Aquaculture






Name: _____

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Date: _____/_____/_____

National Marine Science Centre

This material has been developed as part of the *Australian School Innovation in Science Technology and Mathematics Project* funded by the Australian Government Department of Education, Science and Training as part of *the Boosting Innovation in Science Technology and Mathematics Teaching (BISTMT) Programme*.

Introduction

What is Aquaculture?

Aquaculture is the fastest growing primary industry in the nation. The only way to sustain the increasing need for seafood is to farm.

Aquaculture is defined as:

"The farming or culture of aquatic organisms to use as food, selling them at a profit".

The farmers try to maximise their yield by improving growth rates and minimising mortality rates (disease, parasites).

Why is Aquaculture Important?

- Our natural fisheries resources have been **over-exploited** and may not be able to support our need for food in the future.
- There is a global increase in the demand for seafood.
- Wild fisheries **cannot be sustained** at current levels of harvesting.
- Many cases where wild fisheries have **collapsed** as a result of over fishing (e.g. Orange roughy, Cod).
- The contribution from aquaculture is roughly **20%**, and is worth **US$43** billion per year. Mainly concentrated in **Asia**.

  - **Finfish – 44%**
  - **Molluscs – 26.5%**
  - **Seaweed – 26.2%**
  - **Crustaceans – 2.5%**

Aquaculture considerations

- A species is targeted based on:

- **Need**
- **Ease of rearing**
- **Cost of production**
- **Profit**

- Once a species has been targeted juveniles are collected (from wild or a hatchery) and managed to maximise survival and growth rate until ready for harvest.

- The technology used to achieve culture varies with the species, location and market requirements.

What makes a species suitable for Aquaculture?

- **Known hatchery techniques**
- **Can be kept at high densities**
- **Has rapid growth**
- **Eats artificial diets**
- **Has a good food-conversion ratio**
- **Non-cannibalistic and not aggressive**
- **Hardy and disease resistant**
- **Has high meat recovery**

- It should also cause minimal impact if released (predation or competition with local fauna; changing of genetic make-up; introduction of disease).

Sites suited for different types of aquaculture

- Land including swamplands; river and stream beds; coastal areas including bays, estuaries, backwaters, lagoons, salt marshes and mangrove swamps; lakes, reservoirs and irrigation tanks; other existing water bodies.

Types of Aquaculture

- There are varying methods of **Aquaculture** and many different aquatic organisms being cultured today.

- Let's have a look at some:

- **Pond Culture** (Prawns; Fish; Eels; Crayfish)
- **Tank culture** (Prawn brood stock tank; Prawn culture tanks)
- **Sea Cage Culture** (Salmon; Tuna; Snapper; Mulloway)
- **Lease Culture** (Pacific Oysters; Sydney rock oysters)
- **Long Line Culture** (Pearl oysters)
- **Raceway culture** (Abalone; Oysters; Algae)
- **Hatchery** (Used to grow the 'babies')

So what is Aquaculture Biology about?

- Looking at the **biology** of the animals being cultured so that we can grow them in a **healthy**, **efficient** way.

- We need to understand the needs of the organisms so that they **grow happily** and **do not get sick**.

FISH ANATOMY & BIOLOGY- Implications for aquaculture

- Fish **shape** effects the way we handle fish and the species we choose for aquaculture.
- Shape effects how we catch the fish (e.g. net size).
- Shape and size effects how we physically handle fish (e.g. spines).
- Shape will affect **marketability**.
- Fish rely on support from the water so when taken out of the water they are very fragile
- When moving fish, keep them in water as much as possible.
- When handling fish **do not** remove their layer of scales and mucous.
- Have **WET HANDS** and **WET NET**.
- Because GILLS **COLLAPSE** WHEN OUT OF WATER, a fish will die quickly if left out of water.

CRUSTACEANS ANATOMY & BIOLOGY (Lobsters, bugs, prawns)

Crustacean body shape (Figure 1)

- Not very streamlined.
- Adapted to life on the bottom amongst roots, snags, mud, rocks and sand.
- Allows them to walk.
- Some also swim.
- Body covered by a **hard exoskeleton** reinforced with calcium.

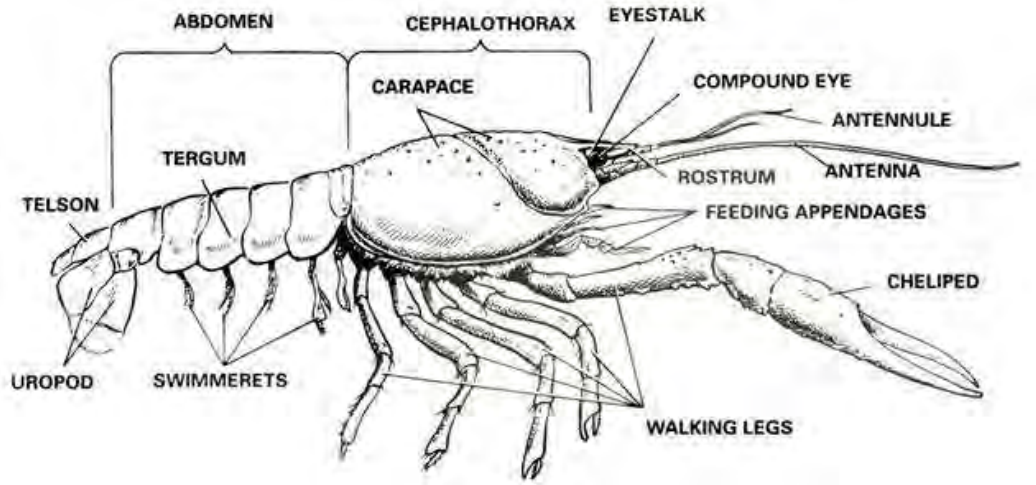
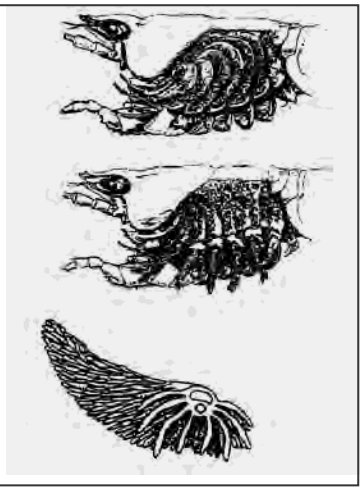


Figure 1. Crustacean body parts

- **Body** is segmented, each segment with a pair of limbs.
- **Carapace** protects most of the organs inside.
- **Segments** of the head and thorax do not move independently as are covered by the carapace.
- **Segments** of the abdomen move independently as are covered with individual pieces of exoskeleton.
- **Tail** can be moved up and down but not side to side.
- **Gills** used for breathing and excreting waste **(Figure 2)**.
- When in water the mouth parts beat to push water over the gills.
- **Gills** do not fully collapse when out of water, but must be kept moist to work.

Figure 2. Prawn gill



- **Legs**

- Legs are specialised for different functions:
- Walking; reproduction; breathing.
- In some species, first walking legs modified in chelipeds (claws) for defense and catching food.
- Crustacean legs can break off and new ones grow to replace them.

- **Setae (fine hairs) on limbs:**

- Setae on claws and walking legs sense water movement and detect food.
- Setae on some female's swimmerets attach the eggs.
- Setae on mouth parts filter food out of the water.

• Crustacean growth

- Crustaceans grow to a maximum size.
- Must **MOULT** to grow.
- Moulting is **shedding** of the exoskeleton to grow.
- Is stressful and makes them vulnerable.

- **Moulting steps:**

- Calcium from shell is taken into body and stored in gastroliths.
- Animal comes out of its old shell.
- Brings water into body.
- Calcium put into new skeleton.
- New shell hardens.
- Water is let out to make room for body to grow.
- Eat old shell.

• Implications for Aquaculture

- When crustaceans, e.g. prawns, are out of water they will find it hard to breathe. BUT, some species (e.g. crabs) can live out of water for long periods.
- When handling crustaceans, the time they spend out of water should be minimised because they can be easily damaged without the support of the water.
- When handling crustaceans avoid the **rostrum** and **claws** (chelipeds).
- Do not pick up by the legs, its antennae or antennules as they will fall off.
- Do not use nets as they will be entangled.

MOLLUSCS ANATOMY & BIOLOGY (mussels; oysters)

- **Body shape**

- Body shape varies greatly in **molluscs**.
- They all have a head, muscular foot and visceral mass.
- They have digestive, reproductive and excretory organs.
- Two hard shells for **PROTECTION** (Mussel, oysters).
- Adductor muscles used to open and close shell (mussel, oysters).
- **GILLS** extract oxygen and filter out food.

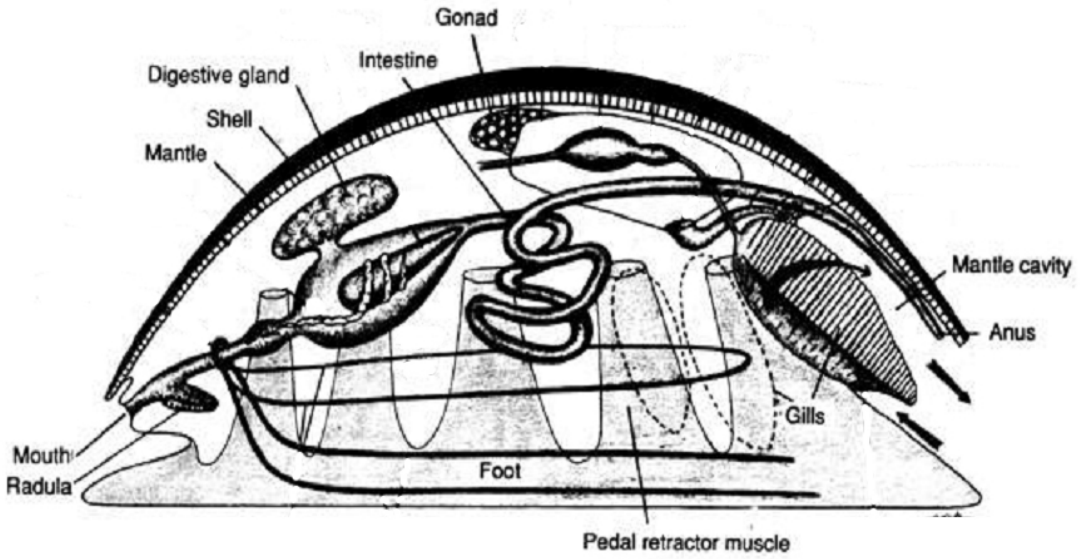


Figure 3. Mollusc anatomy (abalone)

- **Implications for Aquaculture**

- Mussels and oysters are good to handle as they can be kept out of water, in the cool, for up to 2 weeks and not die.

Study Aims

❖ Objectives:

Following completion of this lesson, the students will be able to:

- **Investigate** the nature and scope of aquaculture and the requirements necessary for the culture of various organisms through theoretical and practical investigation.
- **Examine** different morphological features through dissection of prawn and mussel to identify key anatomical features.
- **Describe** the concept of morphology;
- **Relate** shape, form and structure of the animal's parts and aquaculture practices.

Study Equipment

- Dissecting microscope
- Animal specimen
- Scissors
- Forceps
- Scalpel
- Probe
- Cutting board

(Per group)

Study Methods

Dissection of a prawn

-Crayfish and prawns are usually measured in a straight line from the point of the **rostrum** to the end of the **telson** (total body length). Some people measure the **occipital carapace length (OCL)**, also called **carapace length (CL)**, as it is easier to measure, and possible a more reliable indicator of growth.

- **Body shape**

  - Manipulate the legs of your prawn, feel how they move in many planes and positions, allowing the animal to walk in all directions.
  - Feel the claws on the chelipeds and on the first and second walking legs.
  - Also feel the spine on the front of the rostrum.
  - Flex the abdomen backwards and forwards to see the position a prawn is when it walks, and when it darts backwards. Note the abdomen can't move from side to side.

- Make sure you can locate the following:
- dorsal and ventral surfaces
- anterior and posterior ends
- cephalothorax, rostrum and abdomen
- chelipeds, walking legs, swimmerets and uropods

GUIDE QUESTIONS

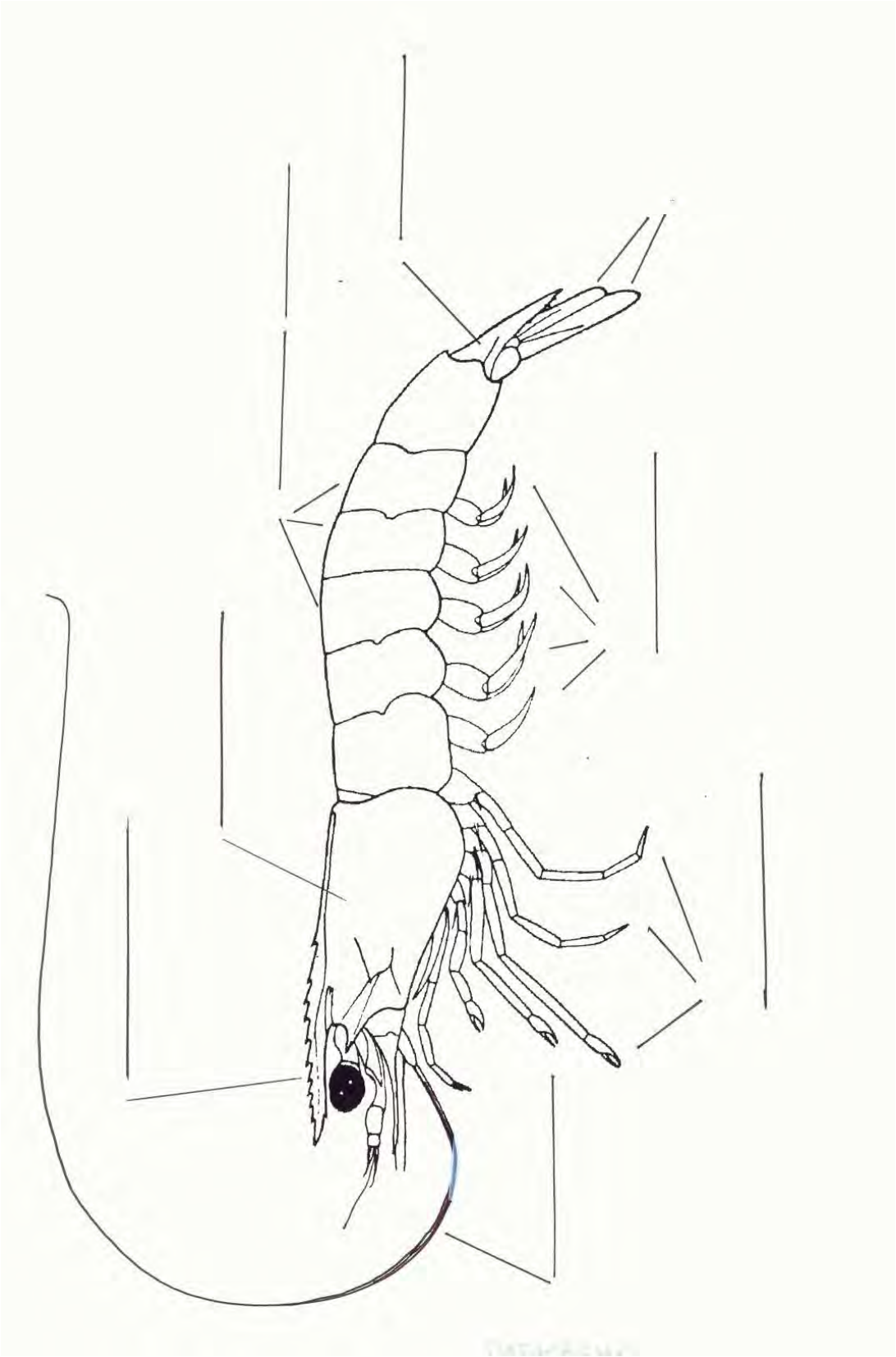
1. How many swimming legs are there? _____

2. How many walking legs are there? _____

3. How many antennae are there? _____

4. How many segments are there along abdomen? _____

5. Is the head fused? _____



Label the external features as you locate the parts on your prawn

-Telson
-Tergum
-Swimmerets
-Antenna
-Rostrum
-Walking legs
-Carapace
-Uropods

Dissection of prawn

- Cut along the underside of the prawn with scissors.
- Make the incision between the left and right of legs.
- Cut along the dorsal surface towards the head and at the cephalothoracic groove turn and cut back towards the ventral surface.
- You can now peel this section of the carapace downs and away from the body. You have revealed the gills.
- Using your probe carefully separate some gill filaments. They will collapse down on themselves if they are not supported by water.

- Note the gill filaments are like many thread like projections.

Sketch a diagram of the prawn's gill

- Now remove a walking leg from the rest of the exoskeleton, keeping the gill attached. **Figure 4** shows what your leg and gill look like if you have removed them intact. Note that one gill looks like a feather.

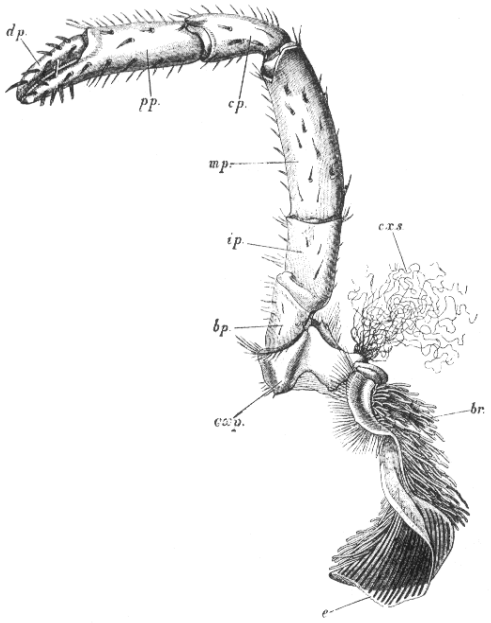


Figure 4. Leg and gill attached

▪ Internal Organs

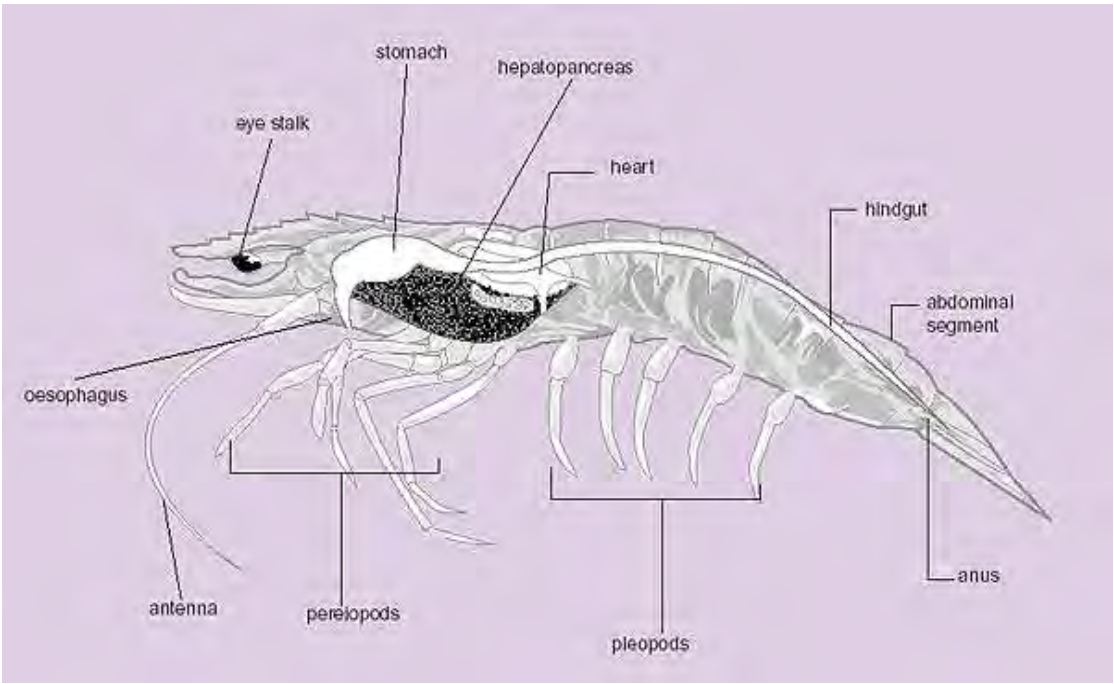


Figure 5. General location of internal organs of a prawn

Dissection of a Bivalve Mussel *(Perna canaliculus)*

Did you know?

Mussels can live for up to 50 years, although cultured ones are harvested at around 28 months! Mussels have been cultivated for almost 800 years in Europe, and have been used as a food source for more then 2,000 years. The byssal threads are so adhesive they can even cling to Teflon; scientists are trying to develop a mussel-based adhesive for use in eye surgery

- In bivalves, or pelecypods ("knife-foot" in Latin) the mantle has become greatly enlarged, and covers the head.

- The gills are highly modified for filter feeding; because the food particles they eat are so small, bivalves have no need for the scraping radula and muscular buccal apparatus seen in most other molluscs.

- Unlike its relatives, the oysters and rock scallops, which attach their lower shell valve to the substrate, *Perna sp attaches* itself with elastic **byssal threads**. You can see these threads protruding from the valves of your specimens Figure 7.

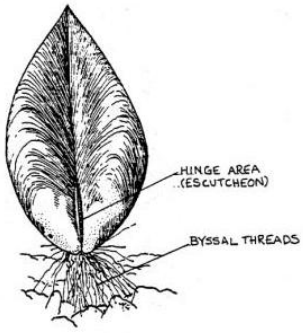


Figure 6. Young mussel attached to substrate (dorsal view)

Mussel general anatomy

- **beak** - the oldest part of the shell, this is the hump-like structure near where the two valves (shells) are hinged together
- **anterior and posterior adductors** - the adductors draw the two valves (shells) together
- **mantle** - "...the mantle is a sheath of skin that hangs down in two folds around the soft body and encloses a mantle cavity... The outer side of the mantle secretes the shell, while the inner side is ciliated, and along with gills or lungs that develop from it, participates in gas exchange."
- **gills** - used for both feeding and breathing.
- **foot** - used for digging and anchoring
- **teeth** - help the valves (shells) to interlock
- **ligament** - causes the valves (shells) to open and close
- **incurrent and excurrent siphons** - circulates water into and out of the mussel.

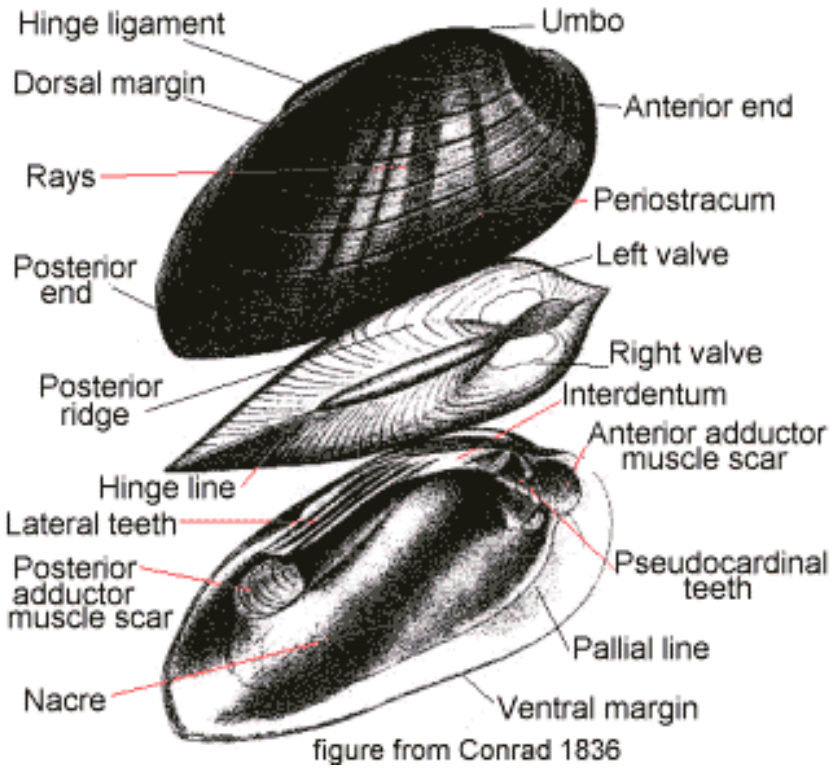


Figure 7. General scheme of a Mussel

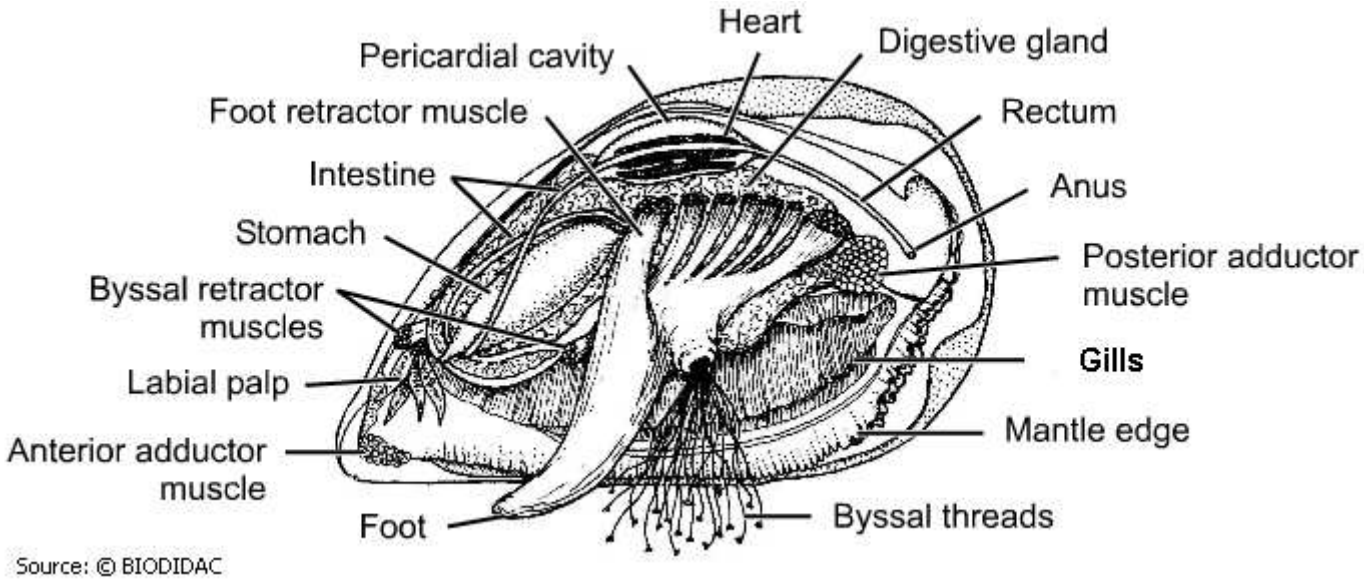


Figure 8. - Internal anatomy of a Mussel

- **Dissection steps:**

Picture 1

Getting started

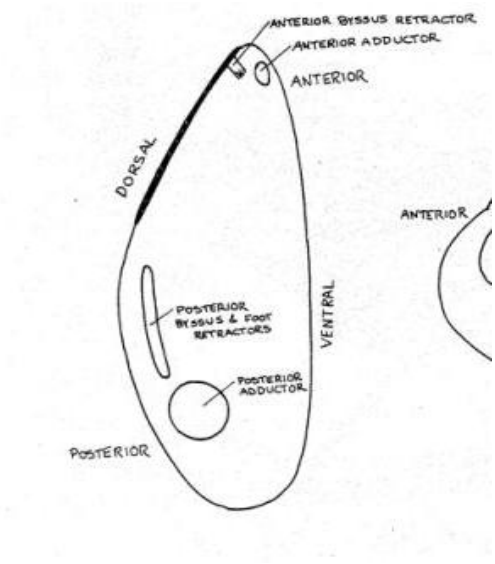
-Assemble the materials.

-Record the species of mussel (if known), and where they were obtained.

Picture 2

Open the mussels

-Open each mussel by cutting through its adductor muscles.



-Major muscles to sever in Perna sp

Picture 3

Anatomy

-Open the mussel and examine the various organs.

Picture 4

Gills

-Locate the ctenidia (gill tissue) in each half of the mussel.

Picture 5

Foot

-Locate the foot (along the midline of the mussel).

Picture 6

Stomach

-Locate the stomach (near the foot).

Picture 7

Adductor muscle (anterior)

-Locate the adductor muscles (that were cut to open the shell). This is the anterior adductor muscle.

Picture 8

Adductor muscle (posterior)

-This is the posterior adductor muscle.

Picture 9

Mantle

-Locate the mantle.

Picture 10

Gonad

-Locate the gonad, within the mantle tissue.

Extension Questions

1. Why is Aquaculture important?

_____
_____
_____
_____
_____

2. Prawns and bugs lose the calcium in their shell when they moult. Because it is hard to find calcium in water, what do they do to reduce this loss?

_____
_____
_____
_____
_____

3. What does the carapace do in crustaceans?

_____
_____
_____
_____

4. Why shouldn't you feed your fish the same amount of food throughout the year?

_____
_____
_____
_____

5. Why is it important for a prawn farmer to sample and examine the gills and shells of his/her stock?

_____
_____
_____
_____

6. List three things which make an animal suitable for aquaculture.

1._____

2._____

3._____

7. Complete the diagram: differences between Mammals, Fish and Crustaceans

Characteristic	Mammals	Fish	Crustaceans
Back bone			
Body temperature			
Support			
Breathing			
Movement			
Number of legs			
Protection			

8. List four different animals or plants that are grown in aquaculture somewhere in the world.

1._____ 2. _____

3._____ 4. _____

NOTES