live starfish in a rocky intertidal zone or a marine aquarium. Pay special attention to their locomotion, reaction to the presence of molluscs, feeding habits, and ability to right themselves when flipped over.

2. On a preserved or freshly killed specimen, study the dorsal surface. The many spines extend from body wall and covered with epidermis. The animal is composed of a central disk with several (usually about five) rays, or arms, extending from it. Among the many spines of the disk, find the sieve plate, or madreporite, the only obvious structure on the disc. Its function is uncertain, but it may allow water to enter the water vascular system.

3. The underside of the starfish displays a mouth at the centre of the disc. From the mouth a groove reaches out along each arm. This groove is lined with hundreds of tube feet. These are tiny suction cups by which a starfish attaches itself to a rock or to the shell of a clam. Fig. 1 shows the vascular system with its tube feet and sieve plate. It also shows the stone canal, which leads from the sieve plate to the ring canal. Water in the ring canal is distributed to the tube feet through a radial canal in each arm.

4. With a hand lens or dissecting microscope, observe the mouth and other external structures just described.

5. Flip the starfish over and observe a few spines. Try to find the small, fingerlike skin gills extending from the surface between spines. Fig. 2 shows an arm in cross section. It illustrates how skin gills connect with the fluid-filled coelom. The thin walls of the skin gills allow oxygen to diffuse in and

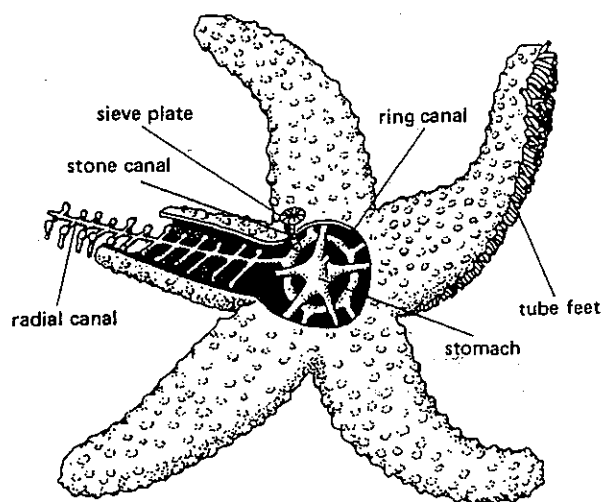


Fig. 1. Water vascular system of a starfish.

carbon dioxide to diffuse out of the fluid in the coelom.

6. The delicate skin gills are protected from small animals that could damage them or form crusts over them. Some protection is provided by the spines, which you have already seen. Also present among the spines and gills are tiny pincers, called pedicellaria. They explain why starfish are usually clean, while most other surfaces in the intertidal zone become crusted over with organisms. If you scrape the upper surface of the starfish, the scrapings may contain some pincers, which can be observed in a wet mount with a microscope.

7. If you have a fresh specimen, you might see a short tentacle and a pigmented eyespot at the tip of each arm. The tentacle is thought to be sensitive to chemical stimuli, such as food.

(PS)

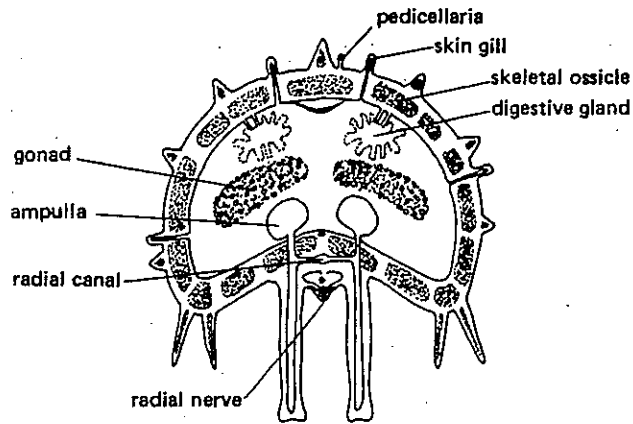


Fig. 2. Cross section of a starfish's arm.

8. Use scissors to snip the end off an arm on a side away from the sieve plate. From the cut end,

carefully clip the skin and skeleton off the top surface of that arm to a point near the disc. This should expose the large, green digestive gland. The two branches of the gland in each arm join before they empty into the upper chamber of the stomach. Above the upper stomach is the small intestine that connects to the outside through a tiny anal pore. A single pair of small, lobed rectal pouches connect to the intestine. The starfish is able to push out the lower, whitish stomach chamber through its mouth for feeding.

9. During the reproductive season, the large gonads can easily be found in each arm under the digestive gland. In fresh specimens, the males have grey testes, and the females have orange ovaries. Eggs and sperm are sent out through tubes which empty on the ventral side.

10. Dissect out as many of these structures as you can before you discard your specimen.

DISCUSSION QUESTIONS

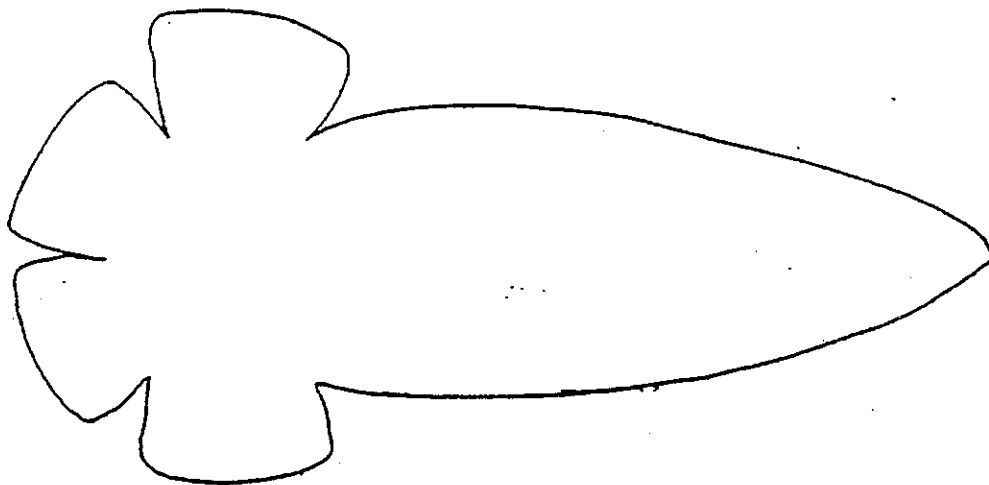
1. List several features of the starfish that would prevent it from thriving on the land in an atmosphere of air.
2. Explain how a starfish can survive with such a short intestine.
3. Using your text or other references, find two reasons why starfish are considered more closely related to chordates than the much more primitive animals that live sluggish lives in the sea.

plb

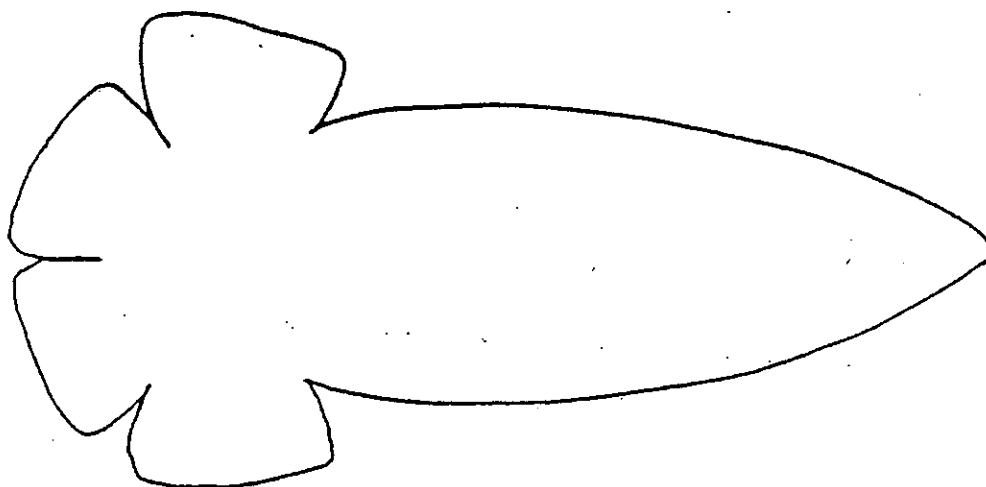
Phylum _____

Class _____

SEA STAR RAY AND CENTRAL DISK LABEL CENTRAL DISC, RAY, TUBE FOOT
AMBULACRAL GROOVE, AMBULACRAL
SPINE, MOUTH



External structure, oral view

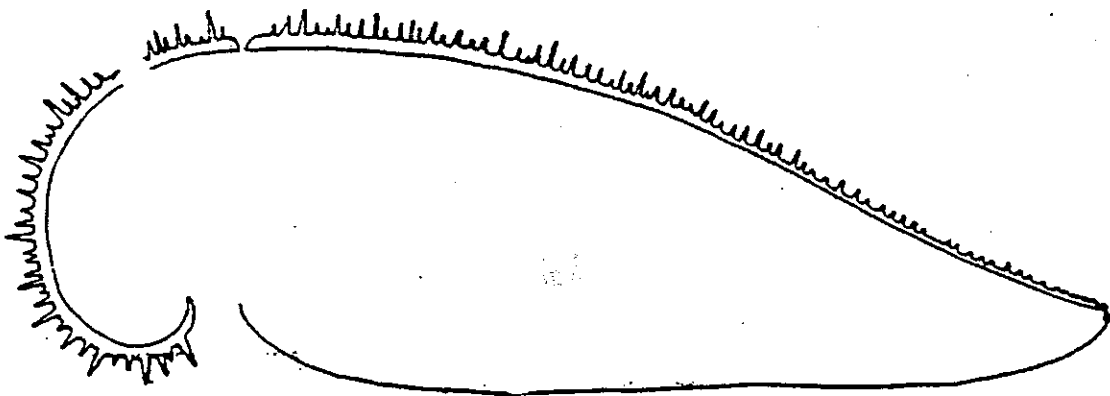


Internal structure, aboral view LABEL

P9

COELOMIC CAVITY, PYLOIC STOMACH, PYLOIC DUCT, PYLOIC CECA, INTESTINE
RECTAL CECA, CARDIAC STOMACH

SEA STAR

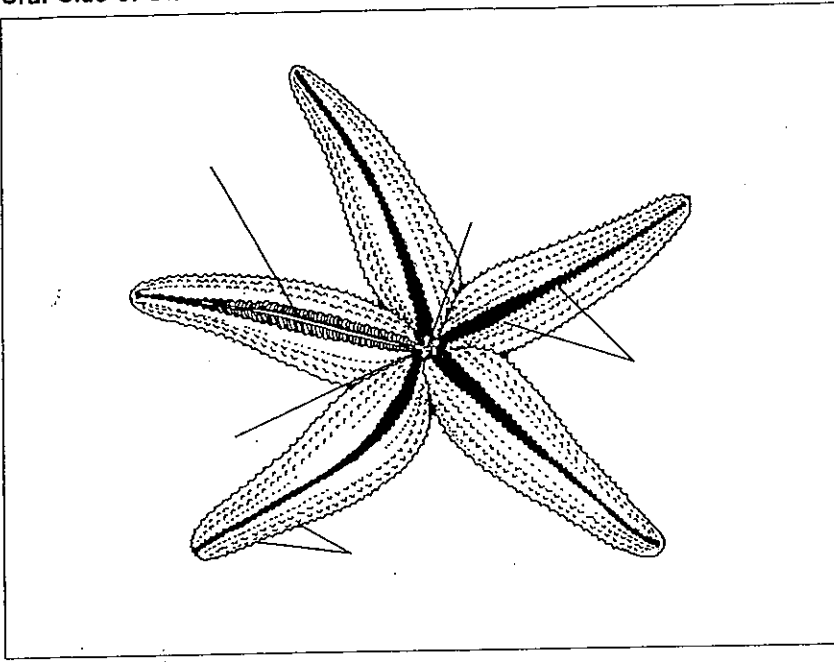


Longitudinal section Label YOURSELF

C.R. OF ARM Label EPIDERMIS, COELON,
OSSECLE, SKIN GILL, ANGULAE, TUBE FEET,
ABORAL RIDGE, ABORAL GROOVE, DIGESTIVE
GLAND, GONAD.

PA

Oral Side of Starfish



1. Describe the feel of a starfish's spines. _____

2. How does the number of spines in the central disk compare to the number of spines in a ray?

3. How many rows of tube feet does your specimen have? _____

Analysis and Conclusions

1. What is the function of a starfish's spines? _____

2. What kind of body plan does a starfish have? _____

3. What are two functions of the tube feet? _____

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4. How does a starfish take in food? _____

5. How does respiration occur in the starfish? _____

6. List two adaptations of the starfish that make it well adapted to life in marine waters.

Critical Thinking and Application

1. Starfish produce large numbers of eggs and sperm. How is this production an adaptive advantage? _____

2. When a starfish pries open the shell of a clam or oyster, the mollusk resists. Even if the shell opens only slightly, the starfish will get its meal. How does this occur?

3. Because starfish were eating many clams and oysters, divers were hired to go out and chop the starfish into pieces. After this, fishermen found even more empty clam and oyster shells than before. Why did this occur? _____

4. Why can a starfish move equally well in any direction? _____

5. Many echinoderms, which are bottom-dwellers as adults, have free-swimming larvae. What advantage do free-swimming larvae provide for the echinoderms?

