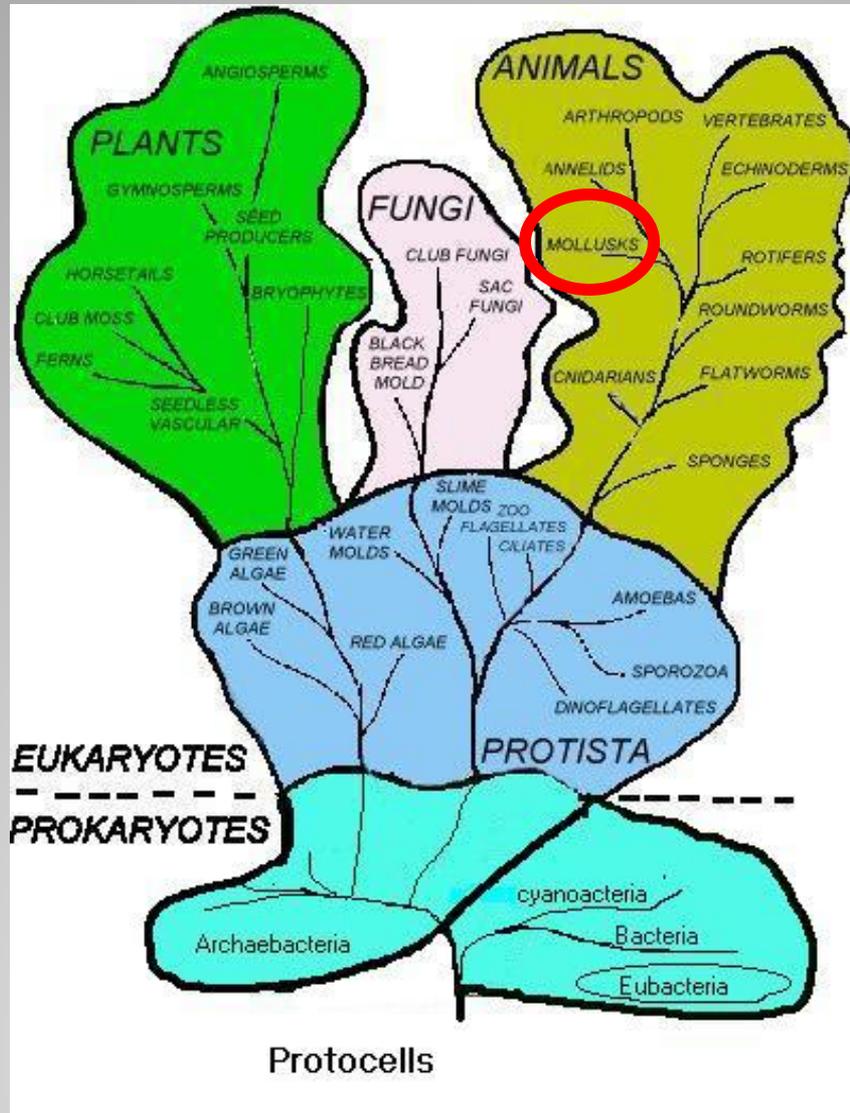


Bivalve Biology

Dale Leavitt

ROGER WILLIAMS
UNIVERSITY



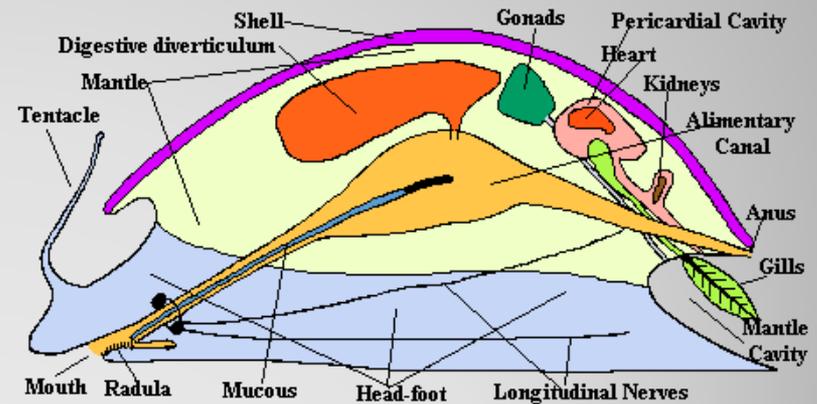
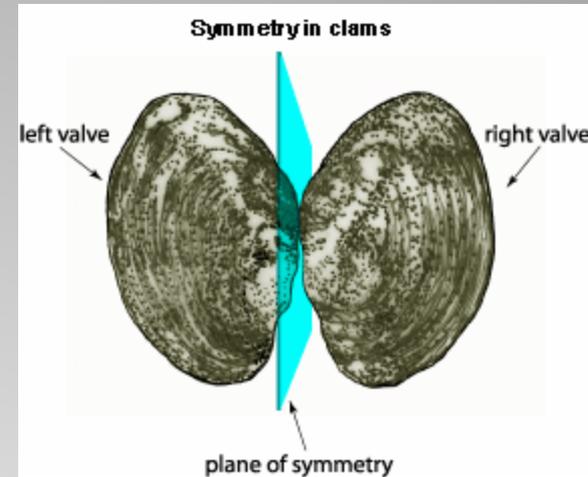
Shellfish Biology 101

Phylum Mollusca



- Best known group of invertebrates
 - animals without backbones
 - well known because of shell collecting
- Second largest Phylum
 - >80,000 living species have been named
 - 35,000 species in the fossil record
- Majority of mollusks are marine

- bilaterally symmetrical
- majority have a shell of some kind
- three distinct areas
 - distinct head area
 - visceral mass
 - large, muscular foot
- mantle is present
- simple digestive system => primarily herbivores



Phylum Mollusca



Murex (Murex) hystricosus Houart & Dharma, 2001
Kangean Island, East Java.



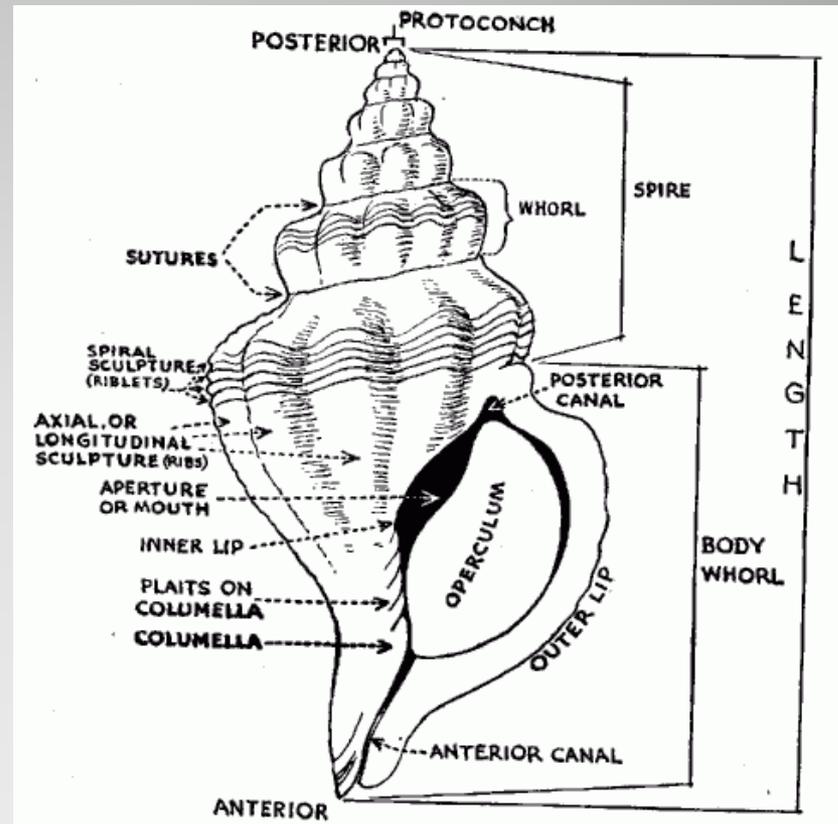
Blue-ringed Octopus



Come in a variety of shapes and sizes

There are seven Classes of Mollusca:

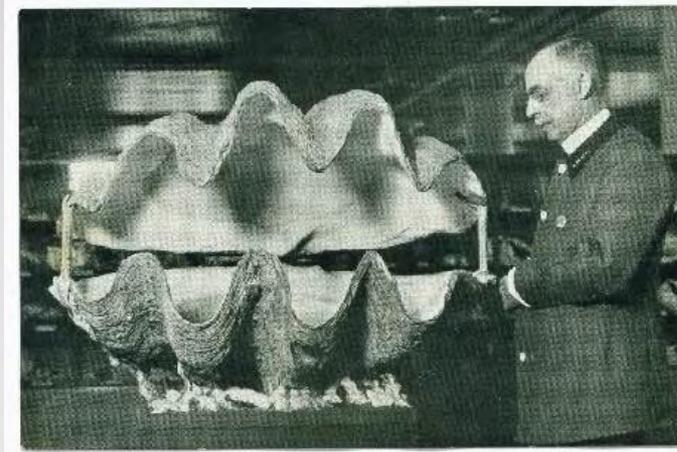
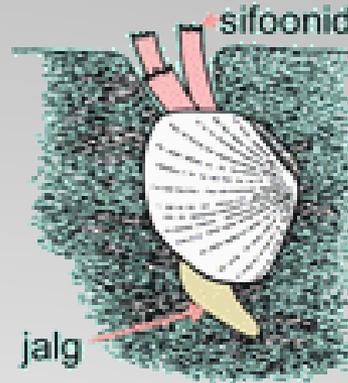
- Gastropoda single, usually spirally coiled shell into which the body can be withdrawn



Phylum Mollusca

There are seven Classes of Mollusca:

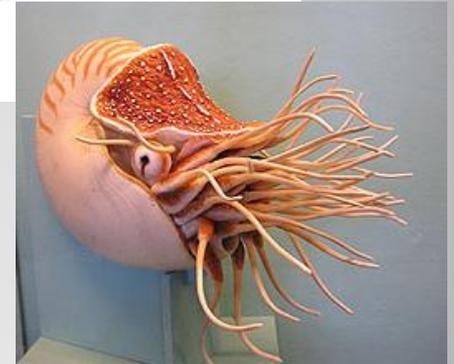
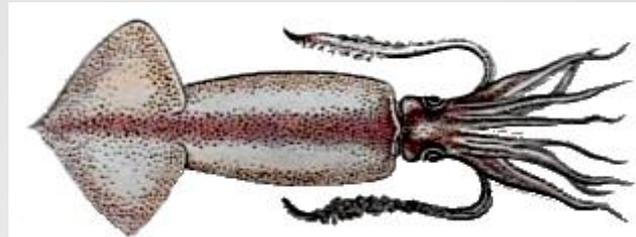
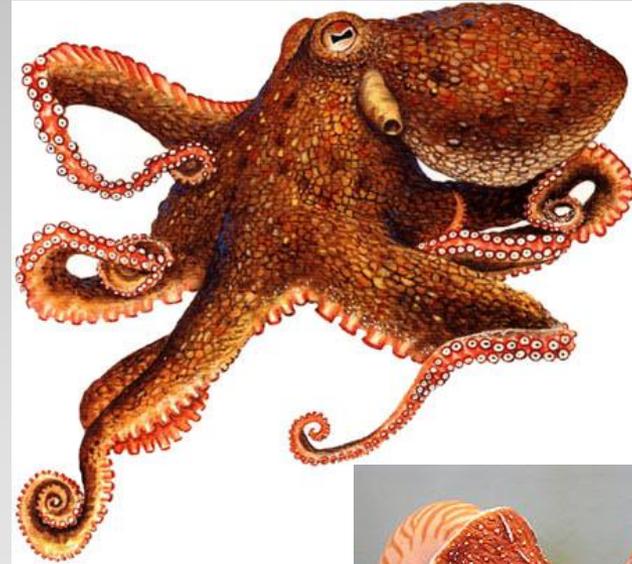
- **Gastropoda** single, usually spirally coiled shell into which the body can be withdrawn
- **Bivalvia** two laterally-compressed shells, hinged together by an elastic ligament and shell teeth



Phylum Mollusca

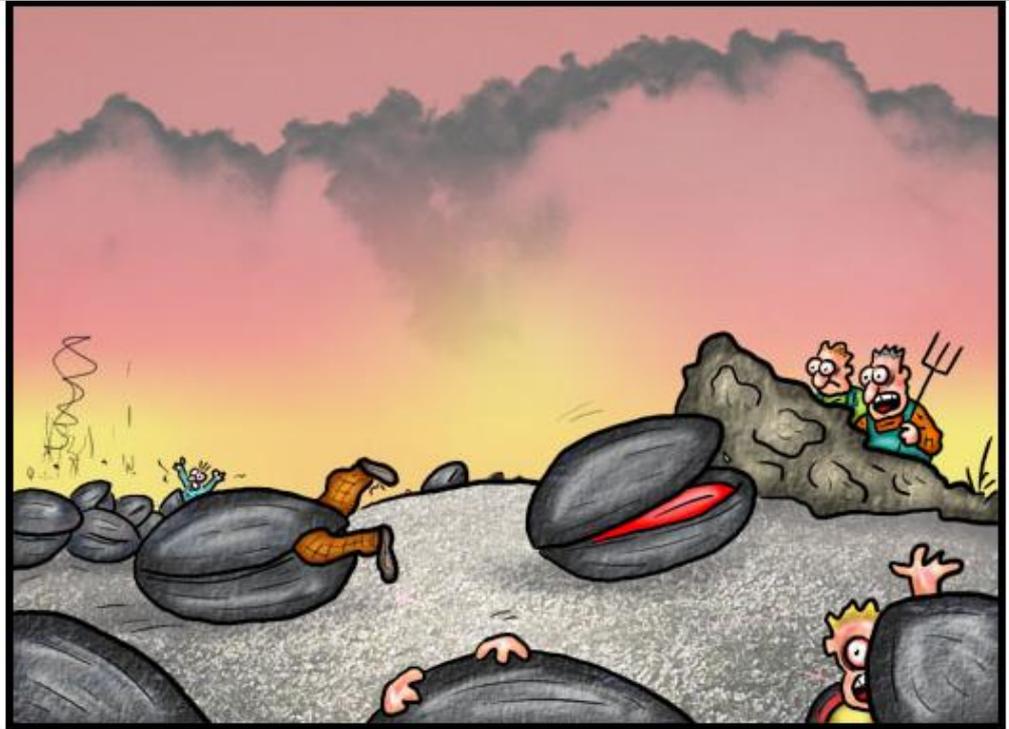
There are seven Classes of Mollusca:

- Gastropoda single, usually spirally coiled shell into which the body can be withdrawn
- Bivalvia two laterally-compressed shells, hinged together by an elastic ligament and shell teeth
- Cephalopoda A funnel derived from the molluscan foot - circumoral arms - chitinous beaks.



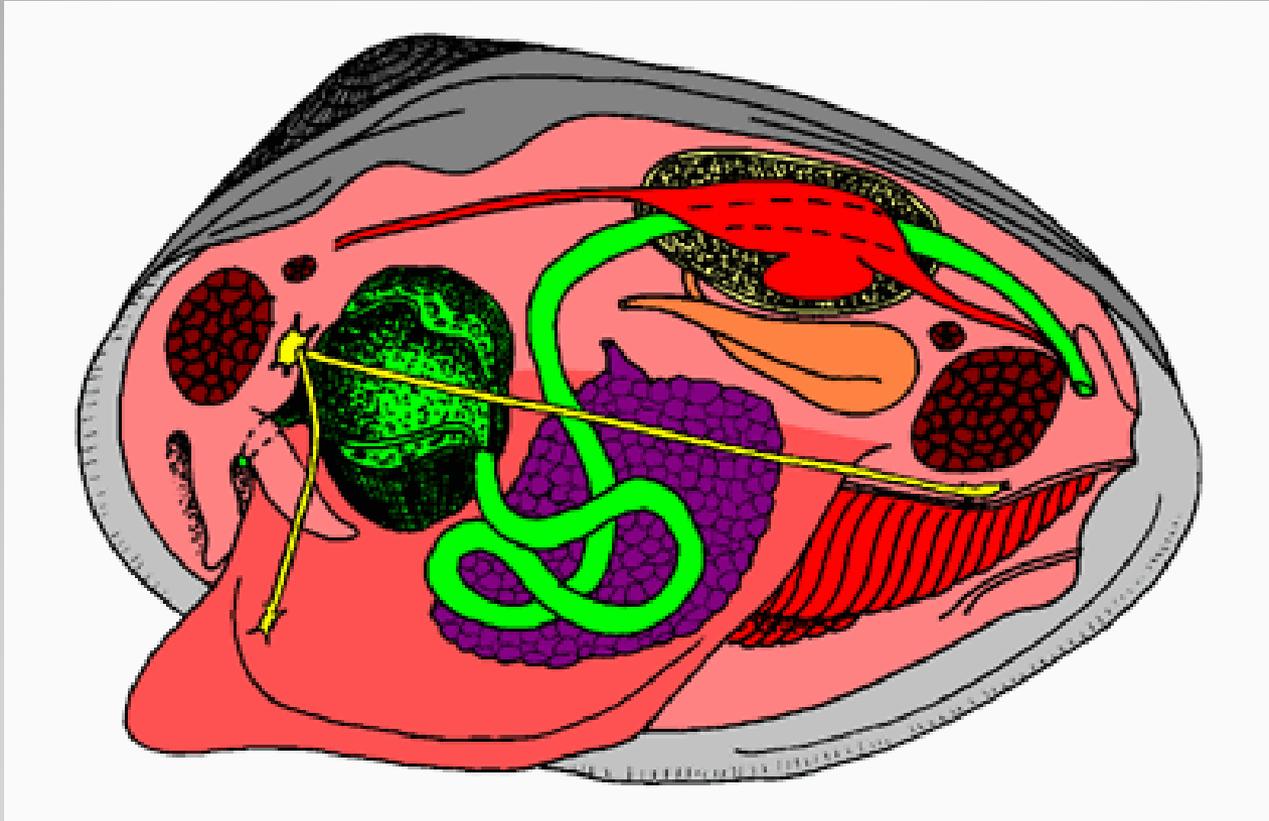
Phylum Mollusca

- Two shells (valves) with hinge
- Laterally compressed
- Head greatly reduced
- Fleshy mantle encasing the visceral mass and a muscular foot
- Lost the radula
- Gills are large and used for feeding
- Sedentary



"Who could guess that when the end came, it would be giant clams?"

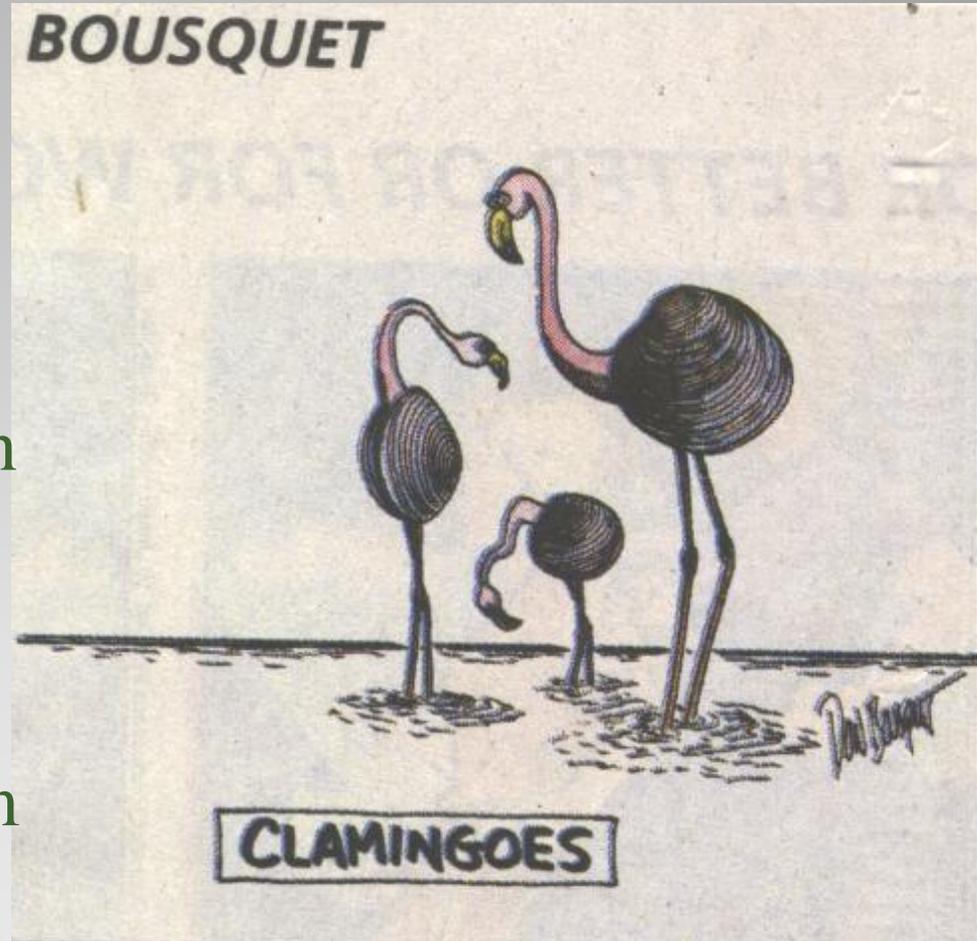
Class Bivalvia



Adult Biology

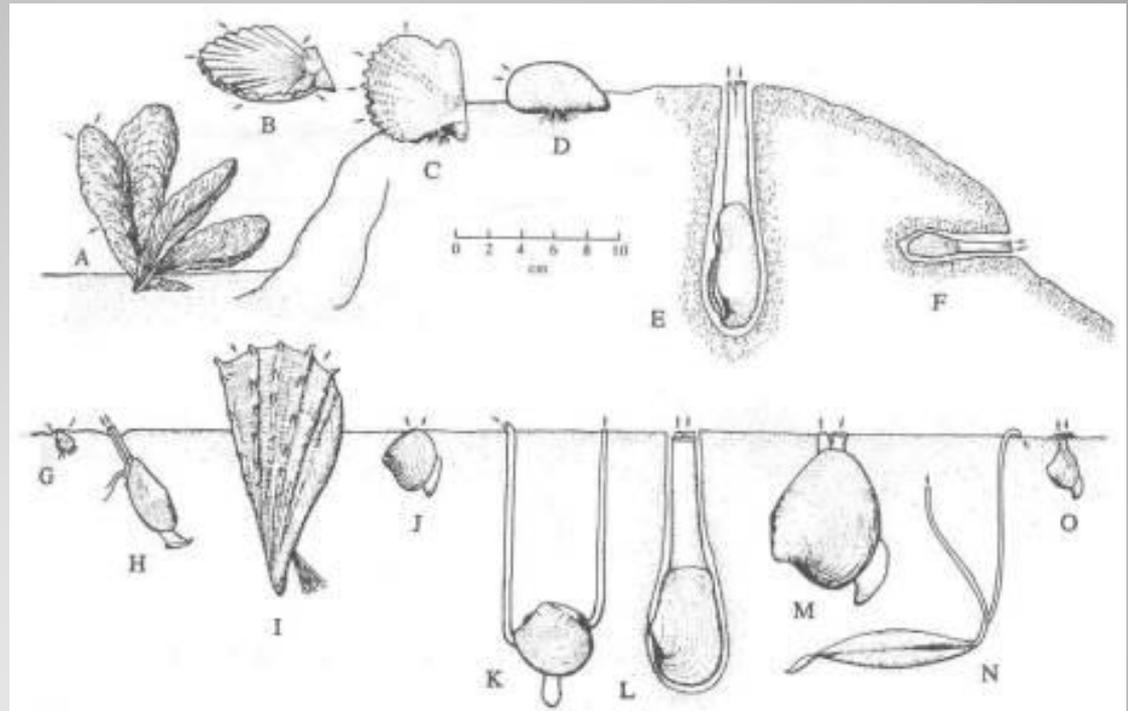
What do you need to know as a shellfish farmer?

- Life styles
- Anatomy
- Growth
- Respiration
- Feeding & Digestion
- Nervous system
- Circulatory system
- Locomotion system
- Reproductive system

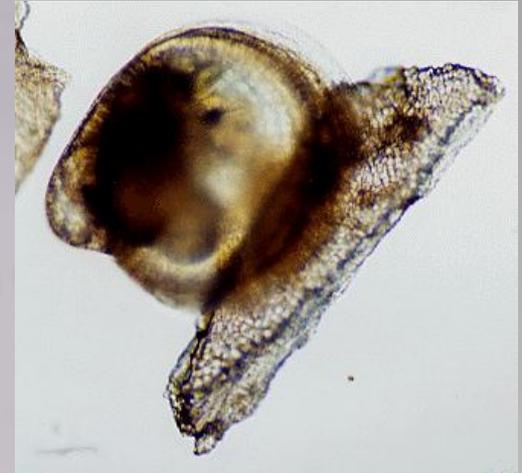


What does a shellfish farmer need to know about shellfish biology?

- Epifaunal
 - Byssally attached (blue mussel)
 - Reclining (giant clam)
 - Cemented (oyster)
 - Swimming (scallop)
- Semi-Infauanal
 - Byssally attached (ribbed mussel)
- Infaunal
 - Burrowing (quahog)
 - Boring (piddock)



Life Styles of the Shelled and Aquatic



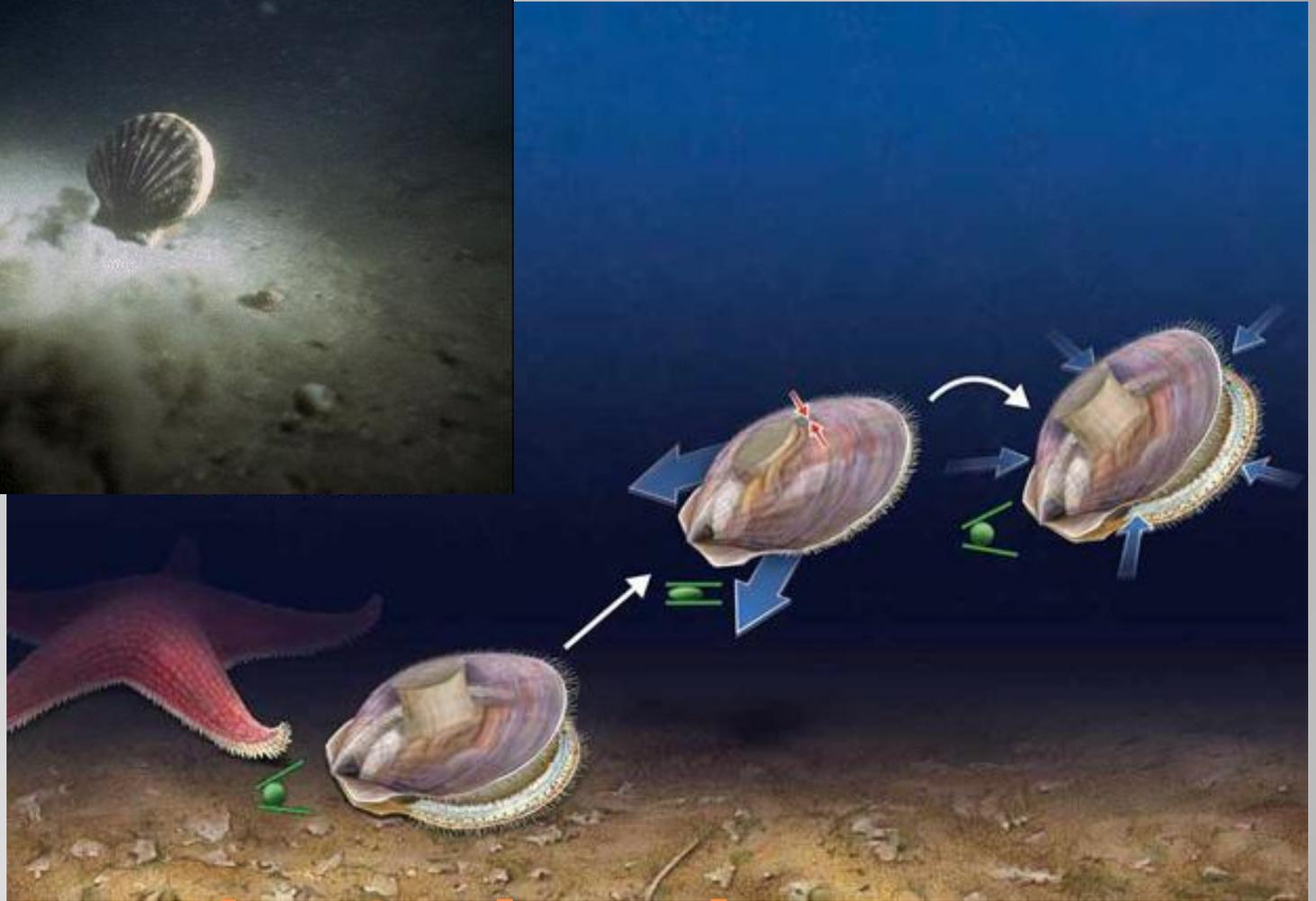
Epifaunal - Cemented



Epifaunal – Byssal attachment



Epifaunal – Reclining



Epifaunal - Swimming



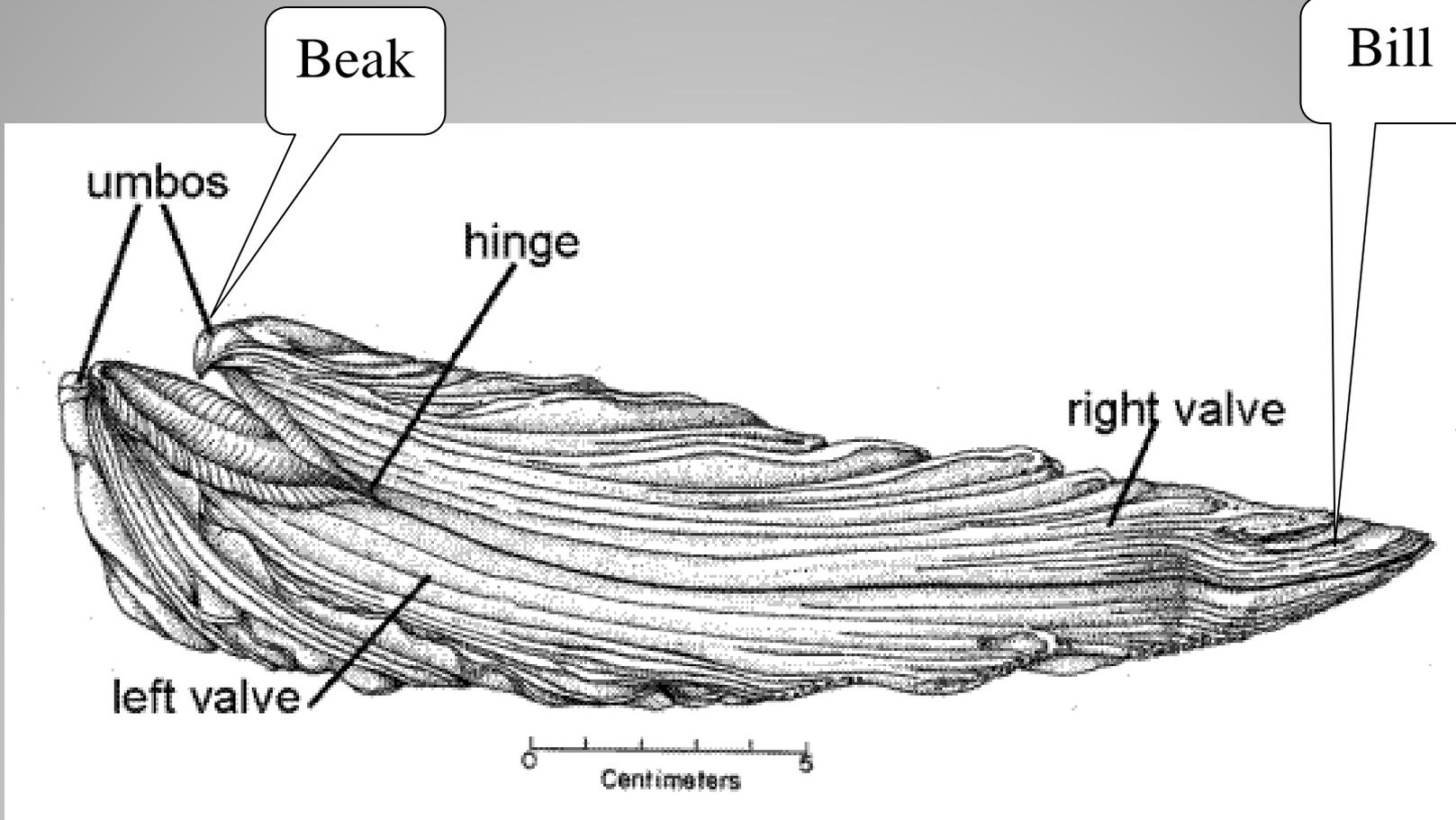
Semi-infaunal – Byssal attachment



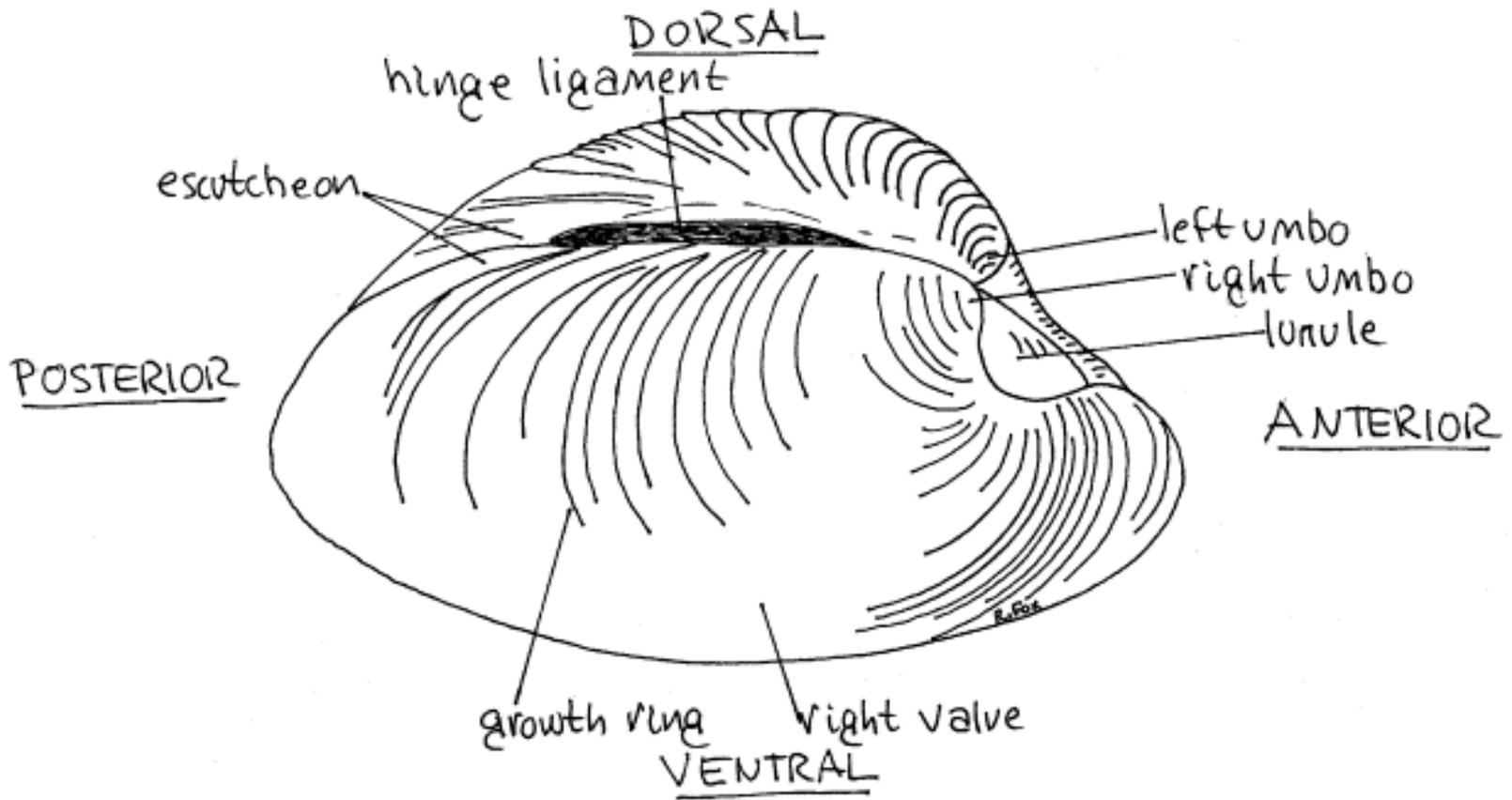
Infaunal - Burrowing



Infaunal - Boring



External Anatomy - Oyster



Exterior Anatomy - Quahog

- *Mercenaria mercenaria*
var. alba

- White color
- Commonly found

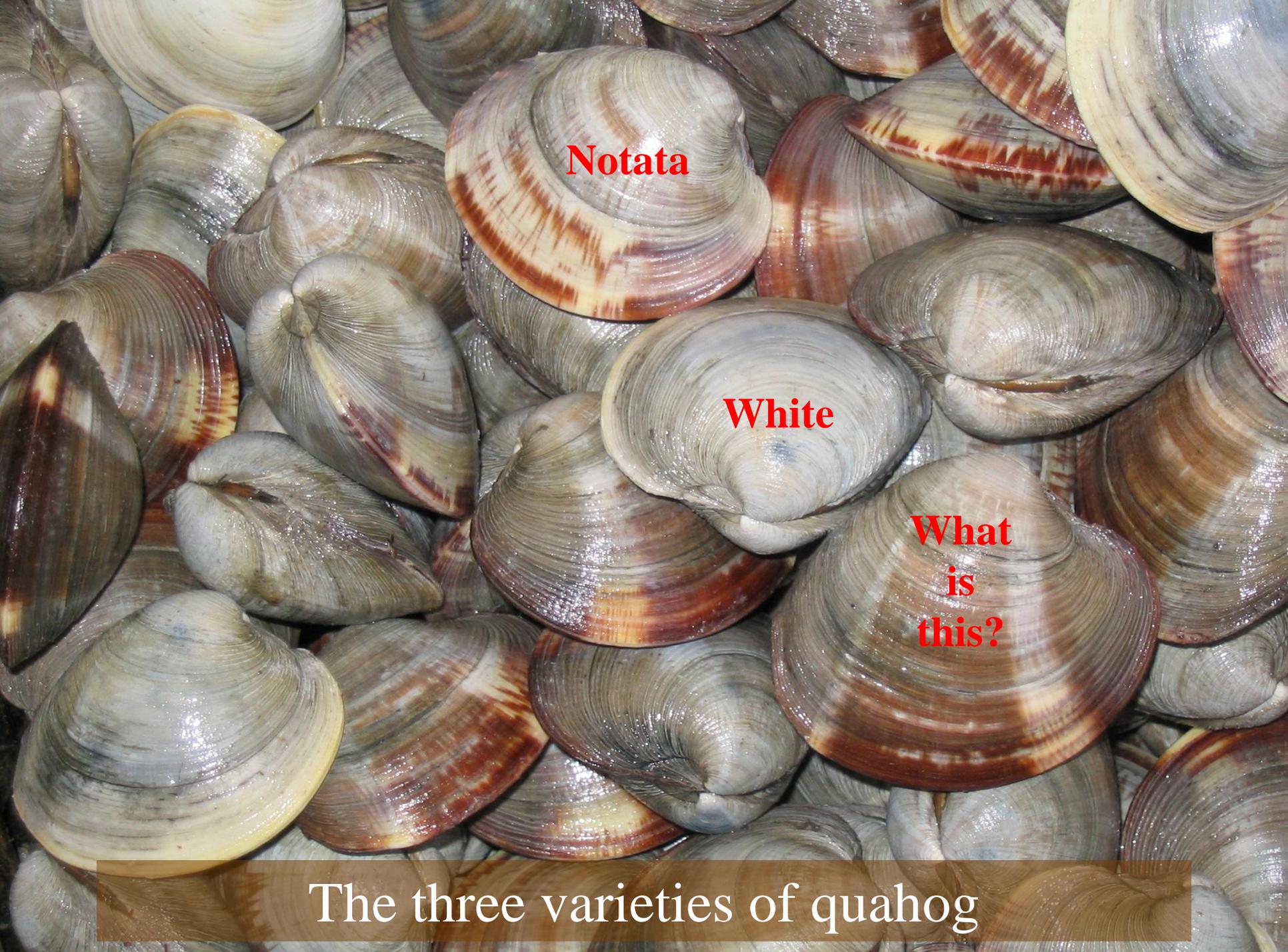


- *Mercenaria mercenaria*
var. notata

- Indian blanket or zig-zag pattern
- "Charlie Brown clams"
- 1-2% of the wild catch



The two varieties of quahog

A large pile of quahog clams, showing various shell patterns and colors. The shells are densely packed and exhibit a range of hues from light beige to dark brown, with prominent concentric growth lines. Some shells have distinct reddish-brown or yellowish bands. The clams are shown from various angles, highlighting their rounded, slightly flattened shape.

Notata

White

**What
is
this?**

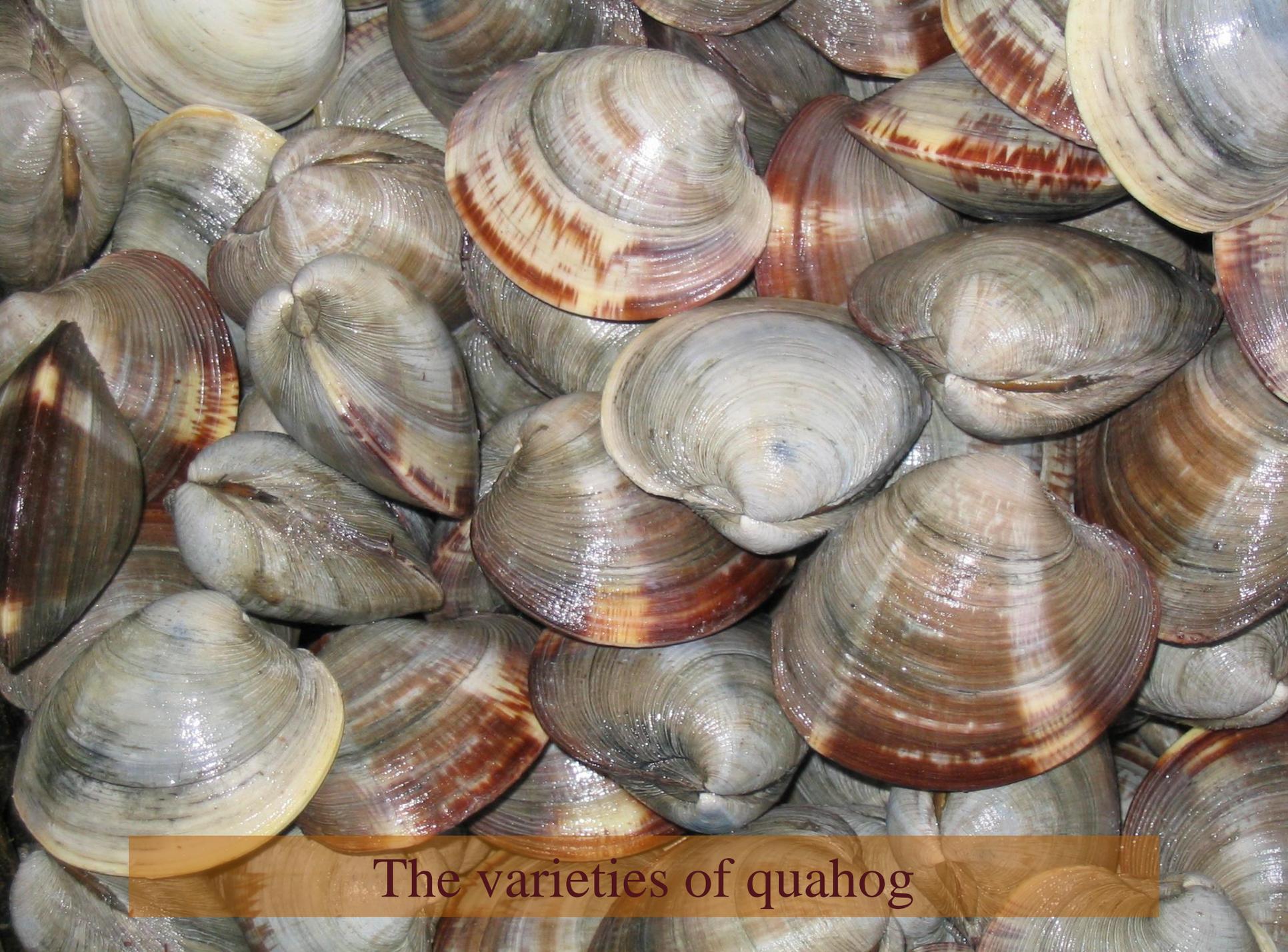
The three varieties of quahog

	Mm x Mm	M	m
White 	M	MM	Mm
Zig-zag 	m	Mm	mm

Diagram illustrating a genetic cross. The top row shows the cross Mm x Mm. The columns represent the alleles M and m. The rows represent the parents: White (M) and Zig-zag (m). The offspring genotypes are MM (White), Mm (Zig-zag), Mm (Zig-zag), and mm (Striped). The mm genotype is circled in blue and labeled 'Striped?' with a blue arrow.

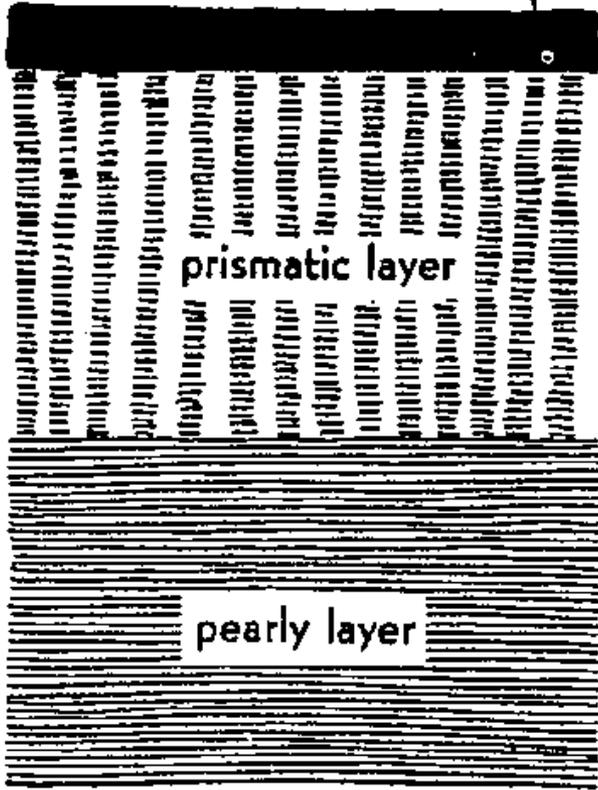
- Classic Mendelian genetic distribution
 - $\frac{1}{4}$ MM x $\frac{1}{2}$ Mm x $\frac{1}{4}$ mm
- Only see striped (mm) in hatchery stock???
- Just one of those mysteries of Mother Nature!!

Where did that third shell color come from?



The varieties of quahog

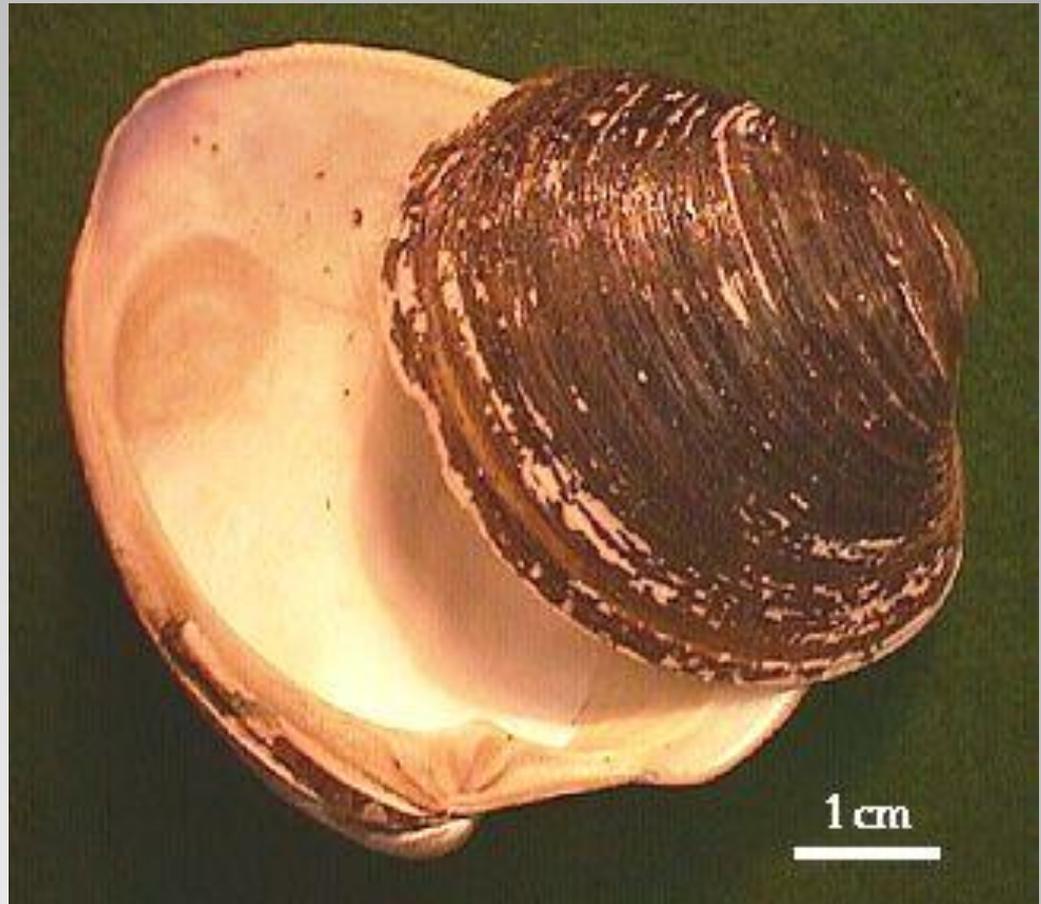
horny outer layer



prismatic layer

pearly layer

The **shell** consists of three layers.



1 cm

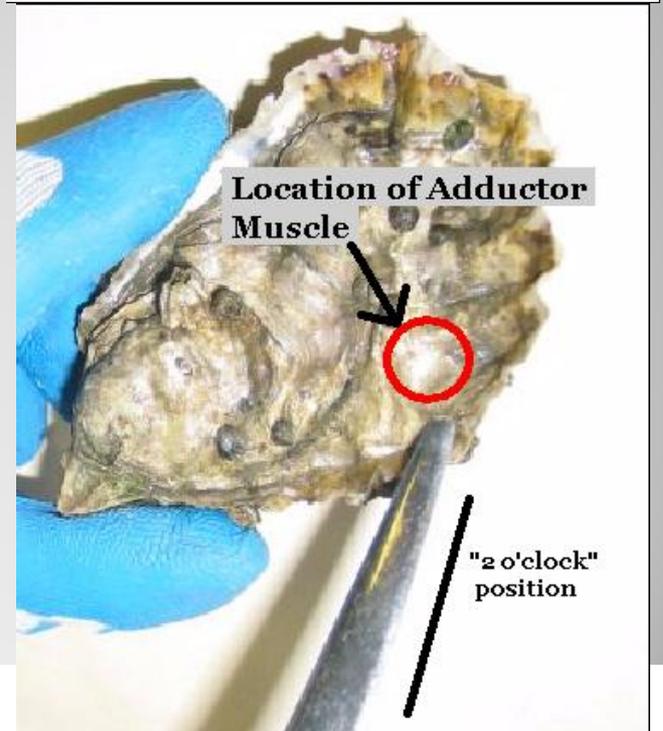
Shell layers

Soft Shell Clam
Scallop Quahog

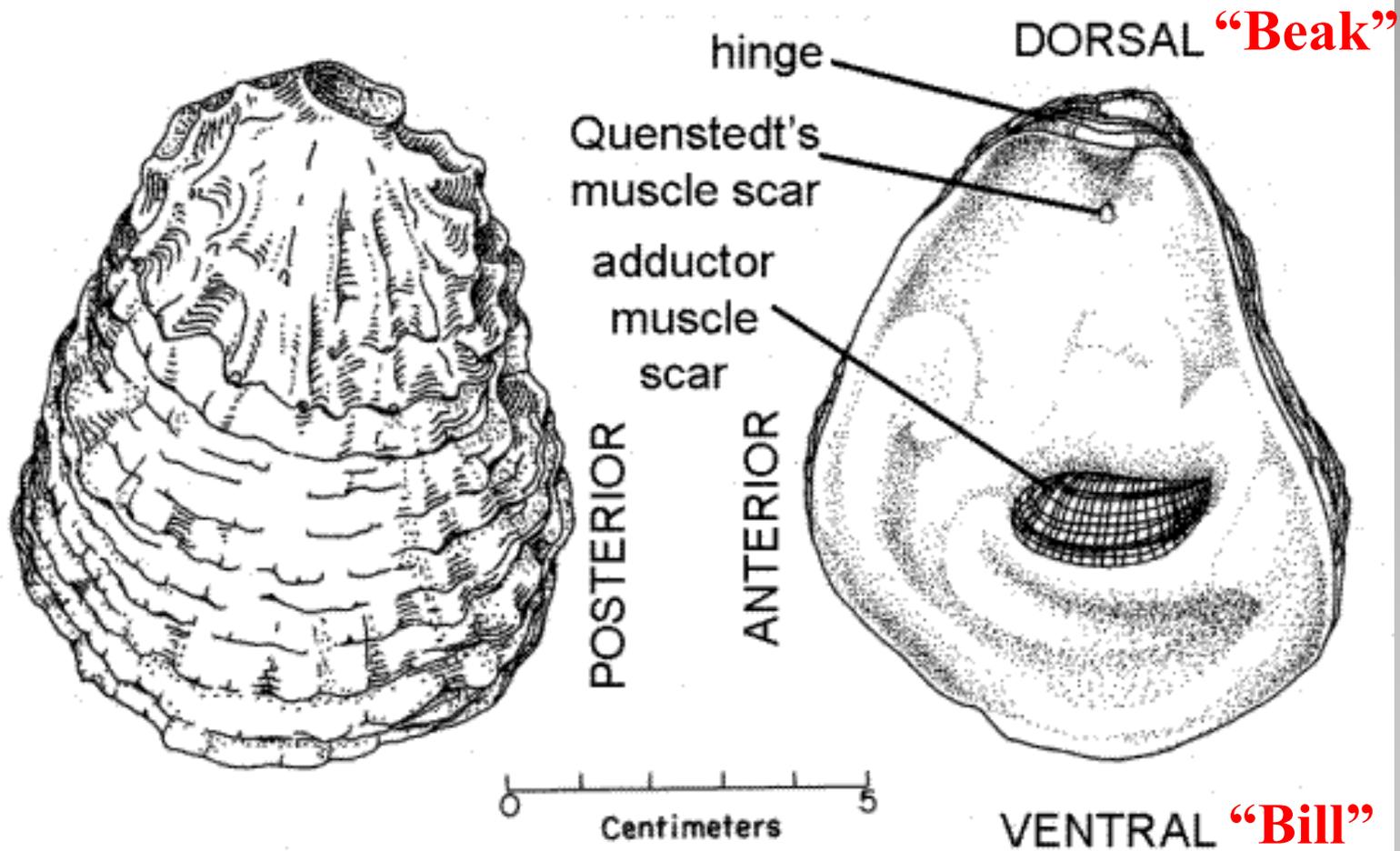


Oyster

Opening shellfish



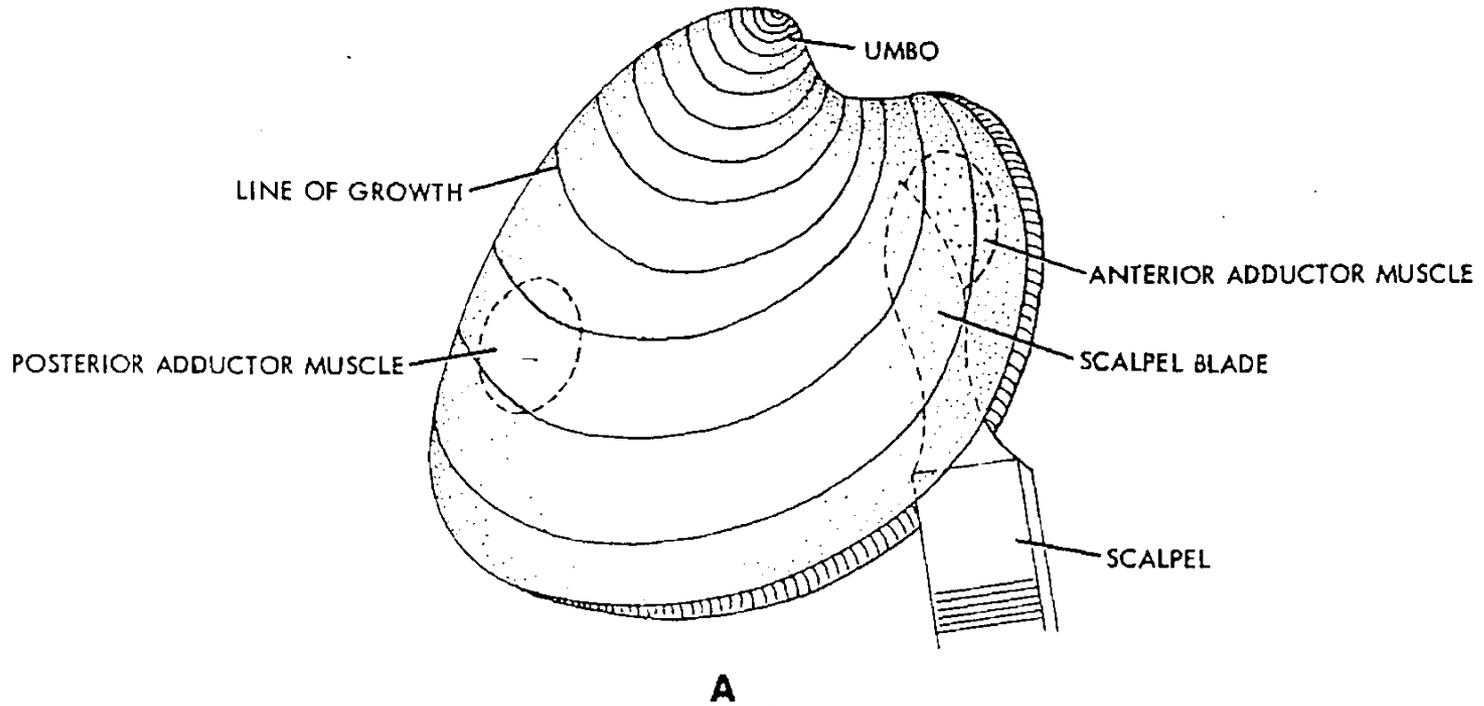
Opening an Oyster



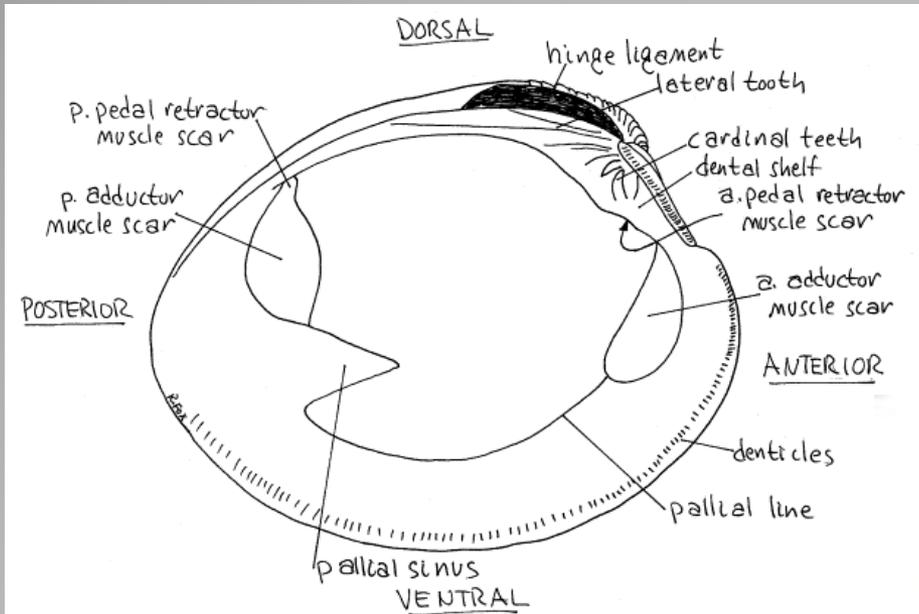
Interior of an Oyster Shell



Opening the quahog



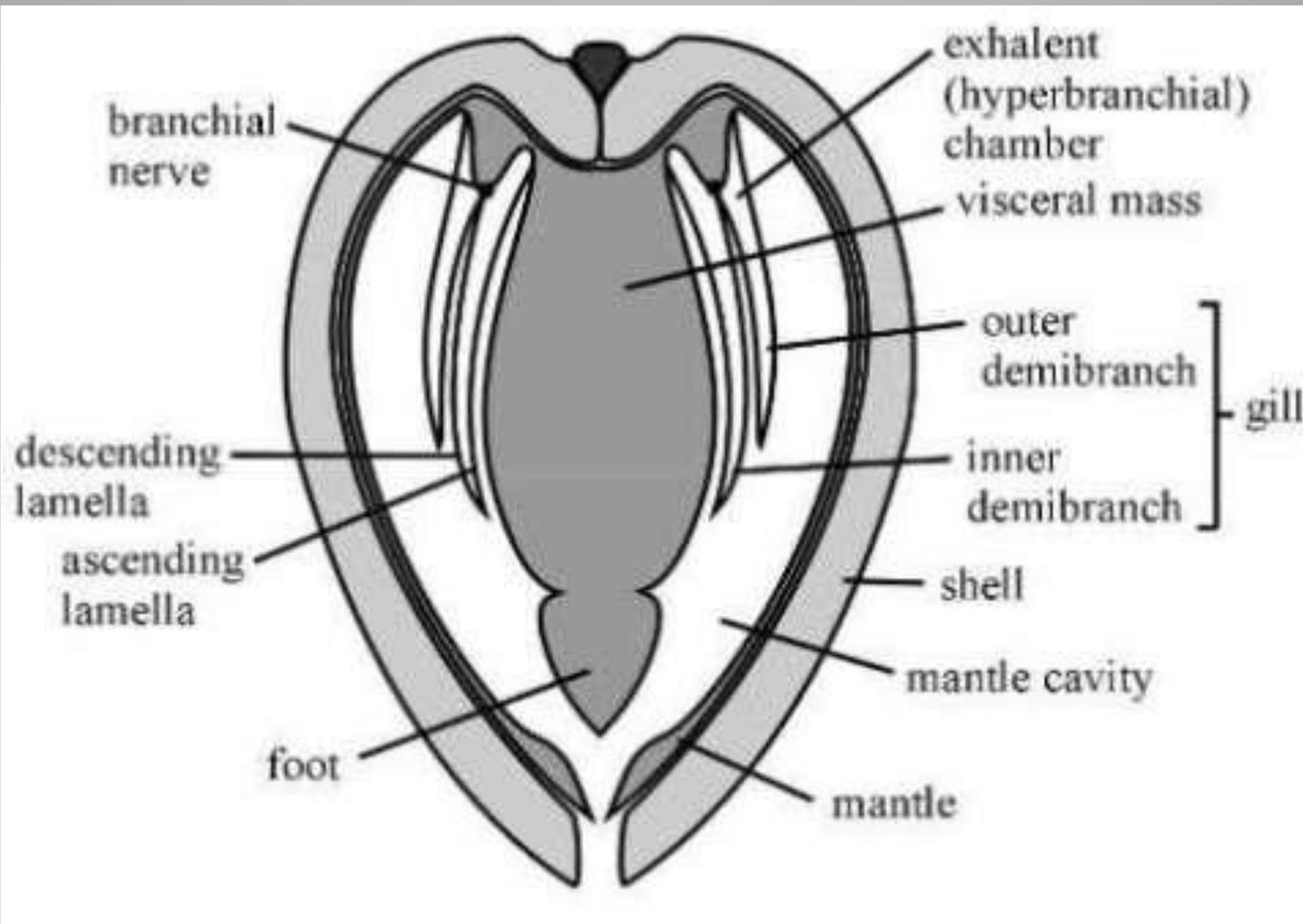
Opening the clam



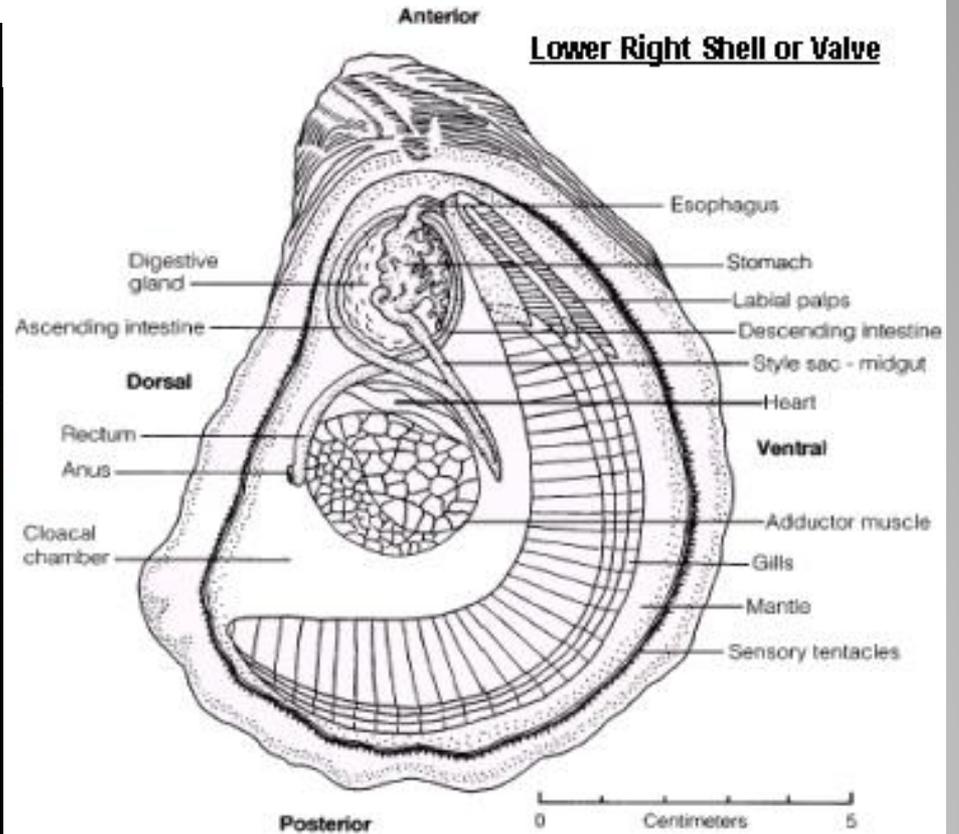
Interior of a Quahog shell



Wampum (Suckáuhock)

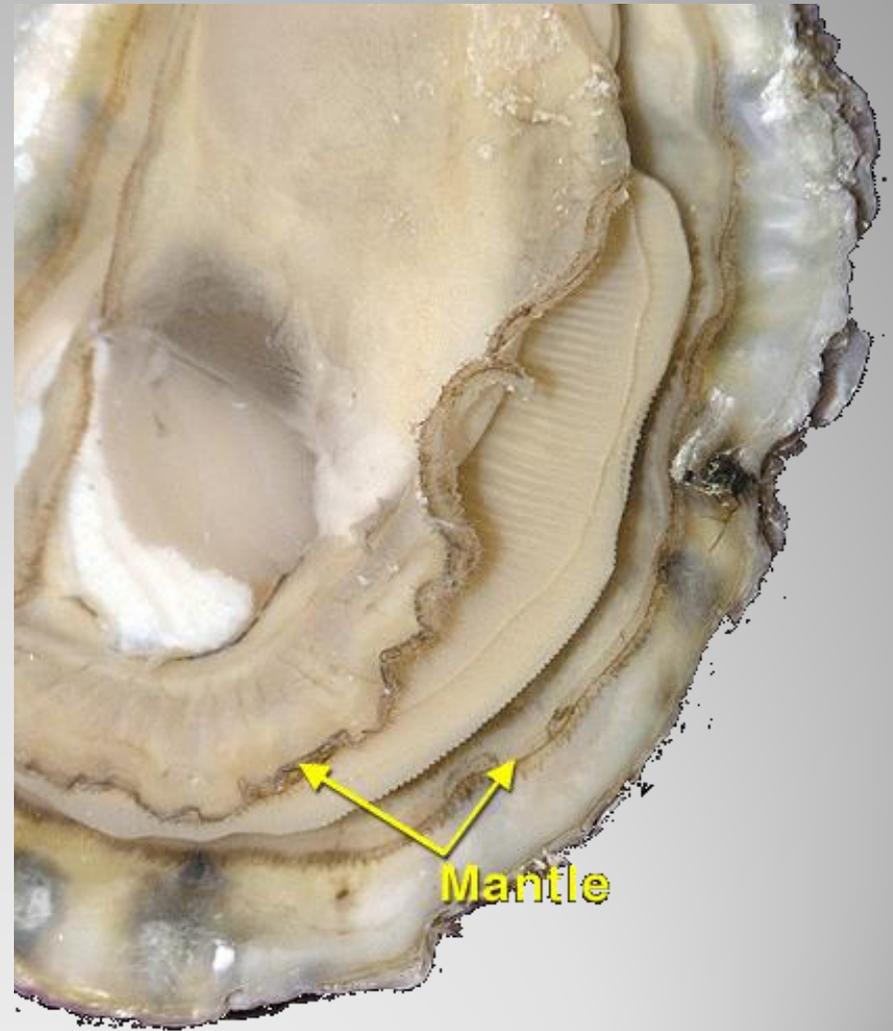


Bivalve in cross-section



Source : Maryland Sea Grant

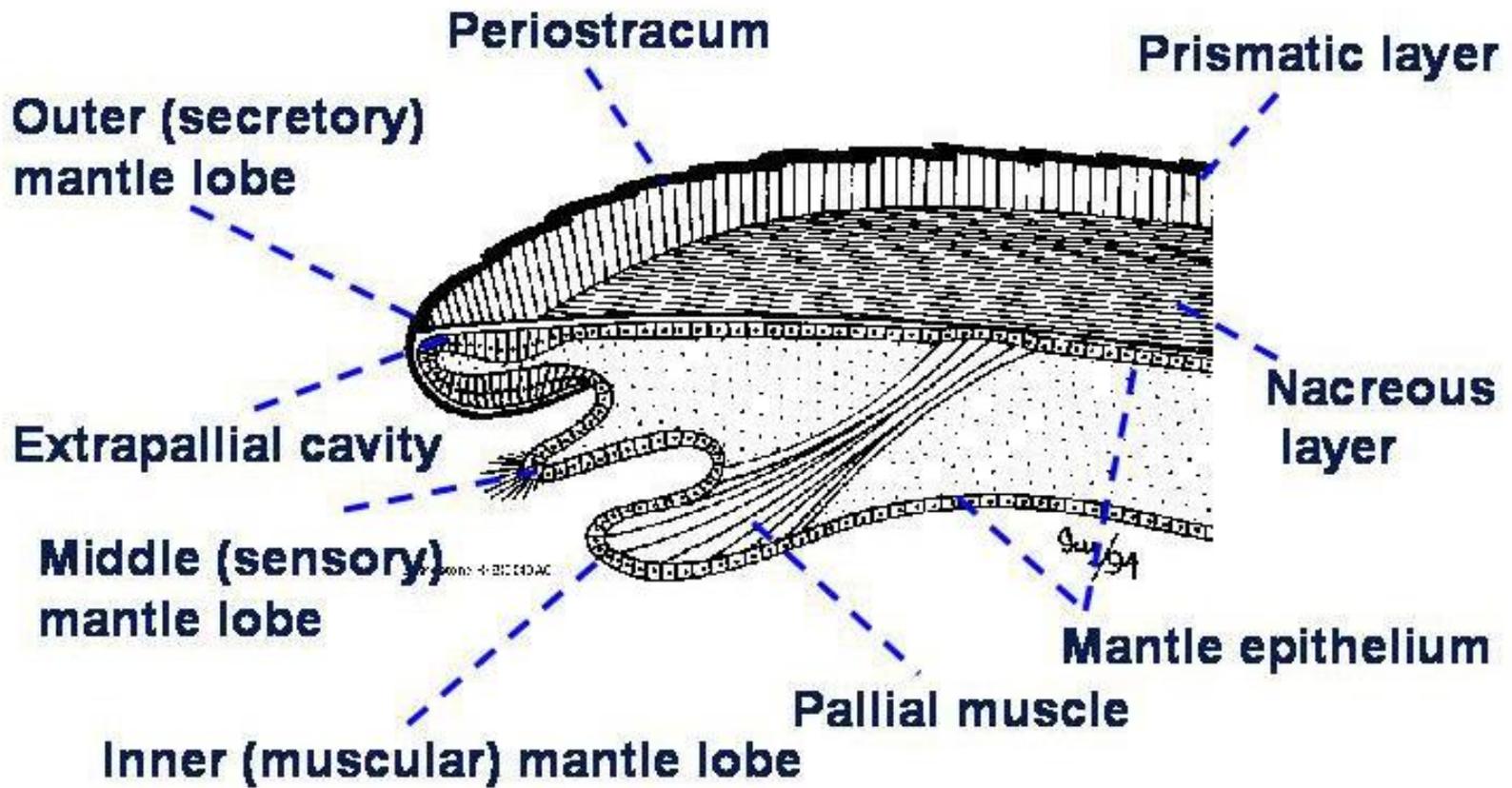
Oyster internal anatomy



Oyster Mantle



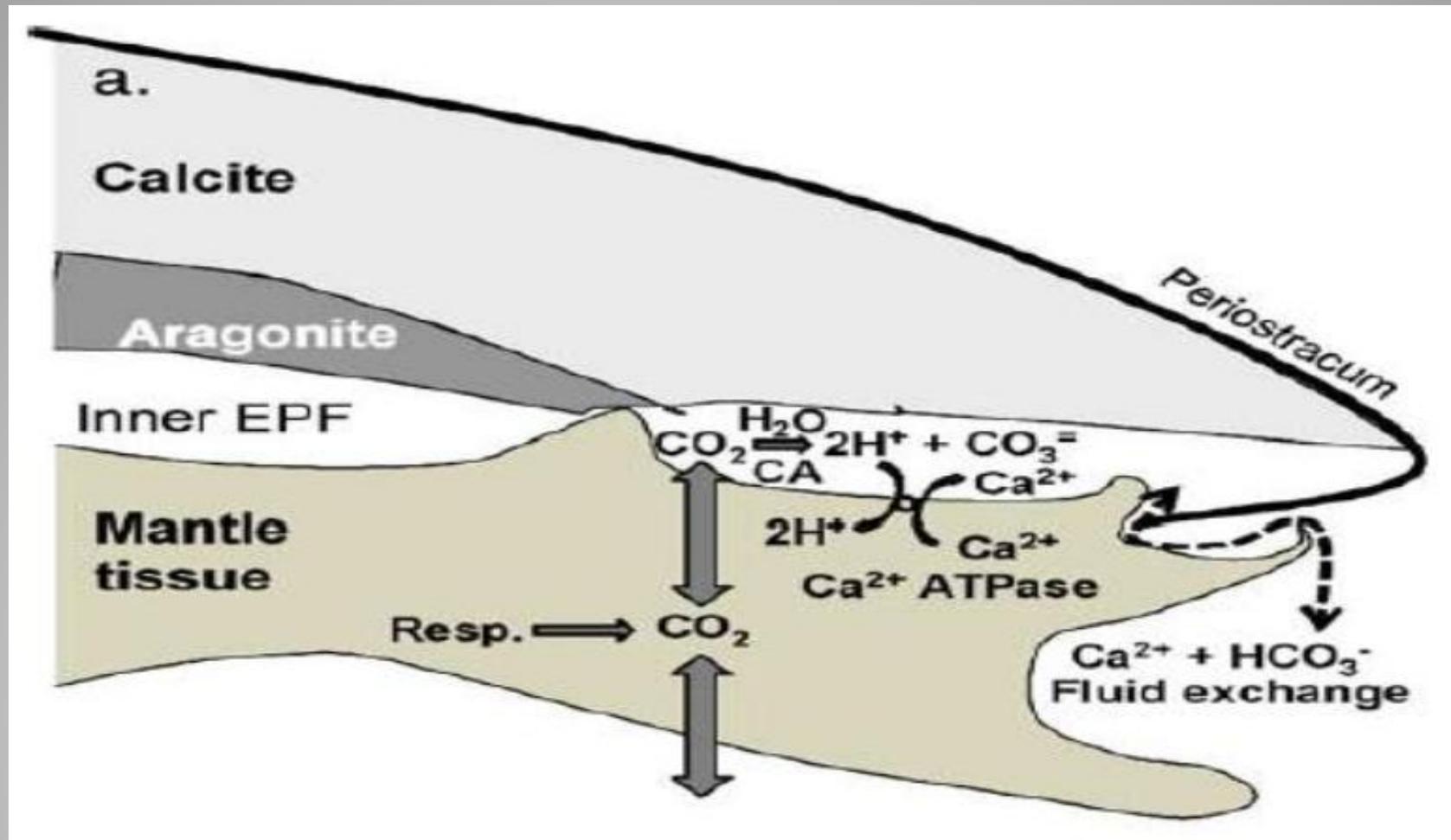
Quahog mantle



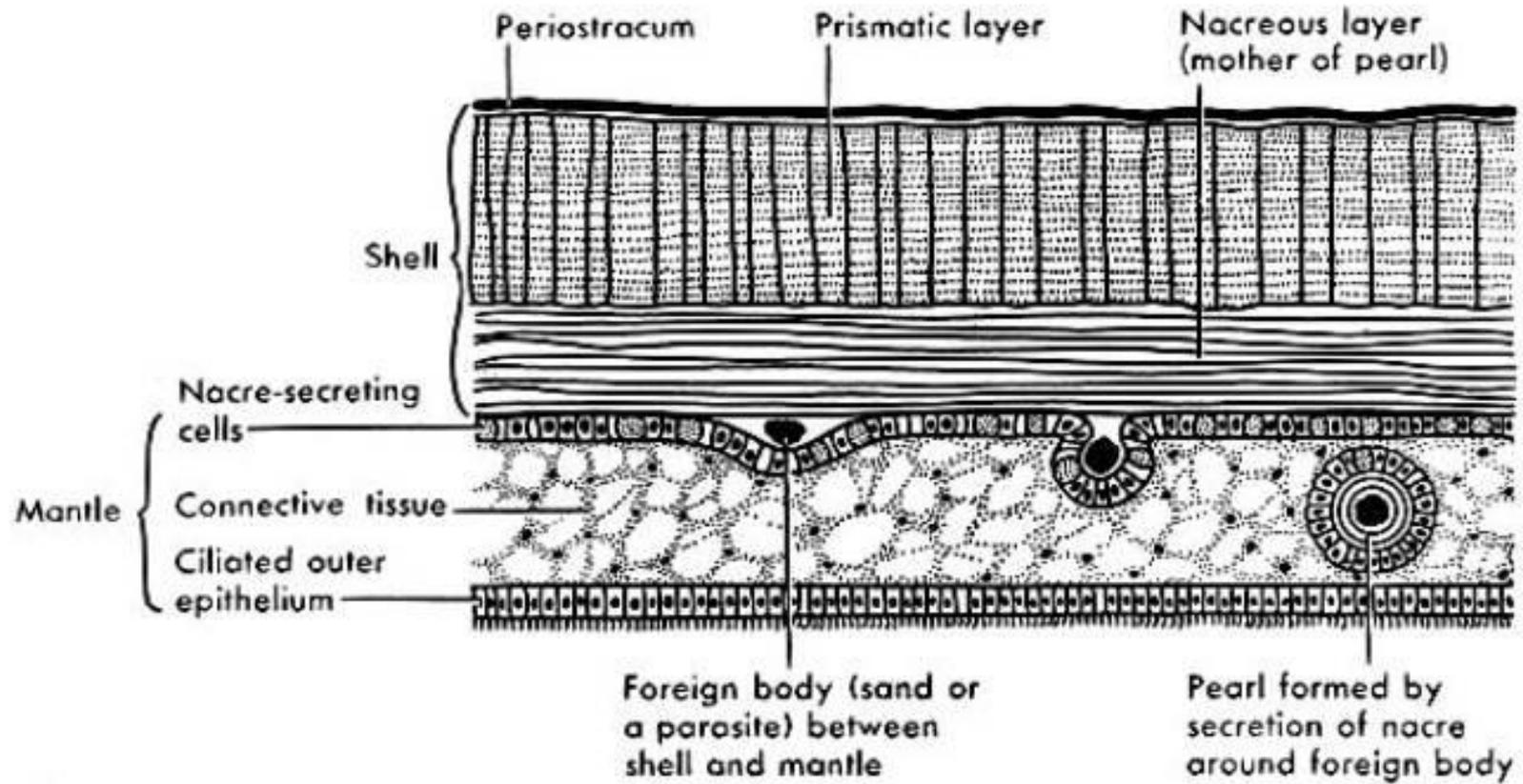
Mantle



Uses for the mantle



Shell growth - Mantle



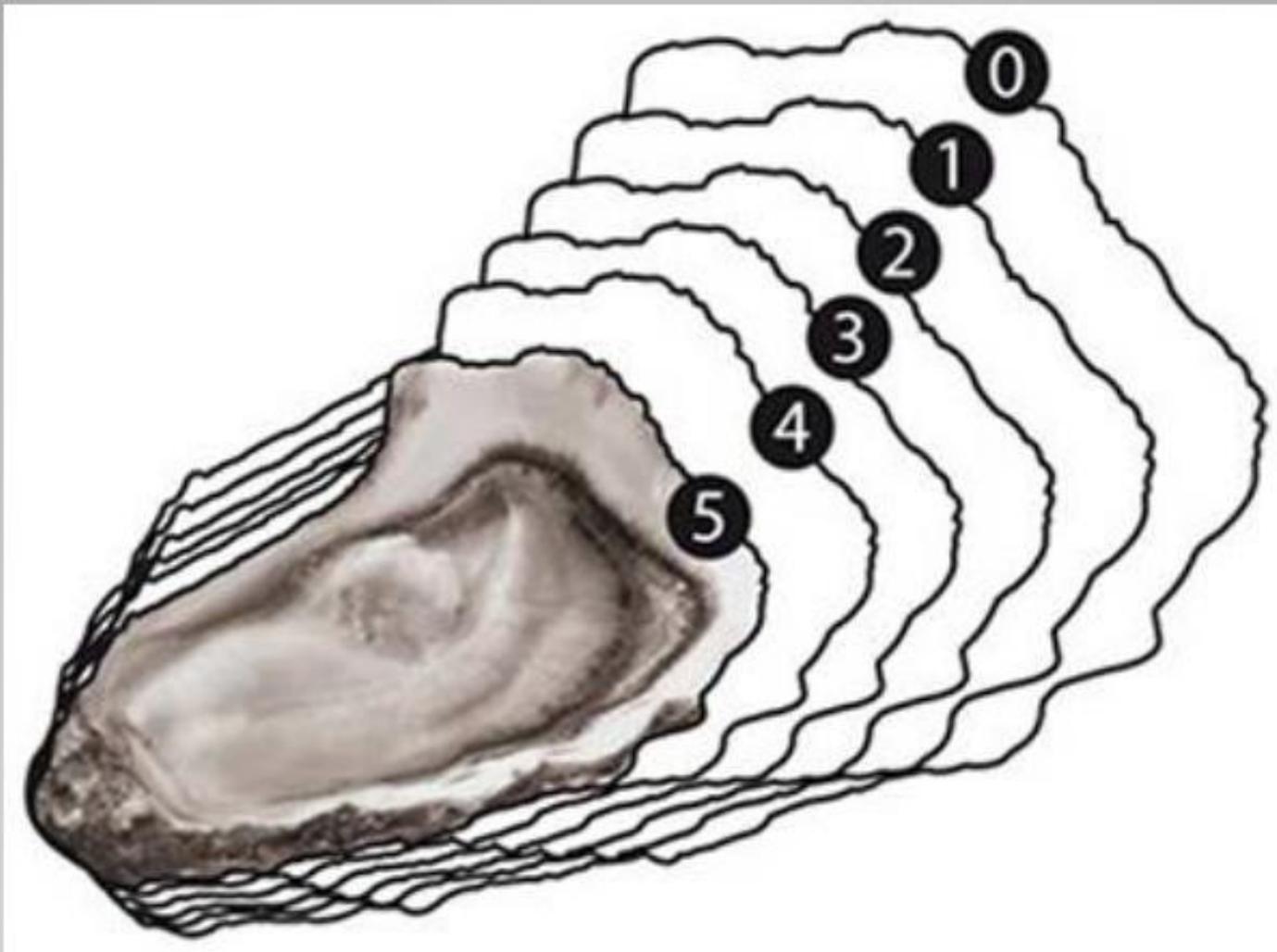
Pearl formation



Seeded Pearls (Freshwater clam)



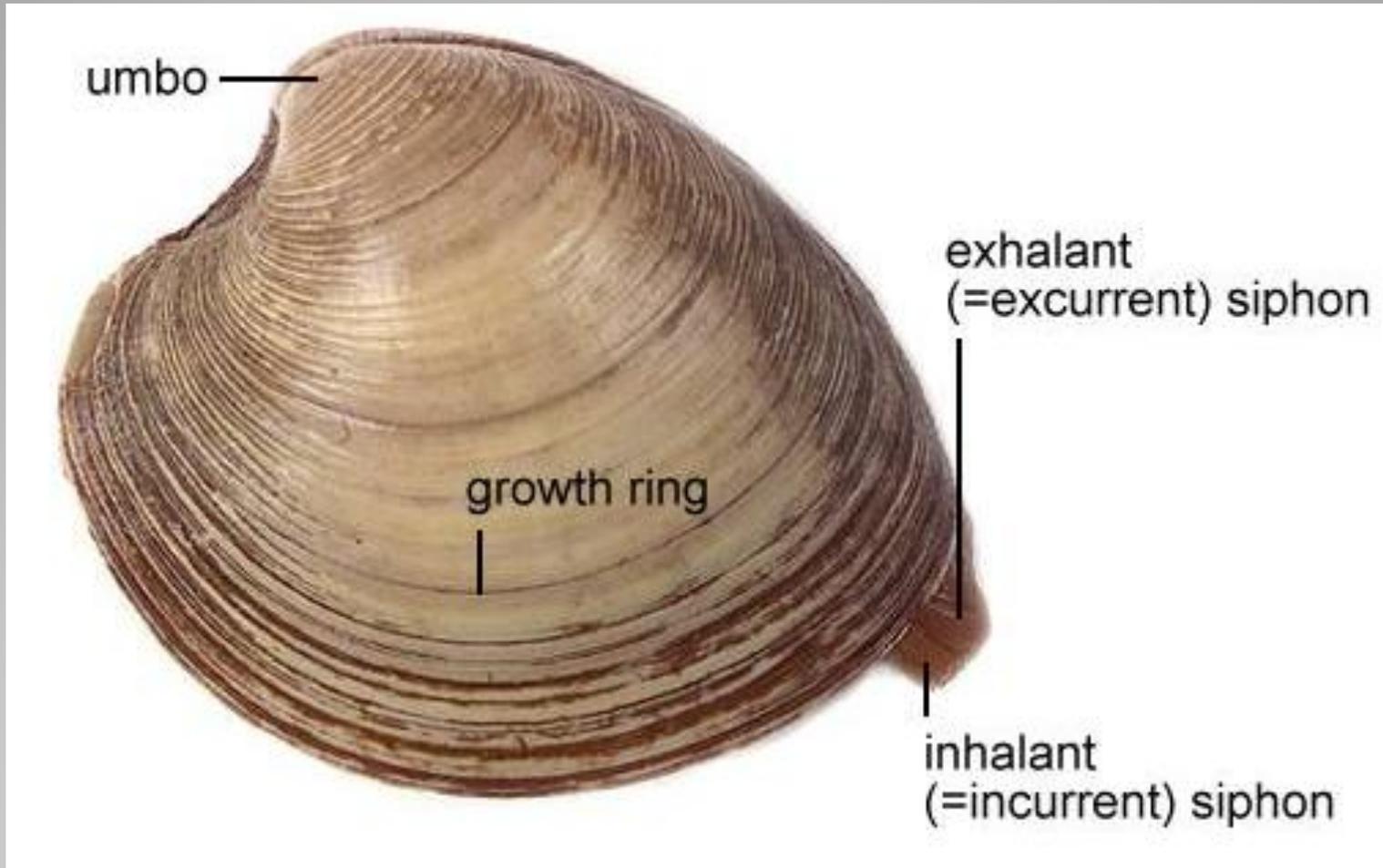
Quahog Pearl



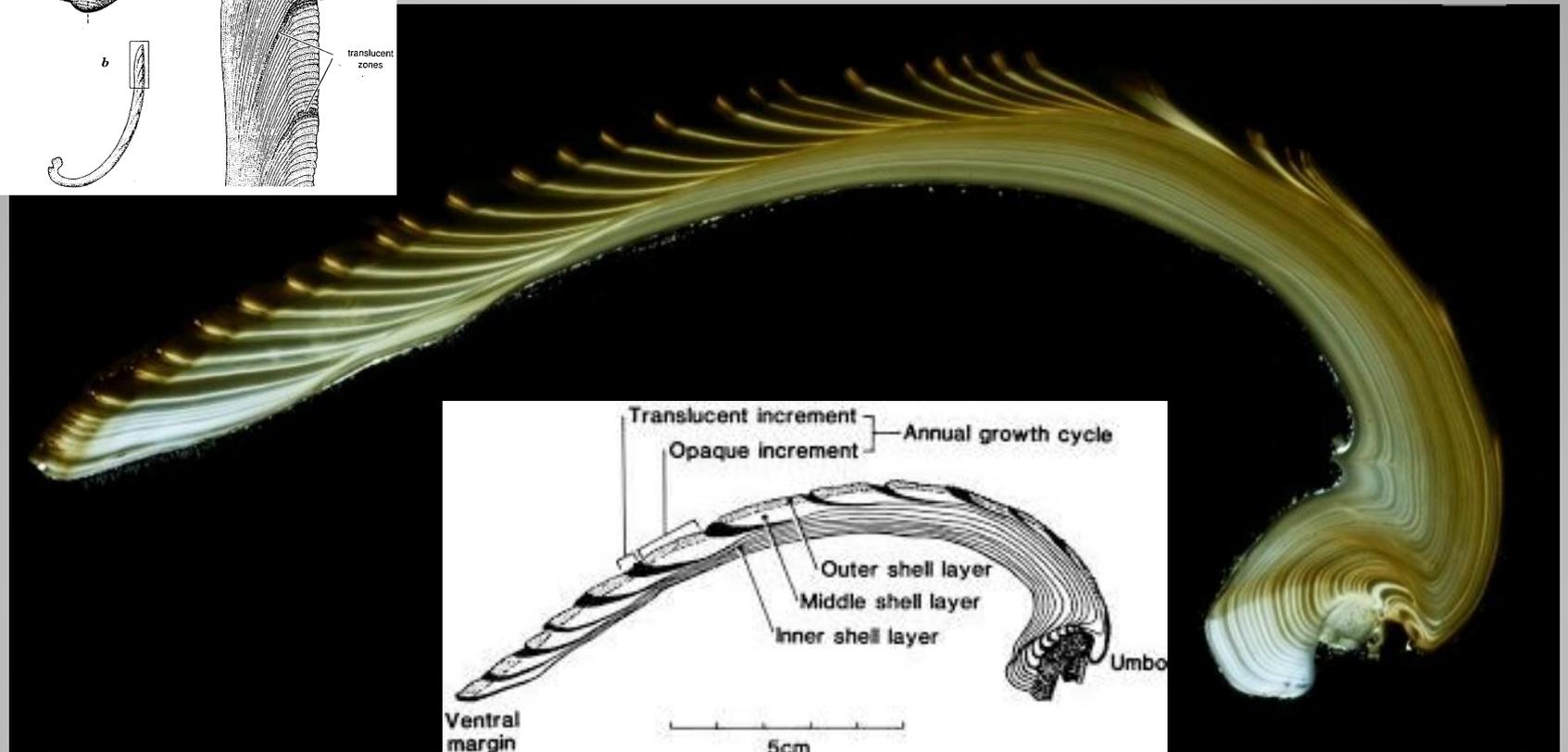
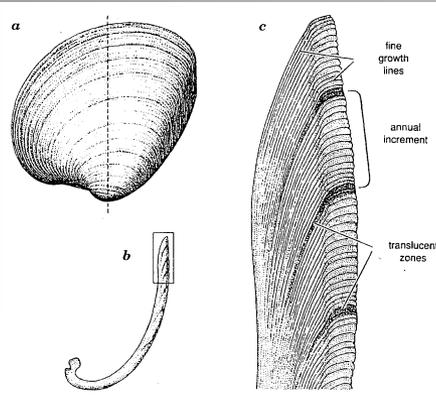
Shell growth in the oyster



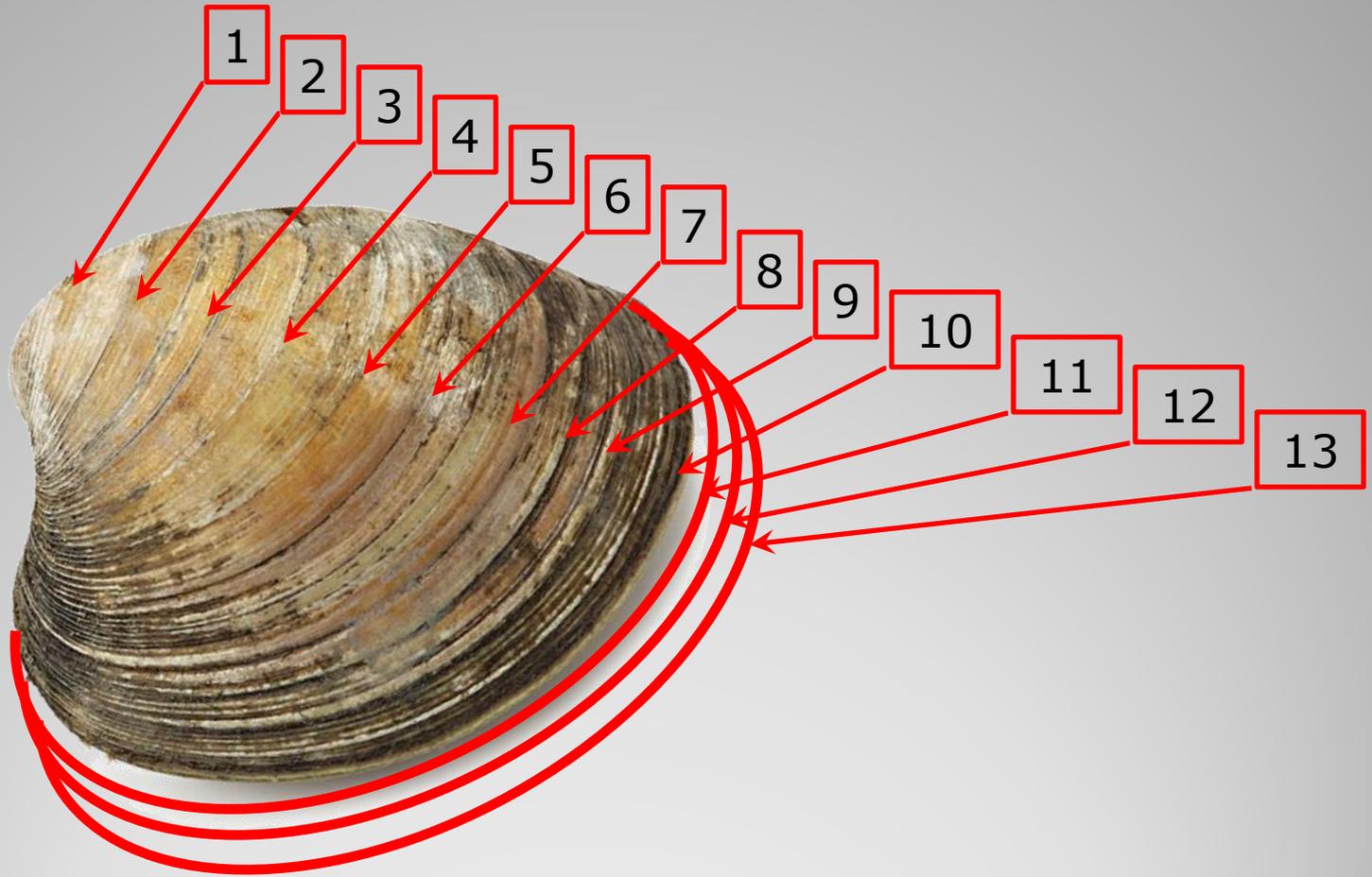
Seed oyster growth



Clam external features



Quahog shell growth



Shell Growth in a Quahog

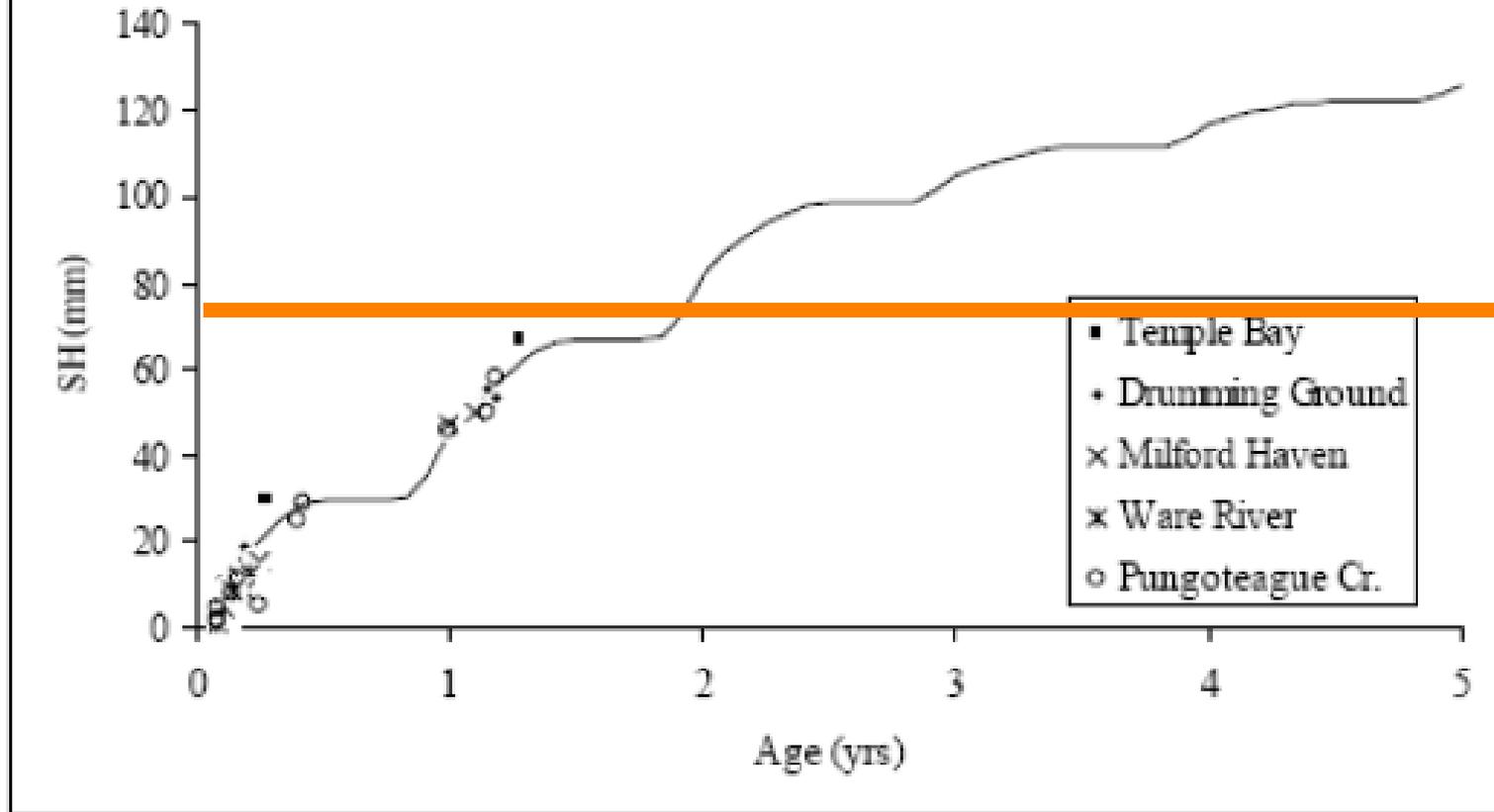
World's oldest animal (507 yrs old)

Genus: *Arctica islandica*
Ref #: 061294
Locality: Iceland
Station: B05 AD03
Dredge/Tow #:
Ave. Latitude: 66° 31,59N
Ave. Longitude: 18° 11,74W
Water depth: 83-81 m
Collector: Scourse
Cruise: Bjarni Saemundsson,
Iceland B05
Collection Date:
Method: Arctica dredge
Live(Y) or dead(A/R/L): YA
Length: 86.9 mm
Height: 72.5 mm
Max Height: 82.1 mm
Width: 48 mm
Weight of shell valve: 52.08g
Periostracum: 1
Ligament: 4 **Shell margin:** 4
Bioerosion: 4
Nacre: 1
Sex: Spent?
Flesh wet weight: 40.28 g
Notes:



“Ming”

Shell Height at Age



Oyster growth (shell length mm)

**Littleneck
Clam**



**Topneck
Clam**



Cherrystone



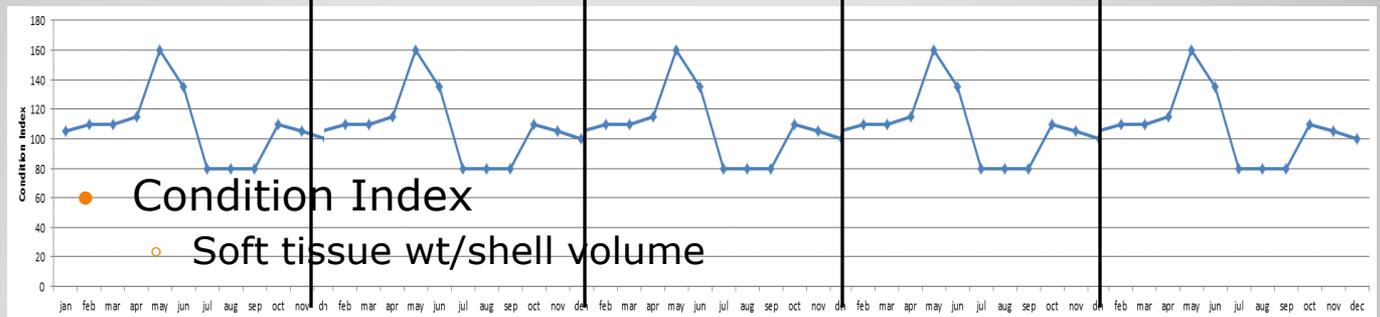
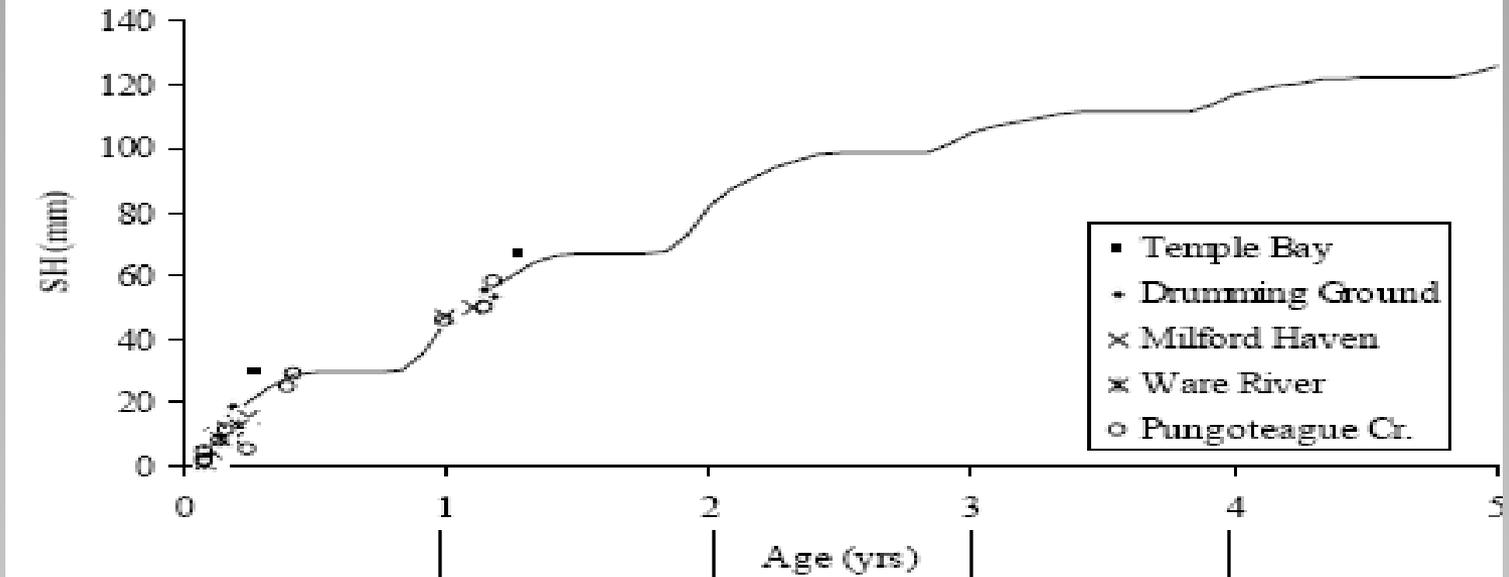
Quahog



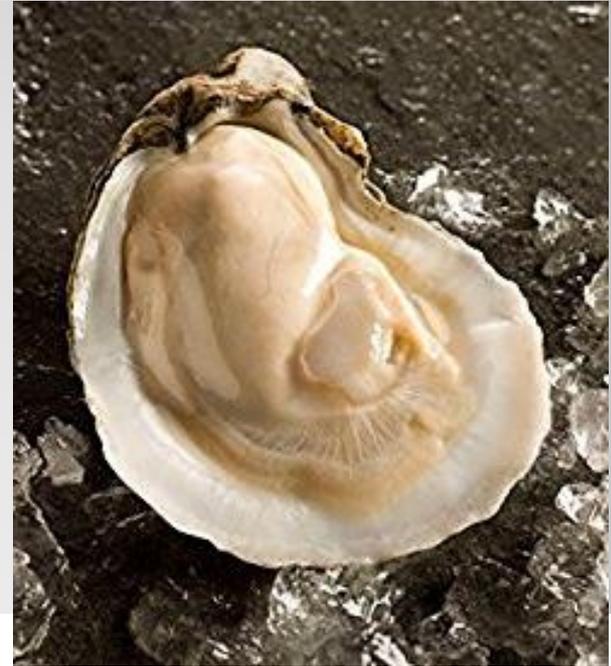
**Button
or Bean**

Size often dictates value

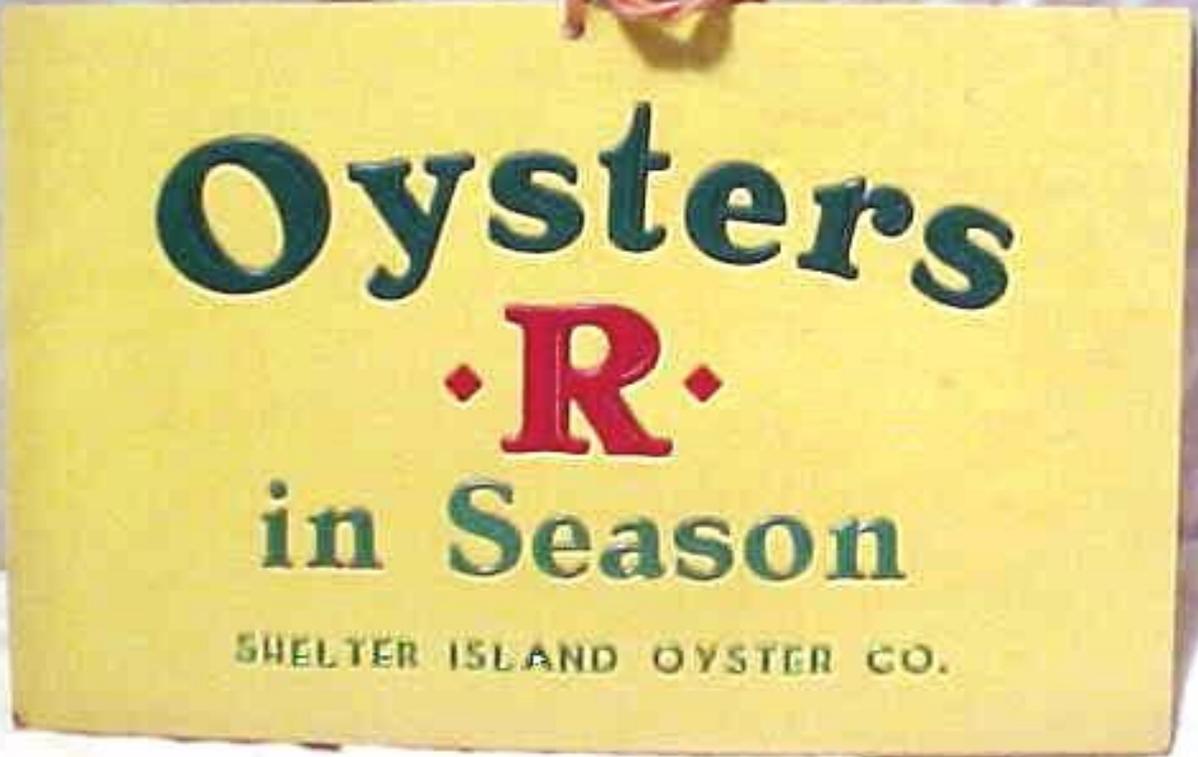
Shell Height at Age



Shell vs. Soft Tissue growth



Meat Quality

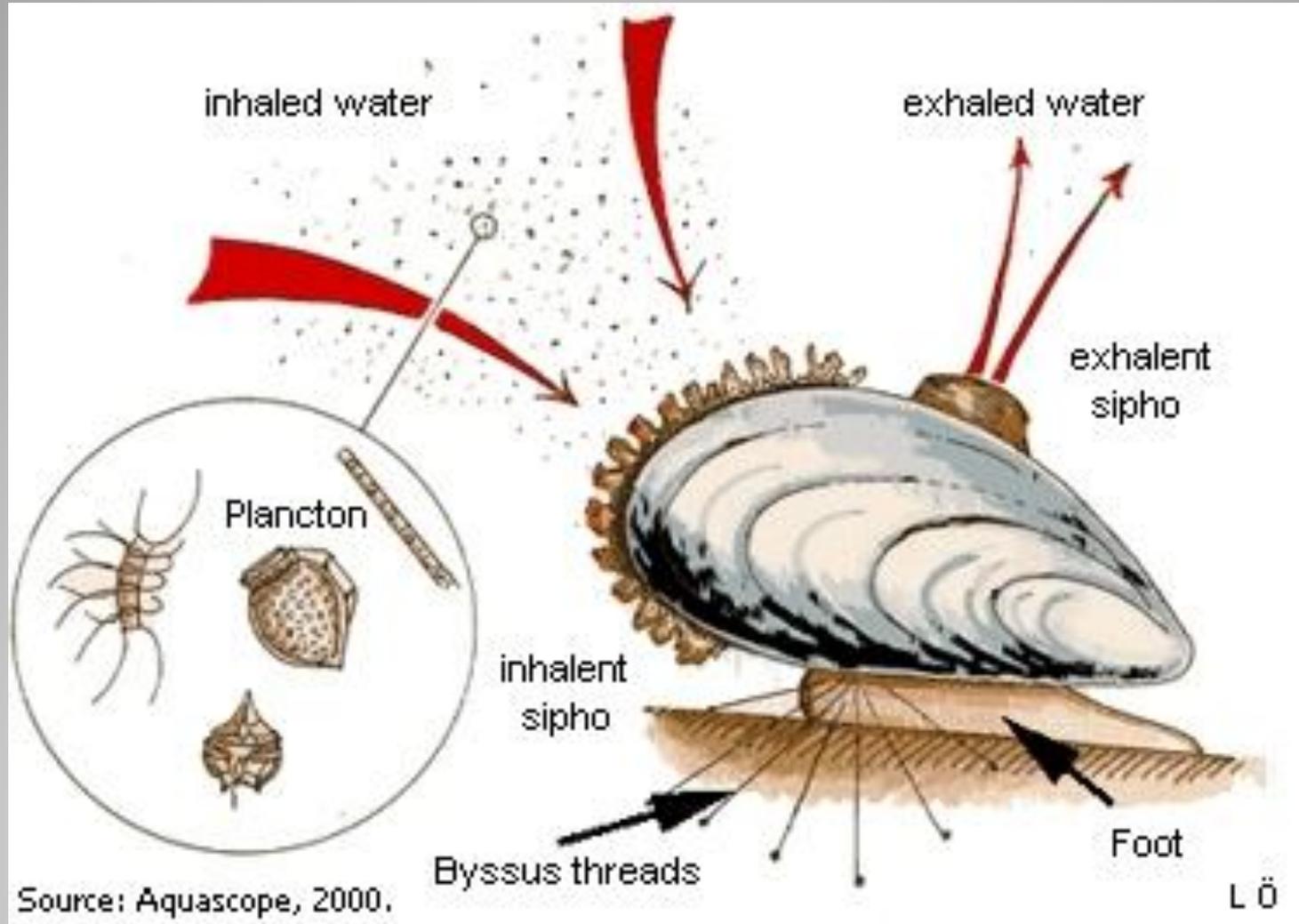


Oysters

• R •

in Season

SHELTER ISLAND OYSTER CO.



Respiration & Feeding

SHELLFISH

VACUUM
CLEANERS
OF THE
SEA

by K.T. Pirquet

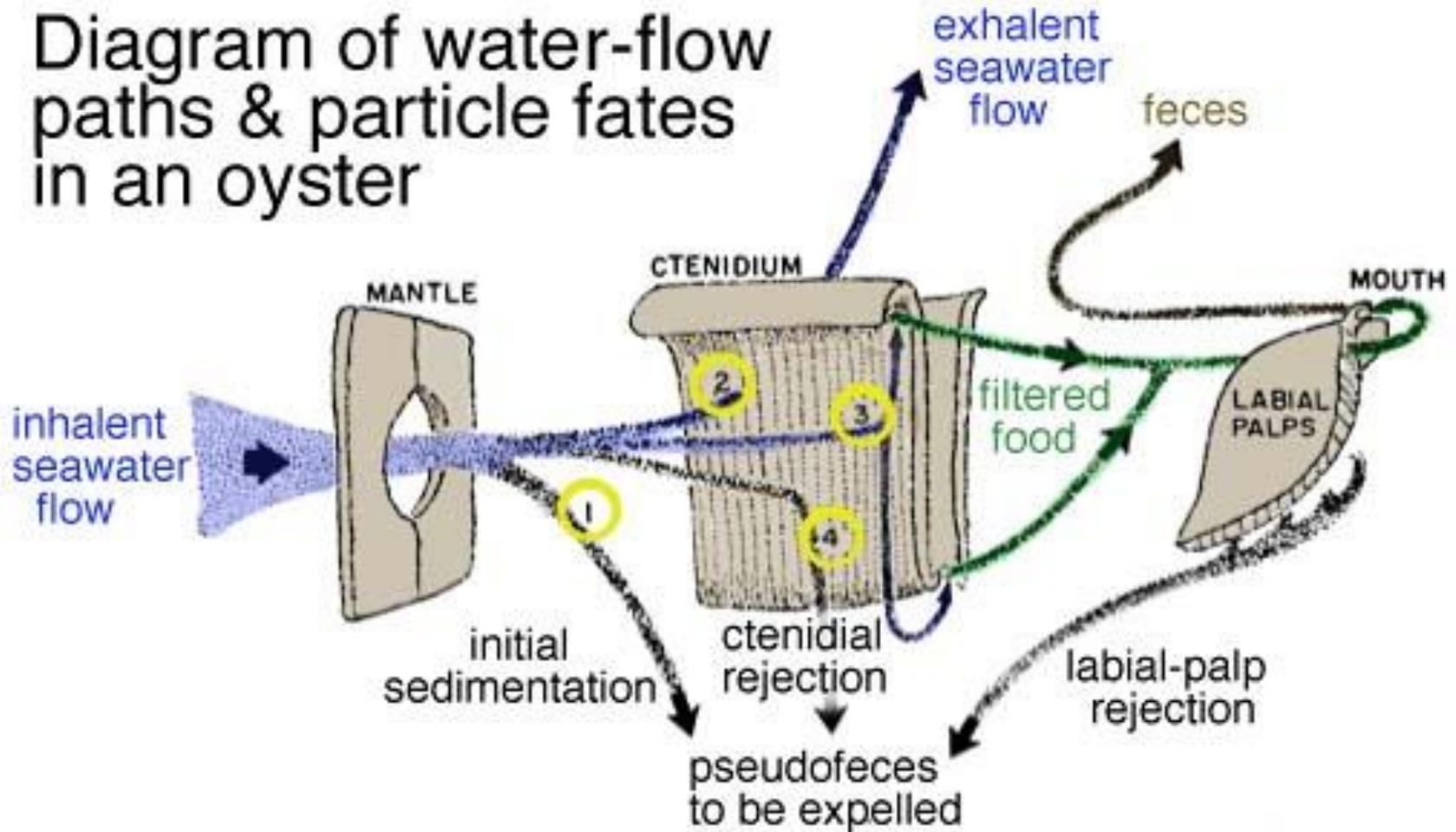


- Filter feeder
 - “Pumps” a large volume of water to feed
 - Has been reported to be up to 50 gallons per day!
 - Removes very small particles (2-3 μm)

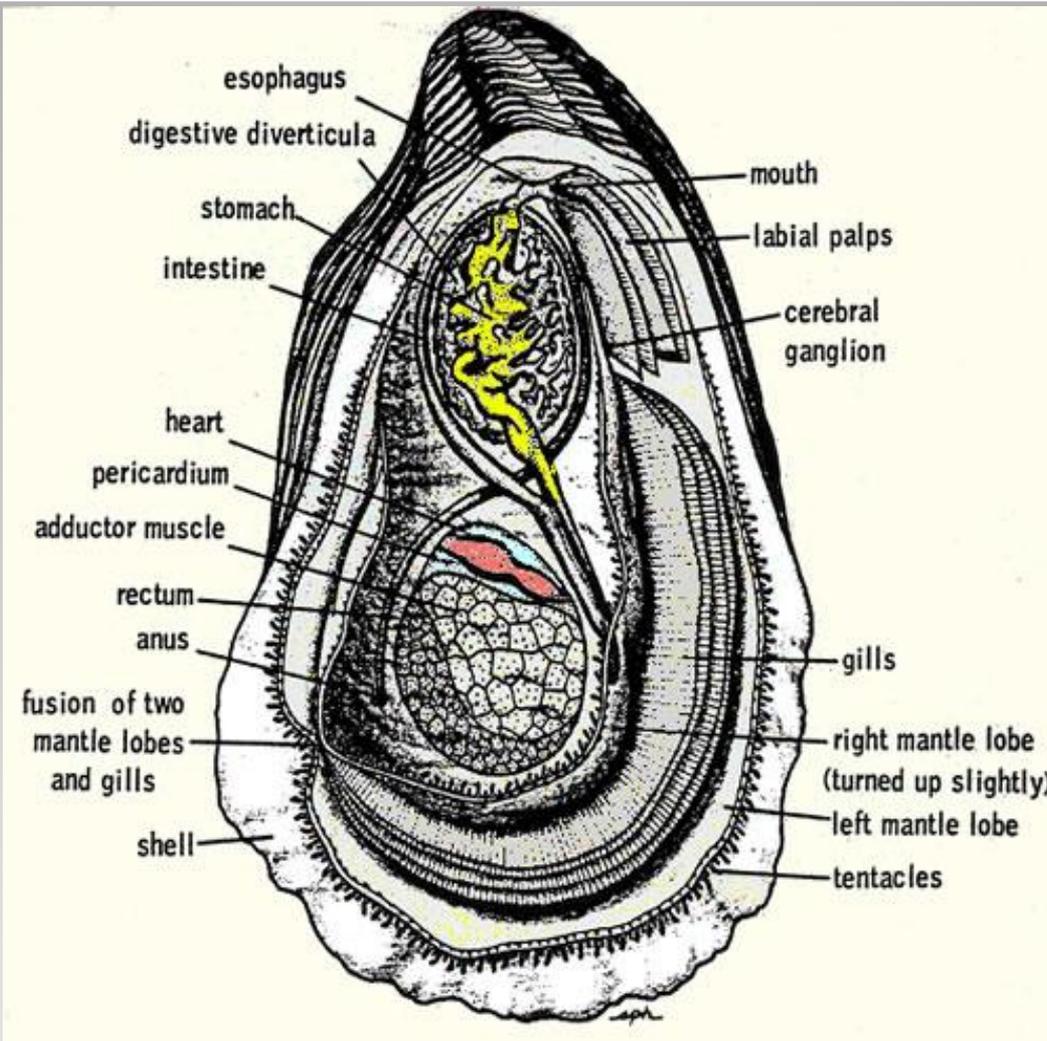
Time Lapse ~ 4 hours

Respiration & Feeding

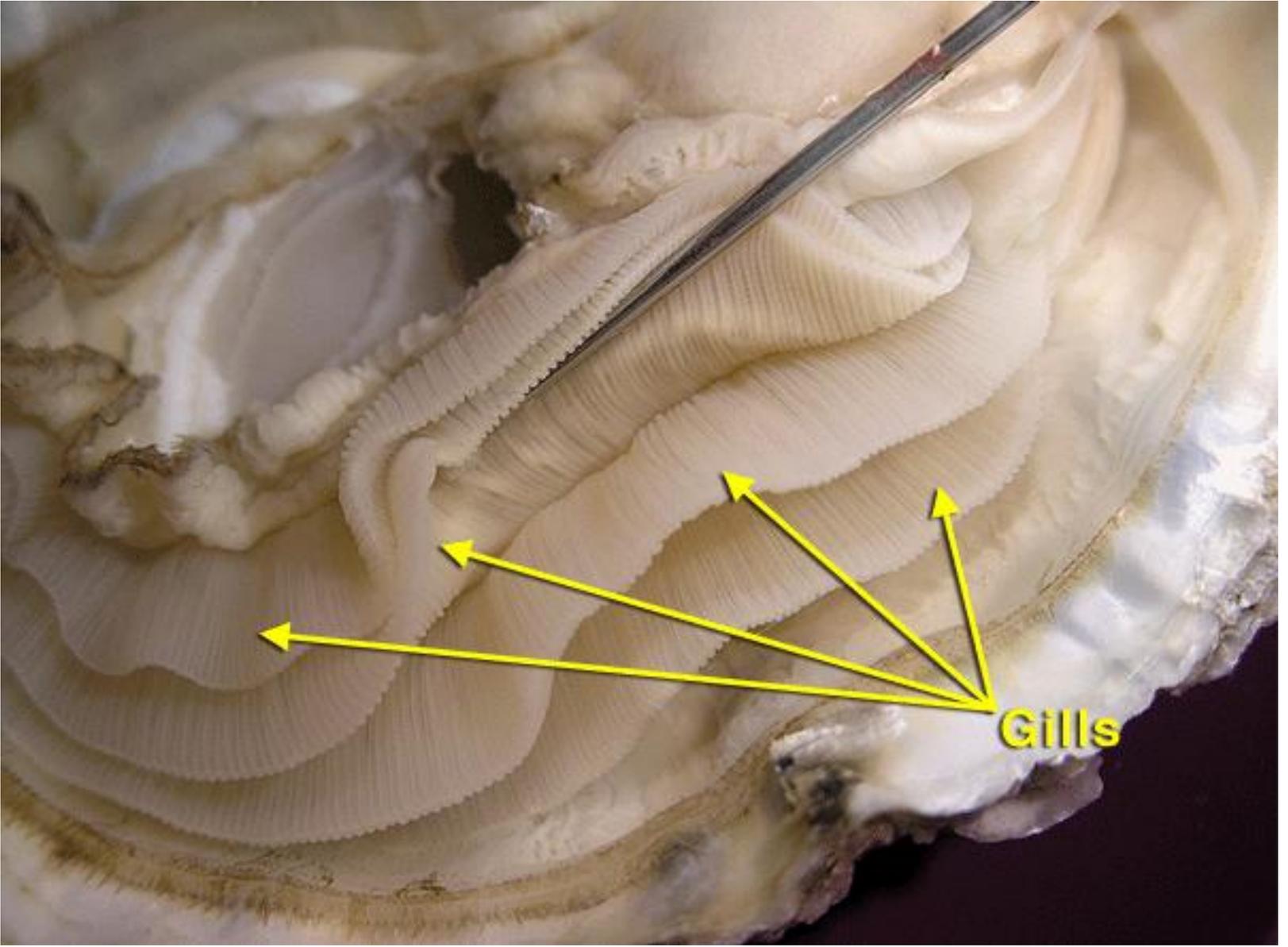
Diagram of water-flow paths & particle fates in an oyster



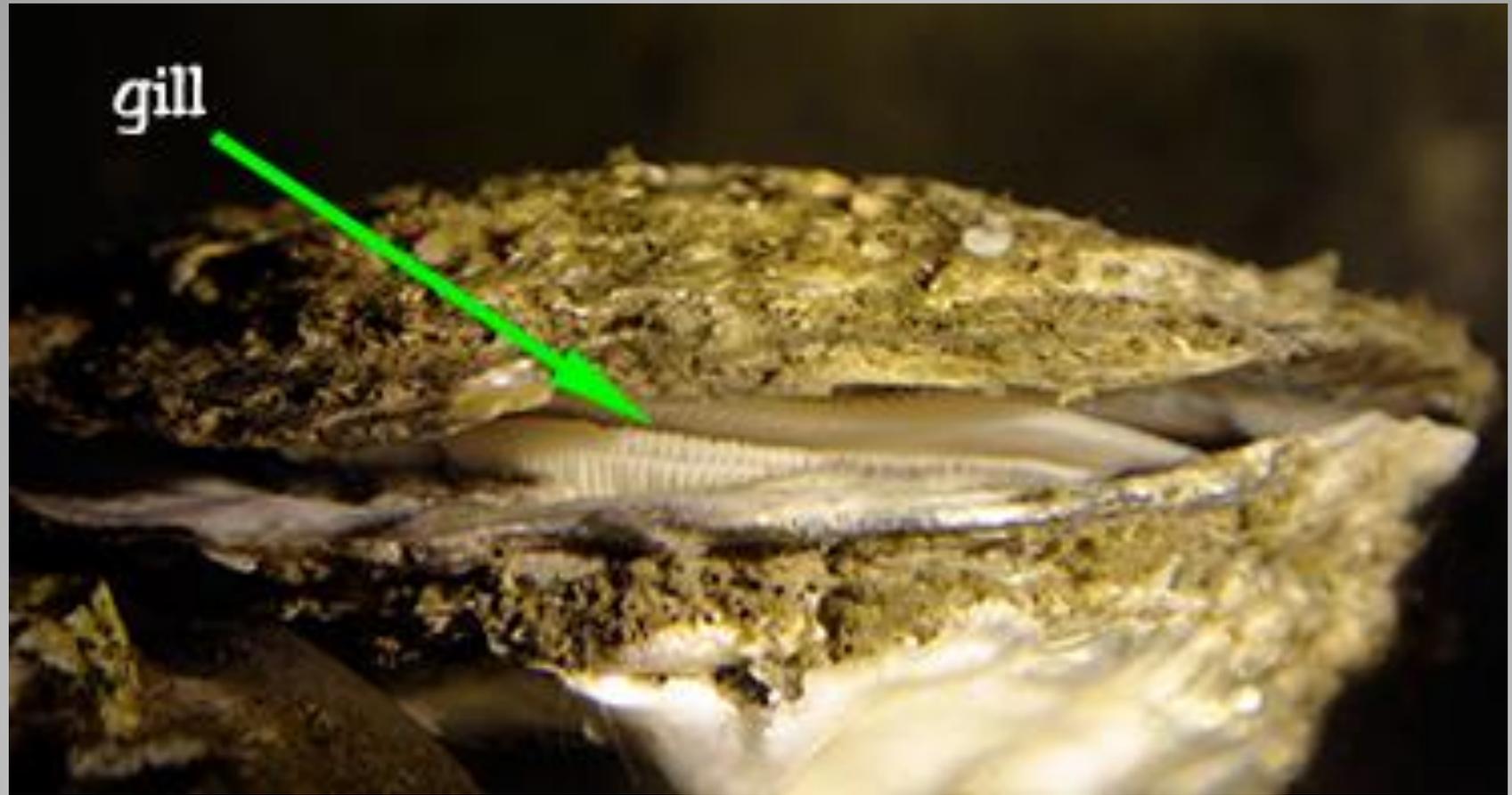
Feeding



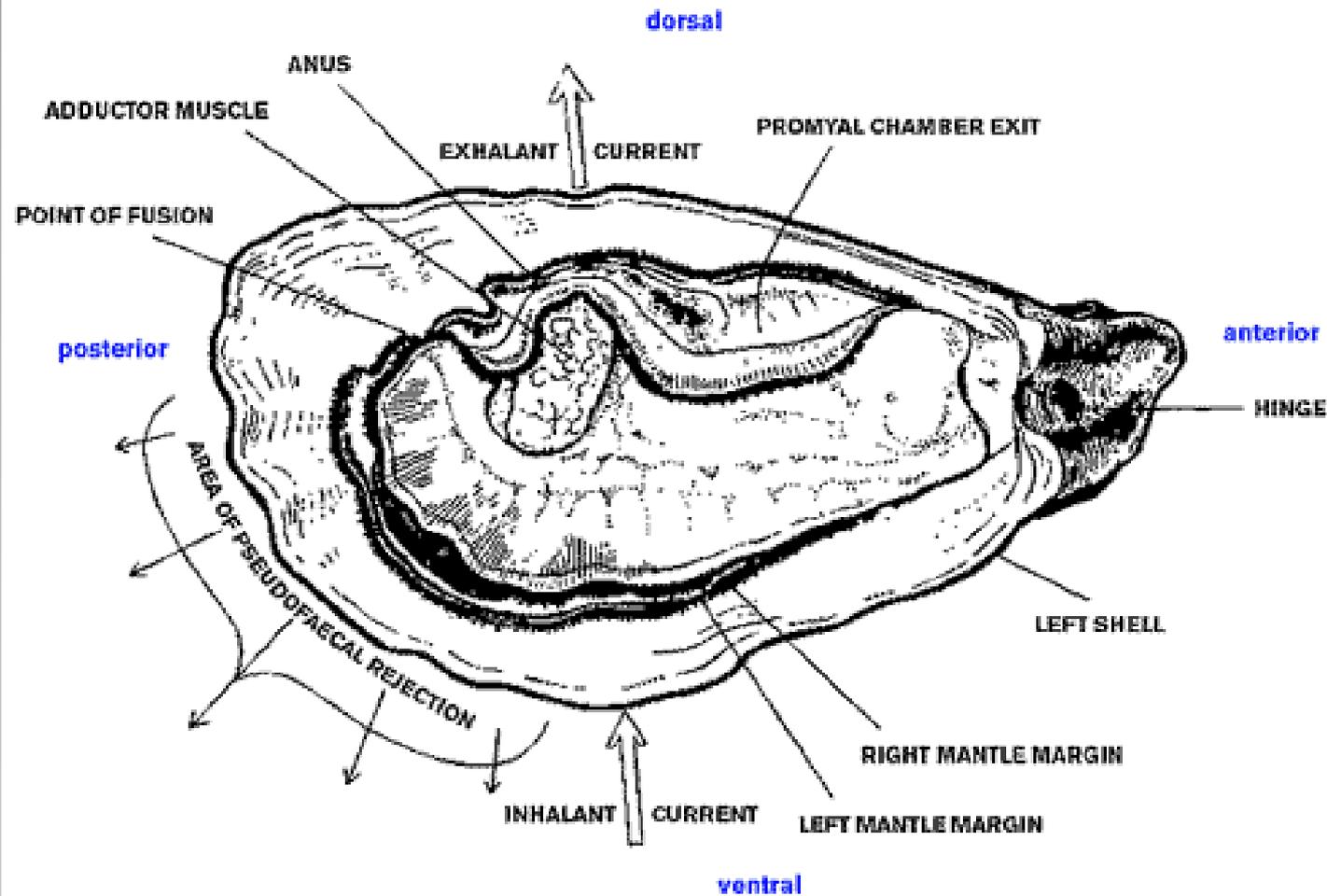
Oyster internal anatomy



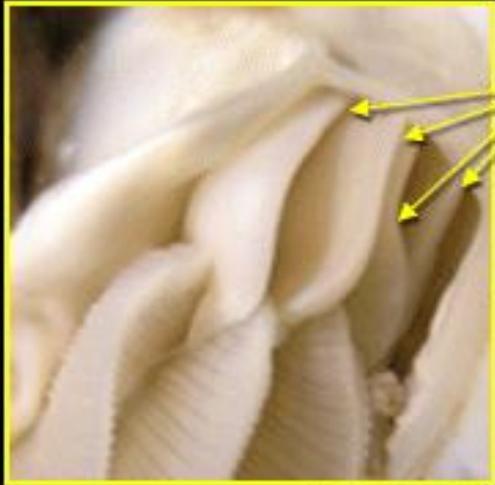
Gills



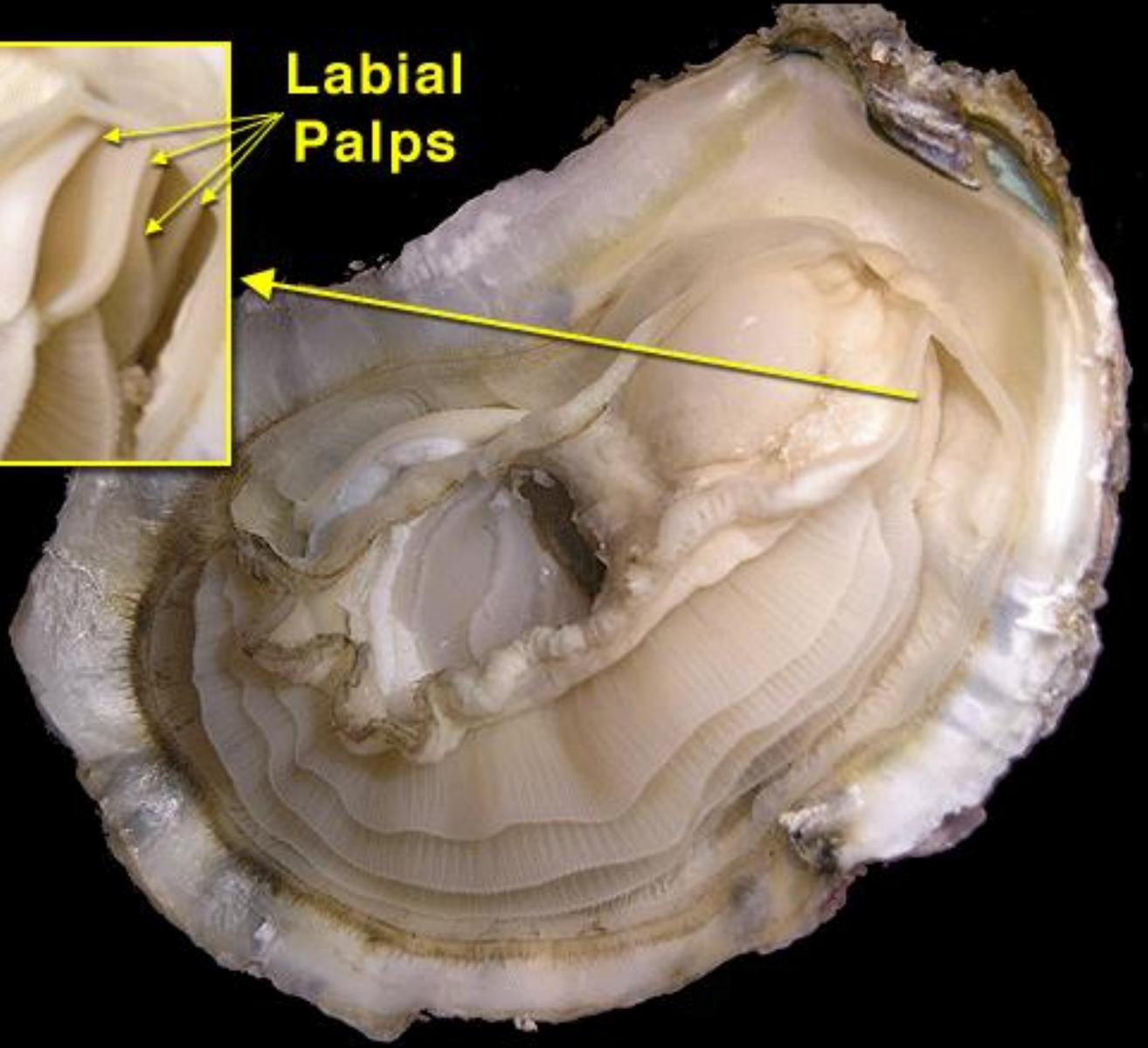
Oyster feeding

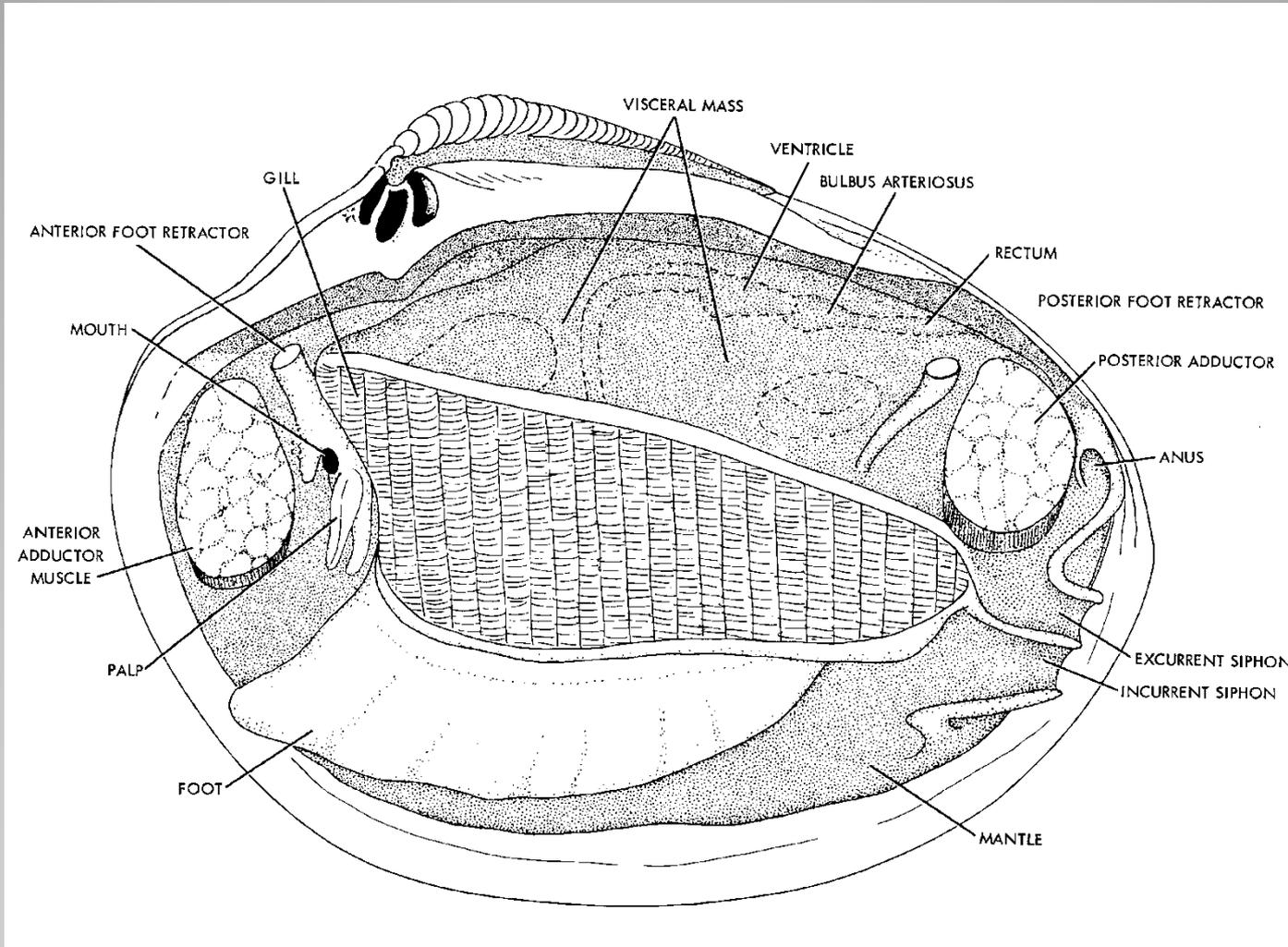


Oyster feeding/respiratory current

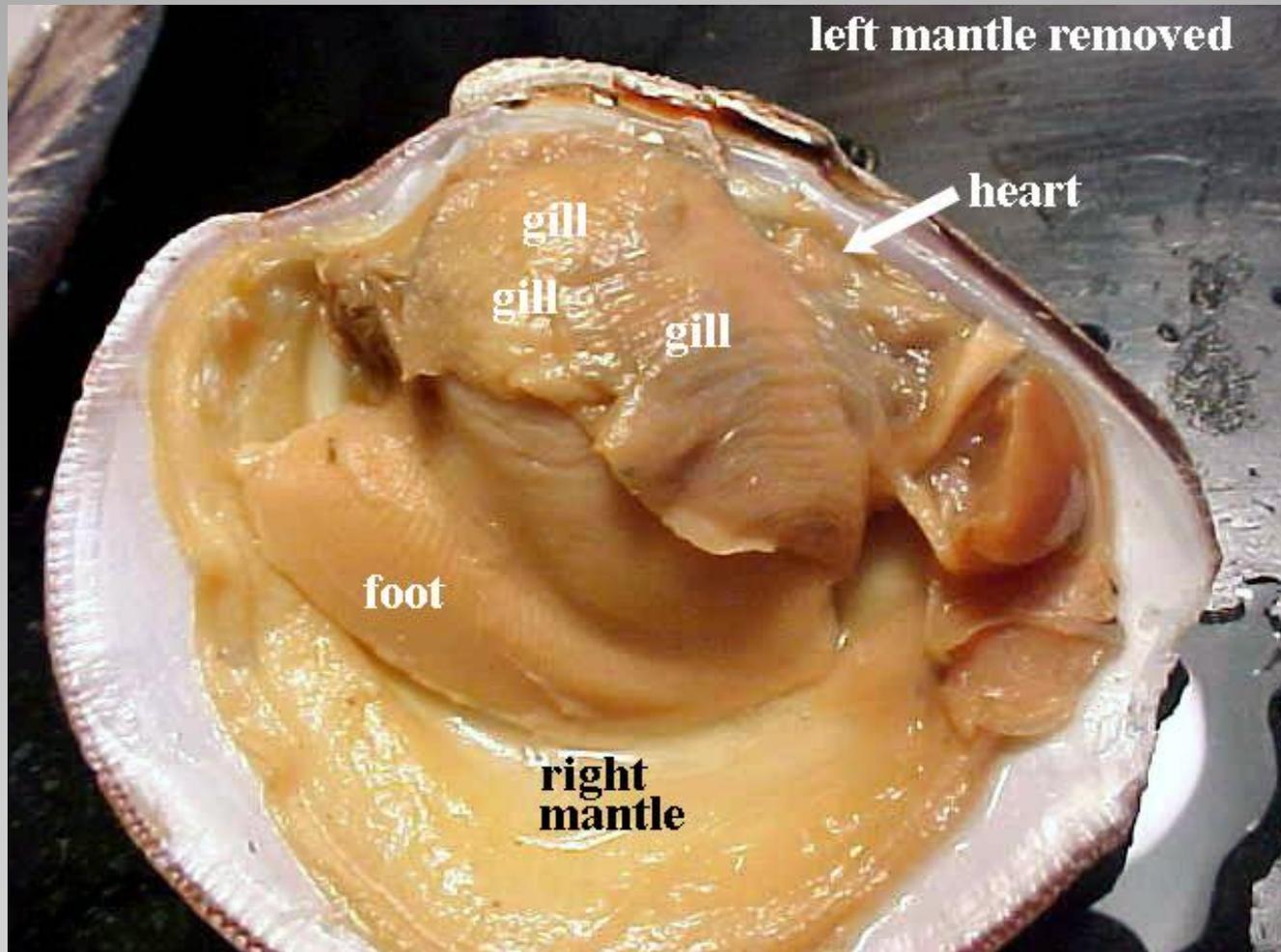


**Labial
Palps**





Gills - Respiration & Feeding

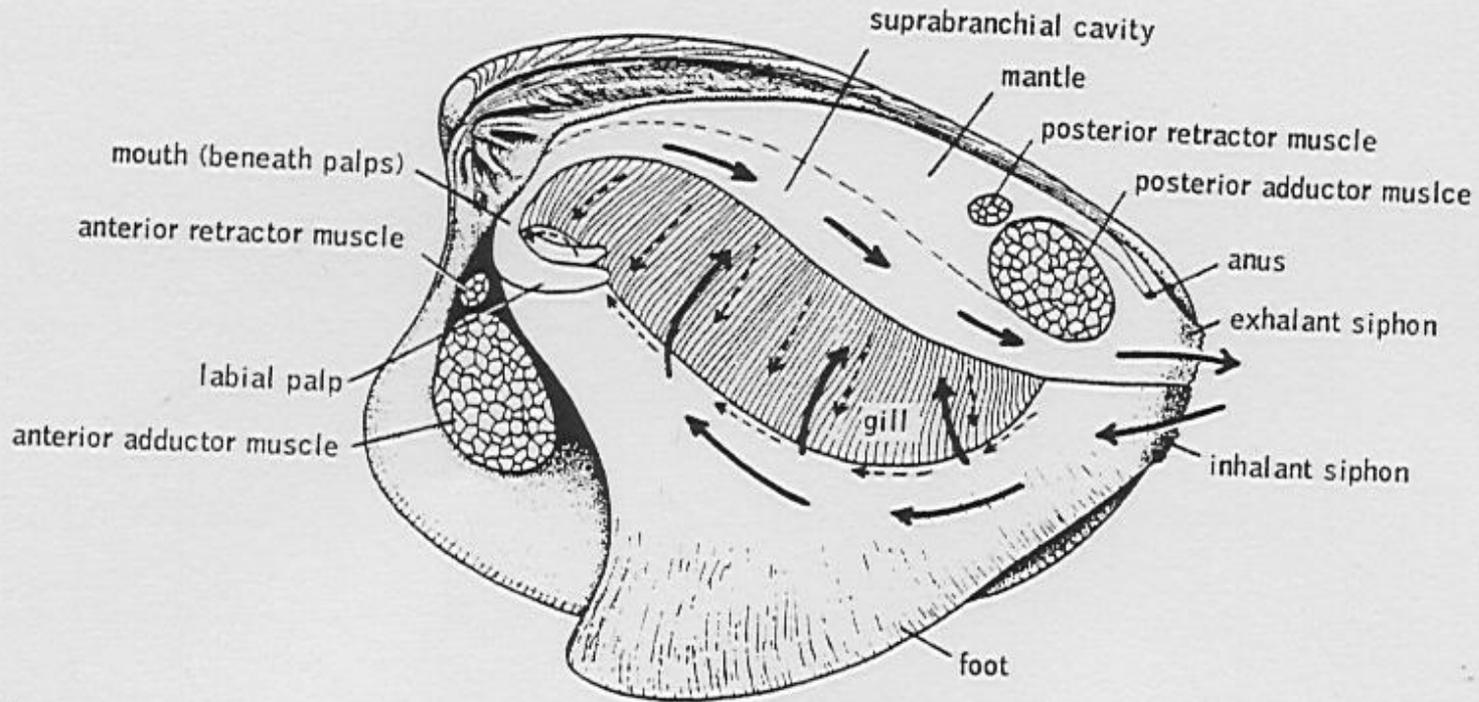


Quahog Gills



Soft Shell Clam Gills

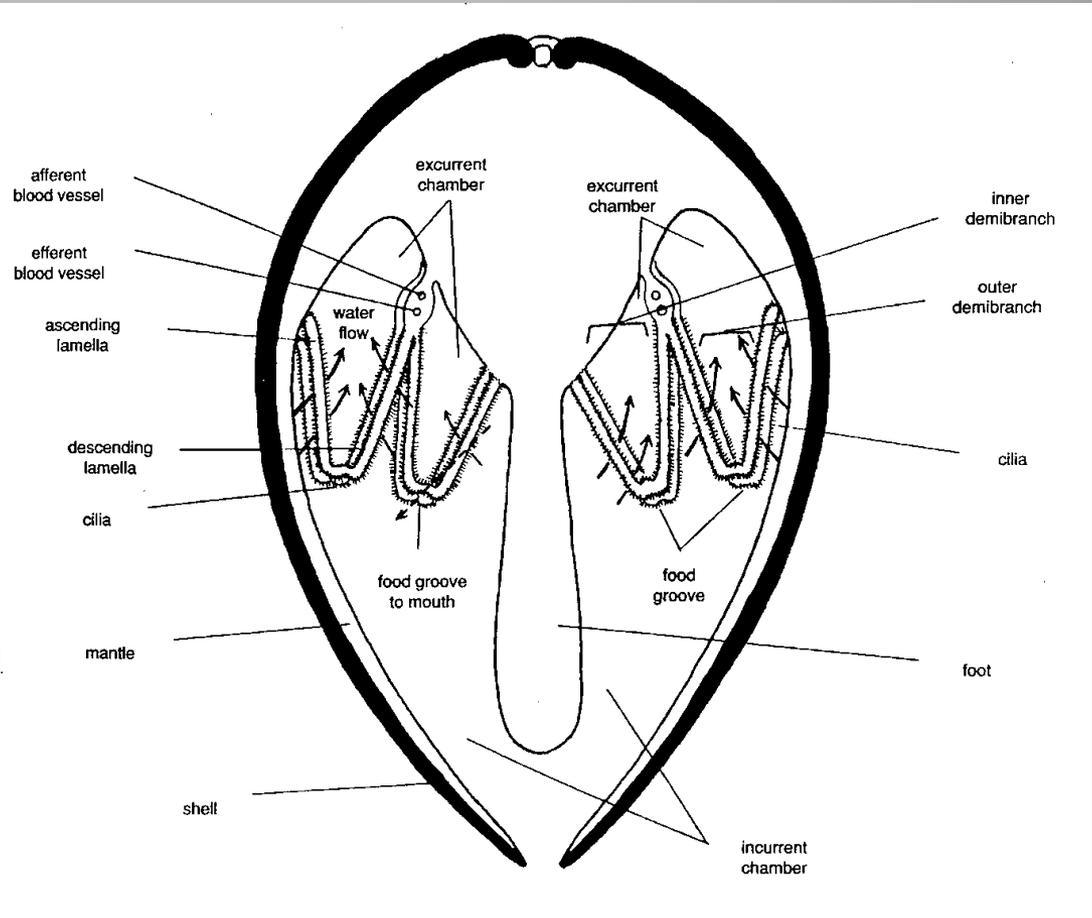
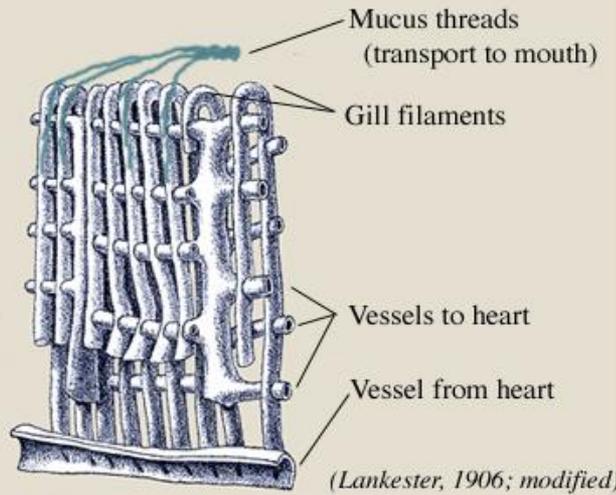
THE MOLLUSKS



Respiration & Feeding

A Food Filter for the Venus Clam

(showing a fold in the gill structure)



Respiration & Feeding



Mussel Filter Feeding

ROGER WILLIAMS
UNIVERSITY

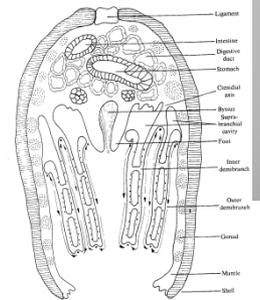
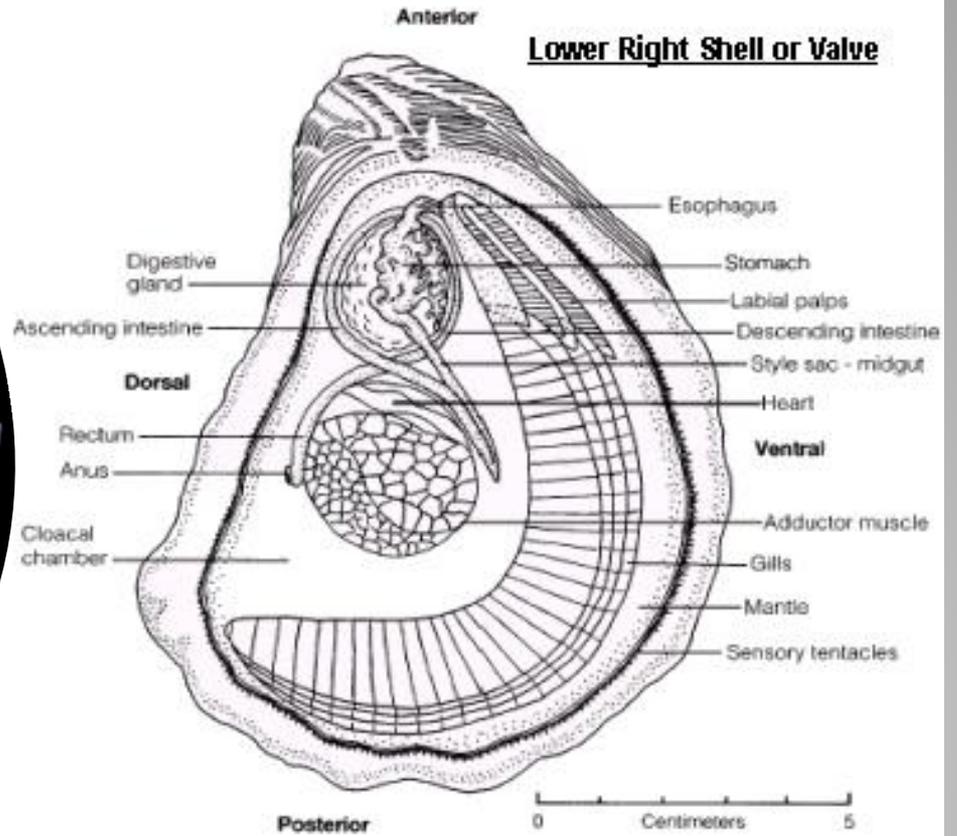


Fig. 1.1. Diagrammatic transverse section through *Mytilus edulis* to show the form of the gills and the direction of the mass silty currents, represented as arrows.



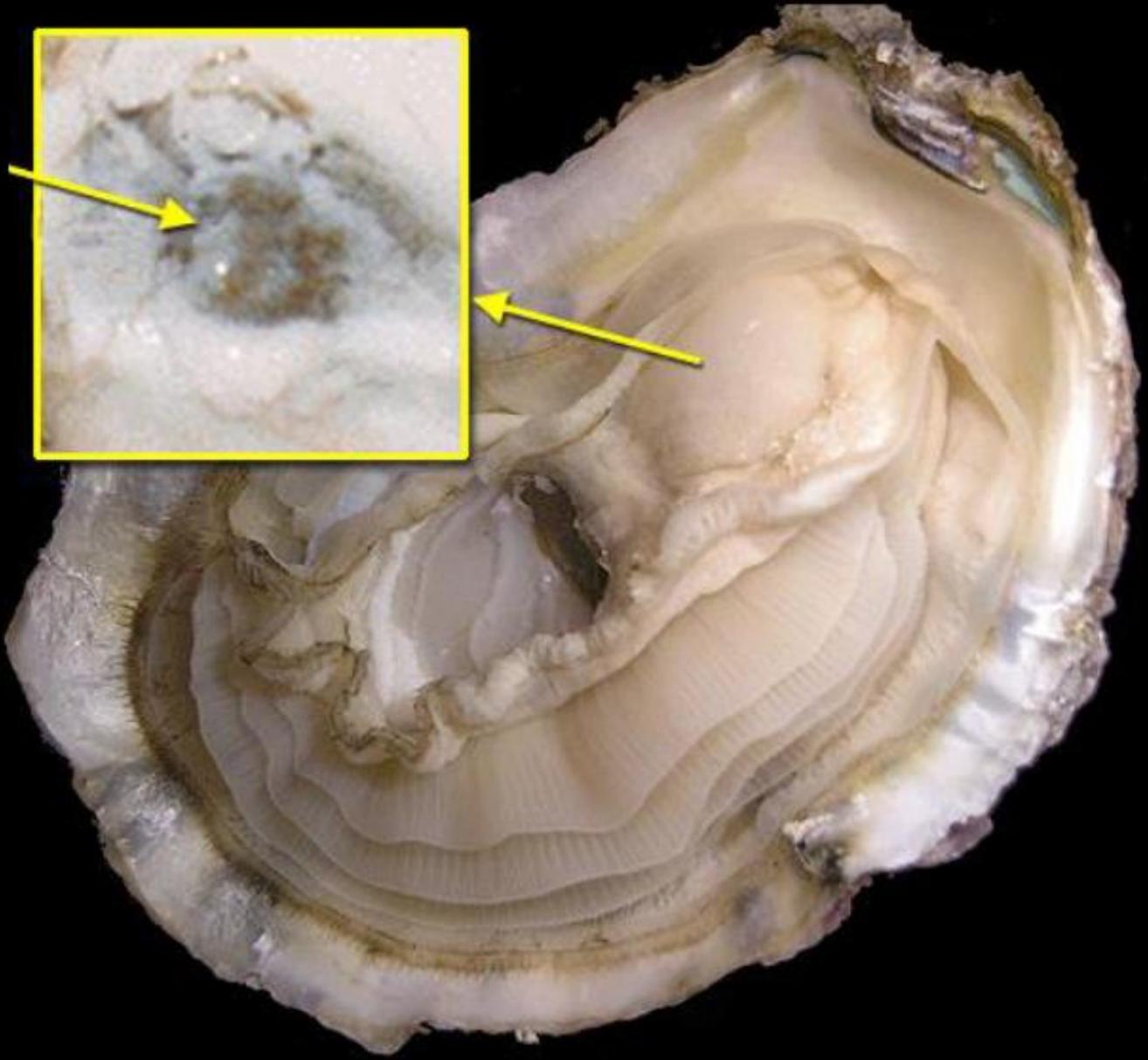
Oyster feeding



Source : Maryland Sea Grant

Oyster internal anatomy

Stomach

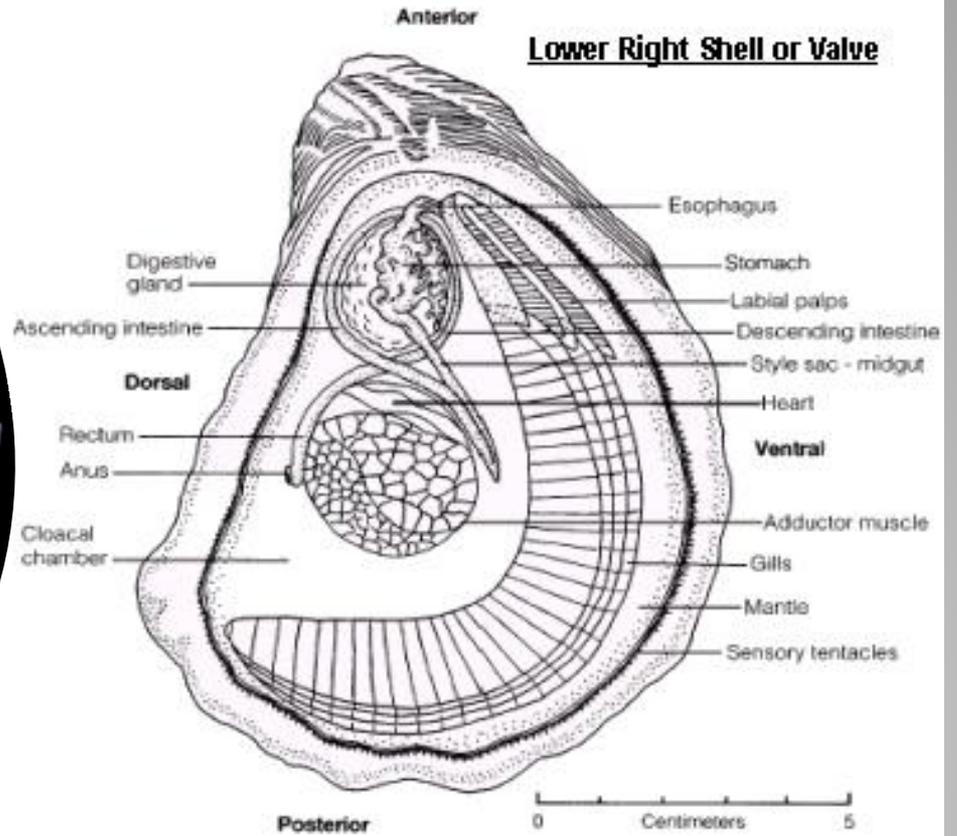




Full stomachs

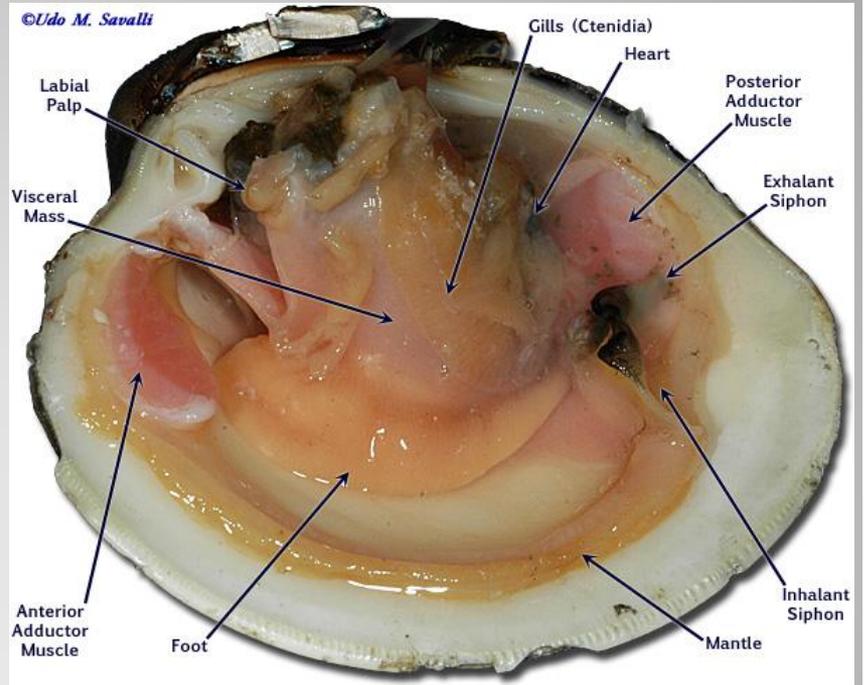
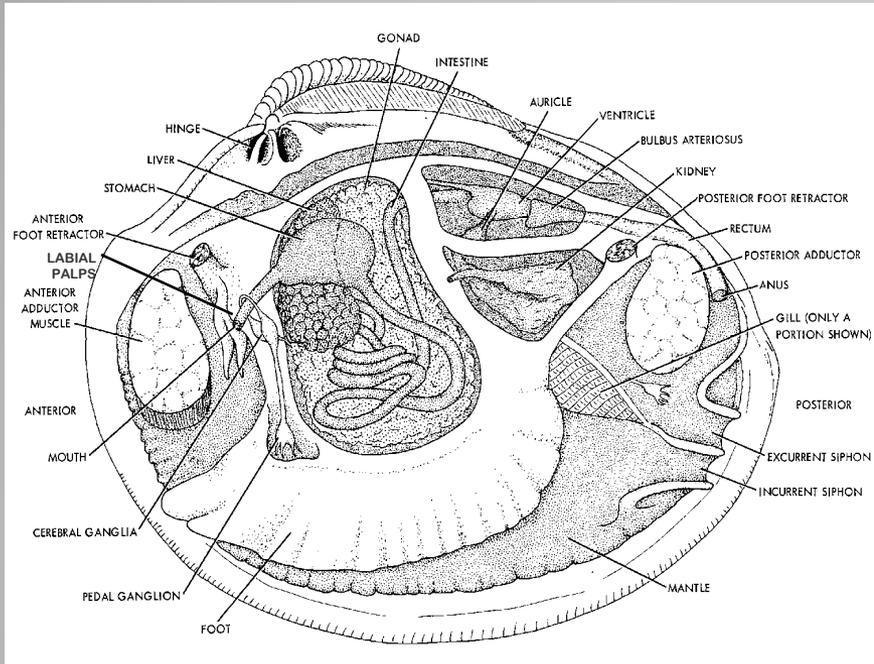


Technicolor bivalves

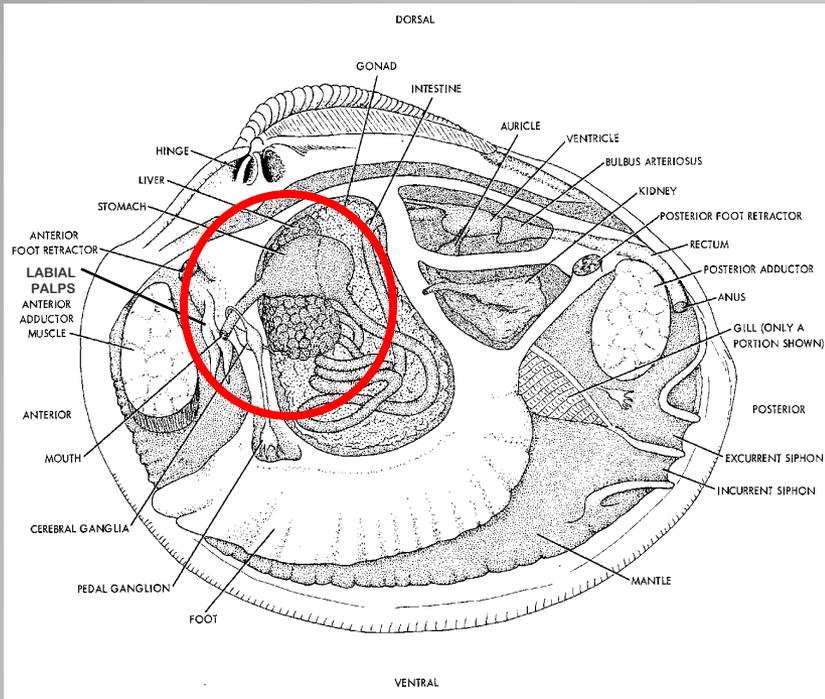


Source : Maryland Sea Grant

Oyster internal anatomy



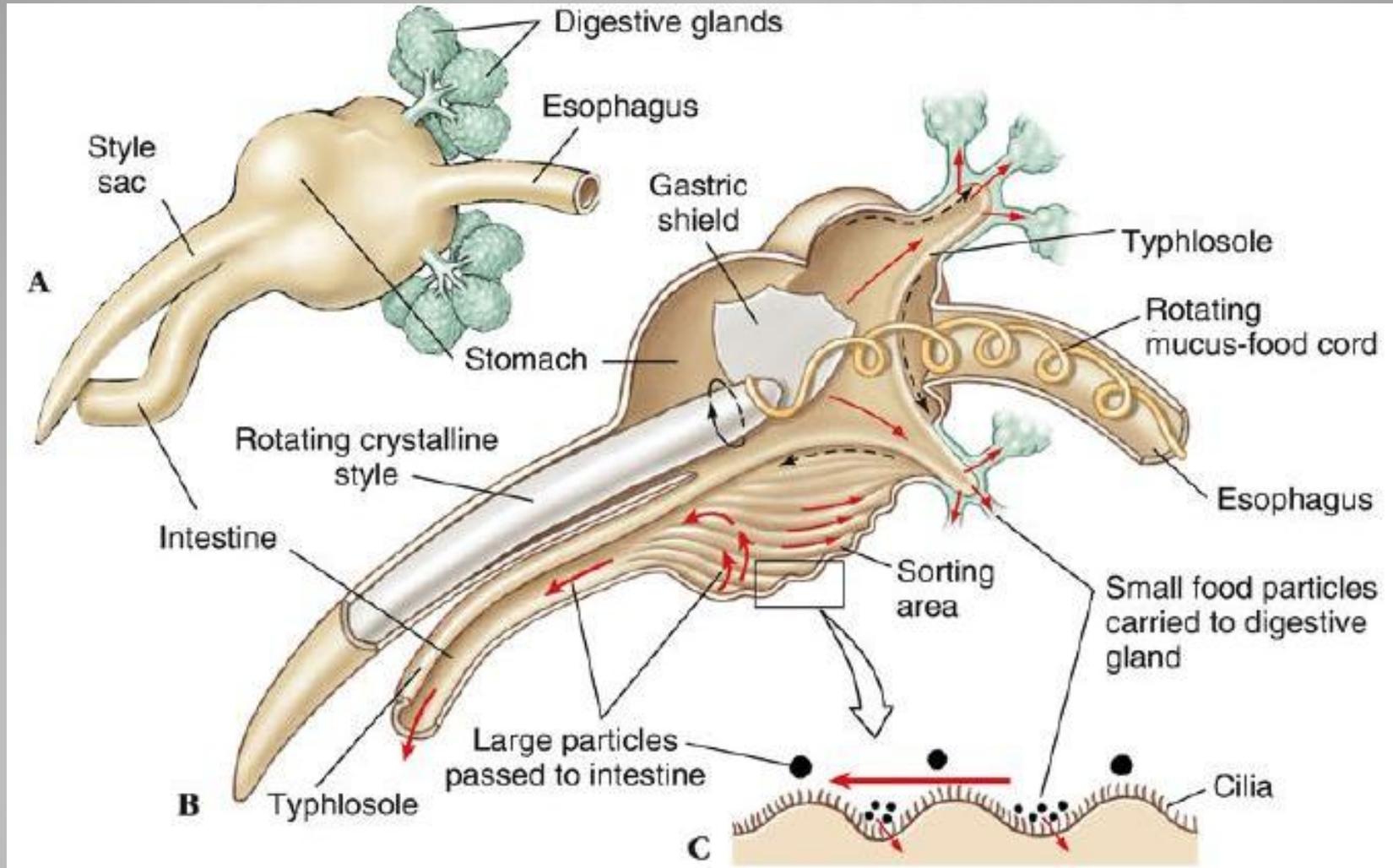
Clam Internal Anatomy



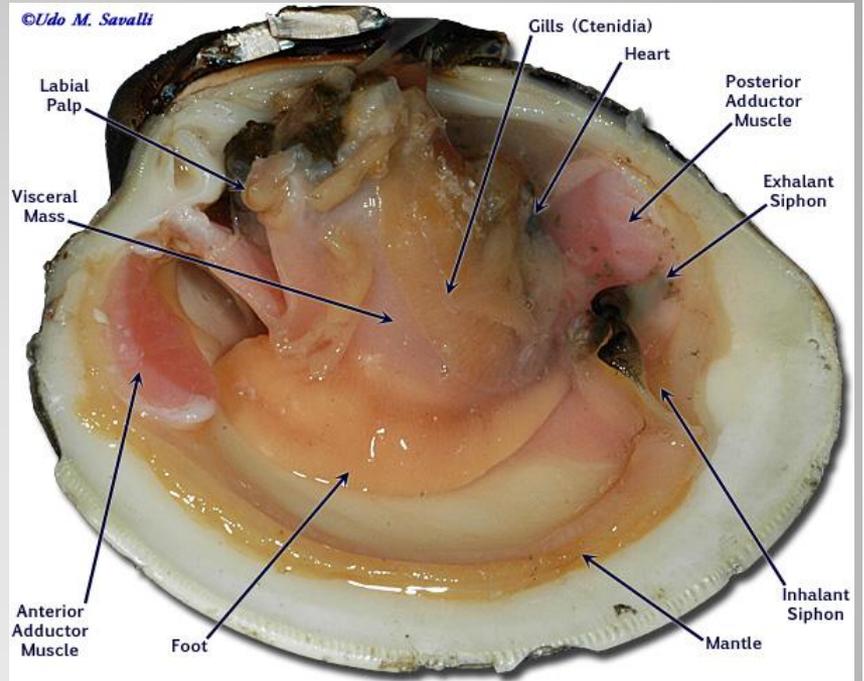
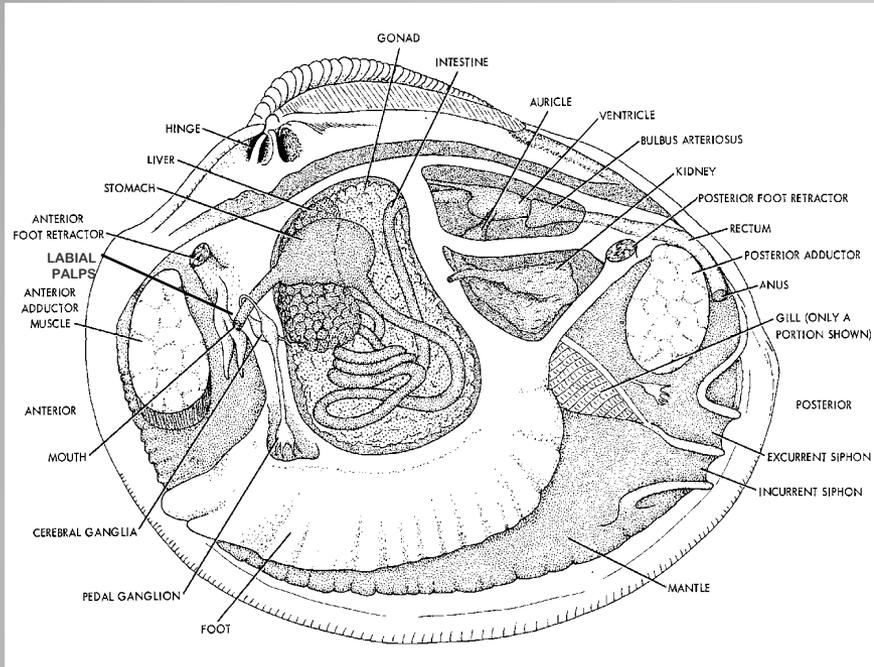
Clam Stomach



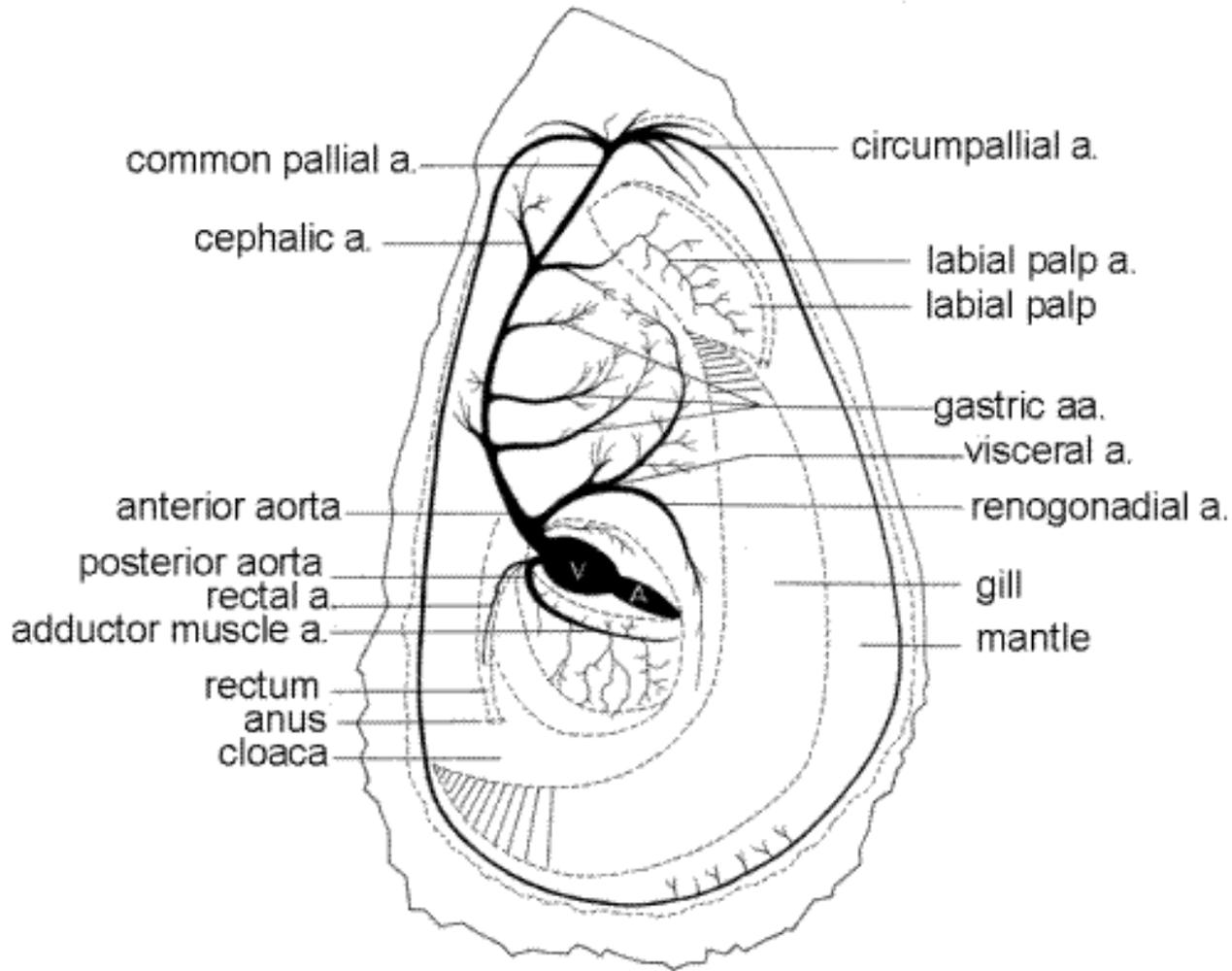
Crystalline Style



Digestion



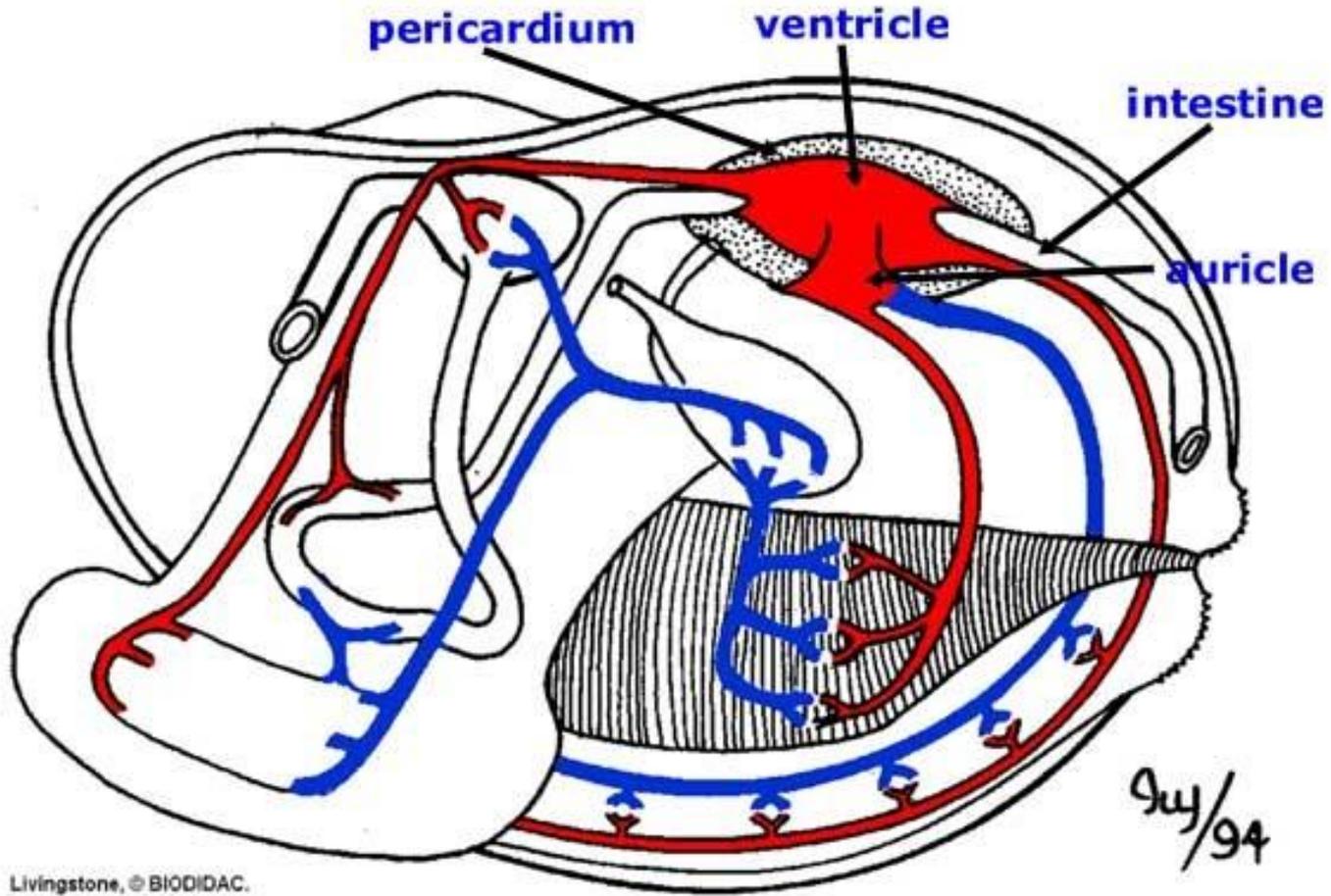
Clam Internal Anatomy



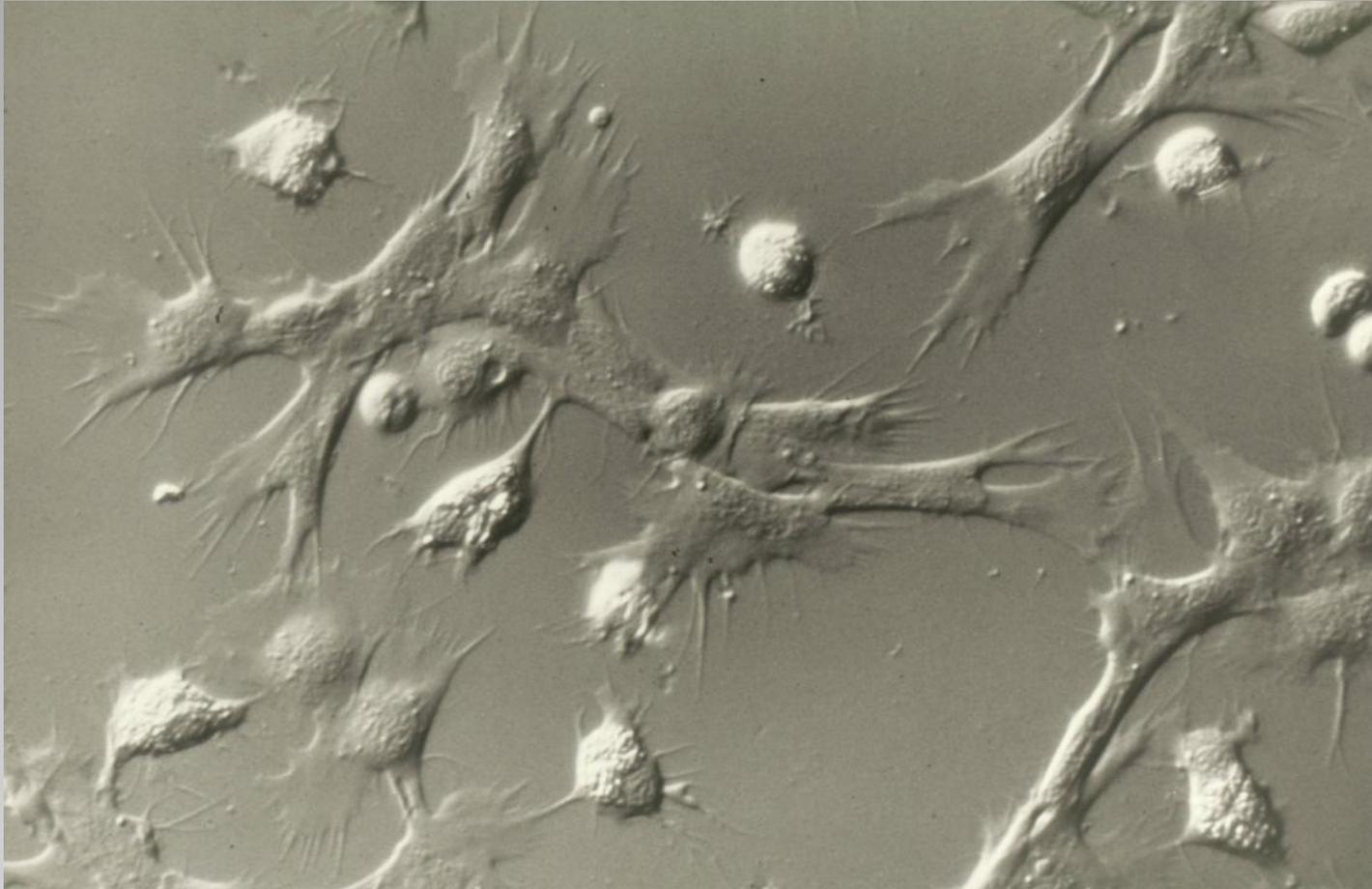
Oyster Circulatory System



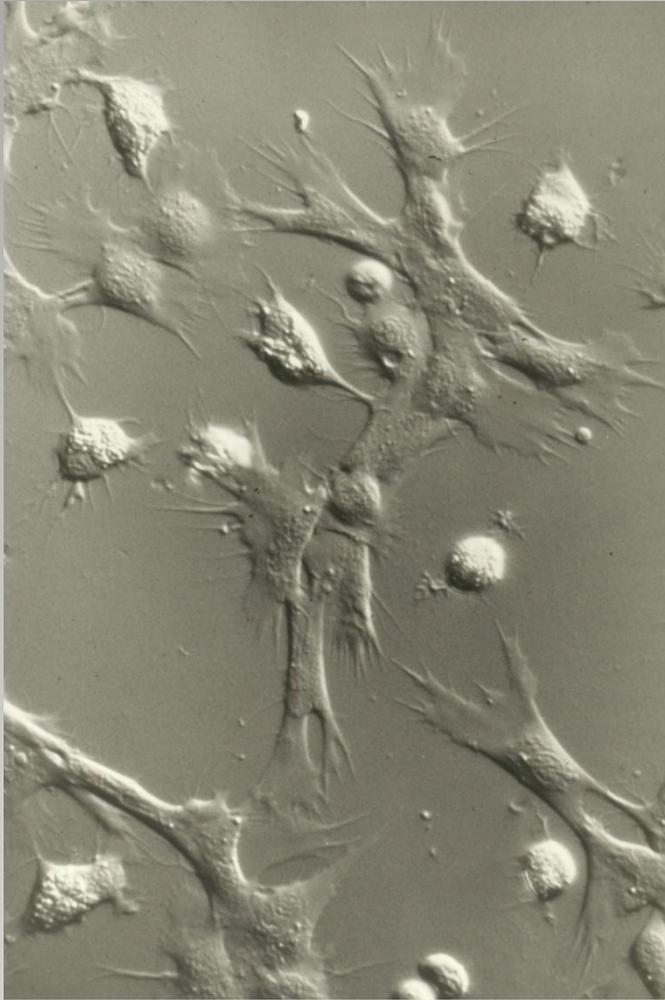
Oyster heart



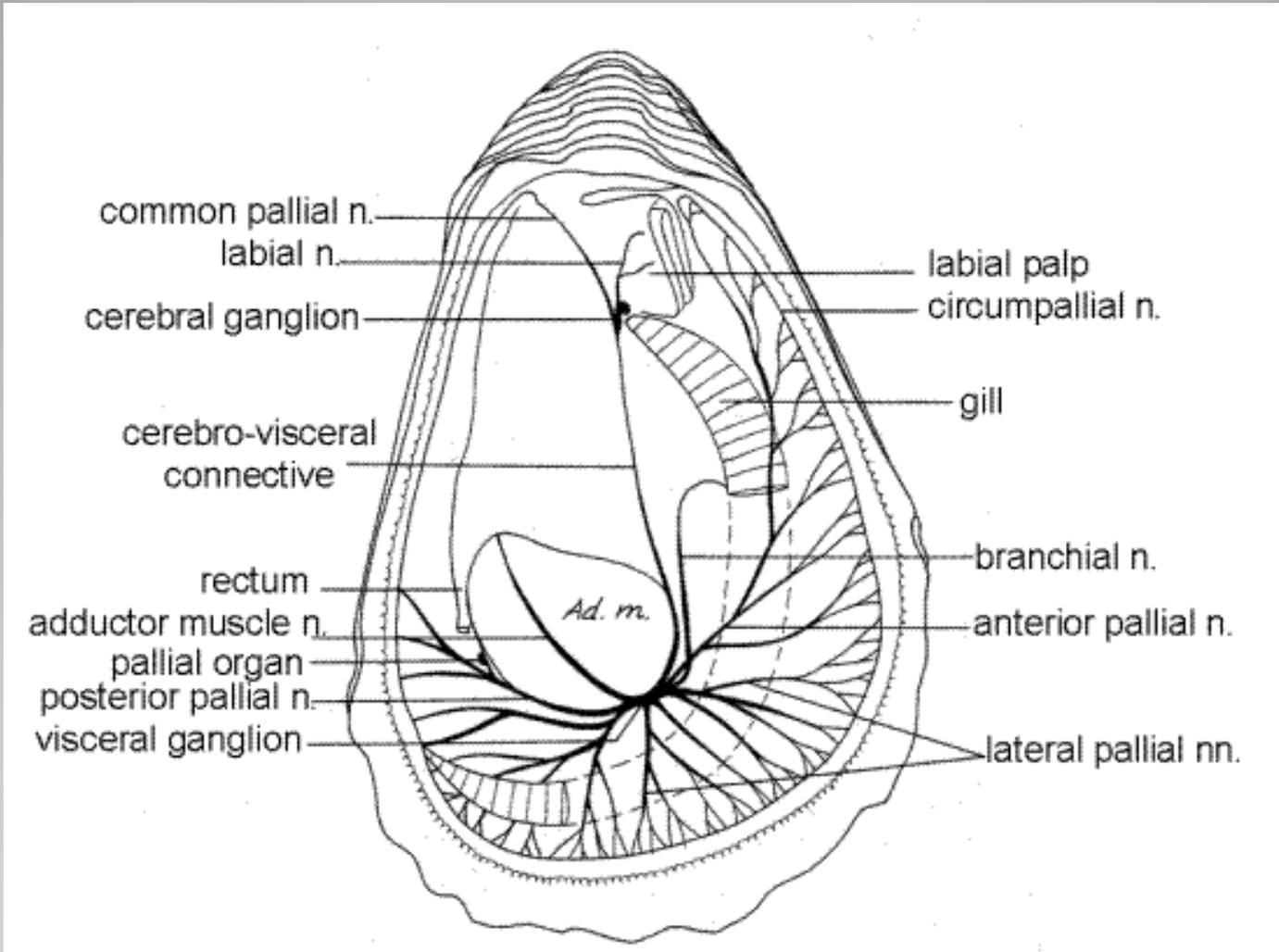
Circulatory System



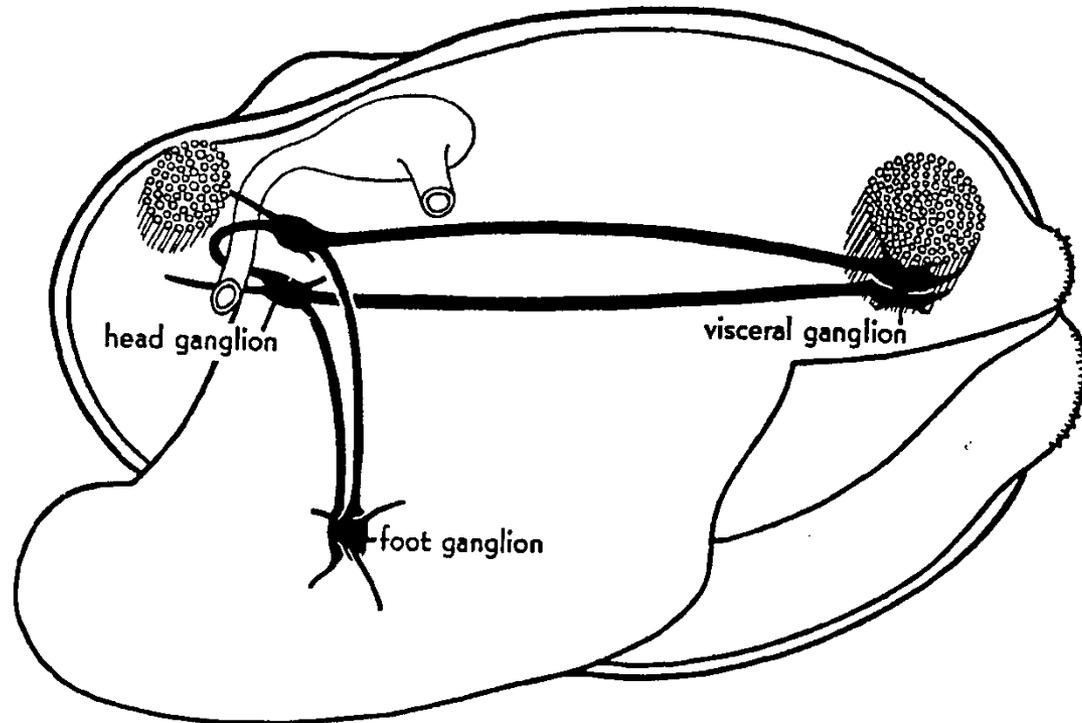
Circulatory System – blood cells



Hematopoietic neoplasia (aka Clam leukemia)

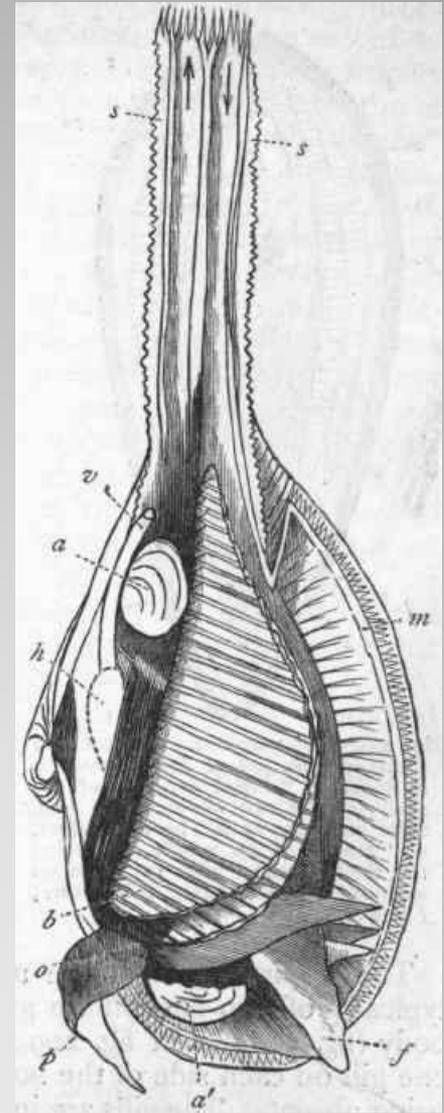
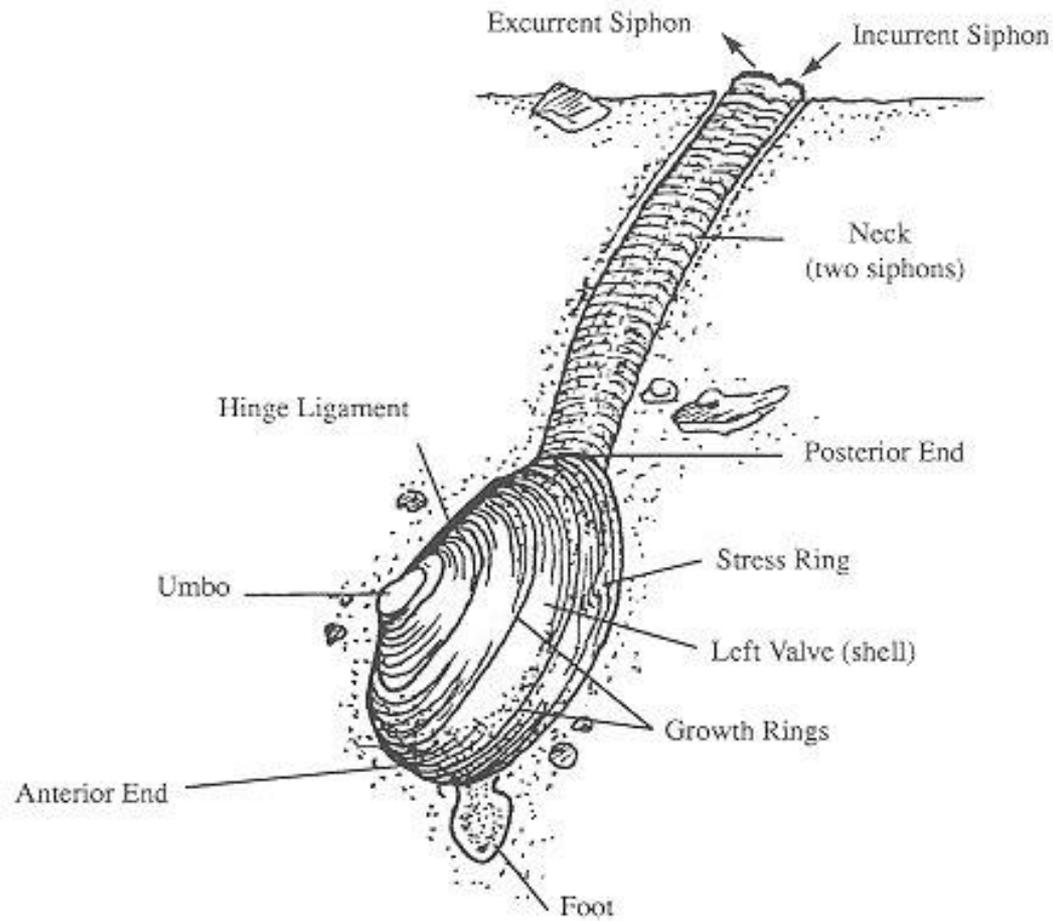


Oyster Nervous System

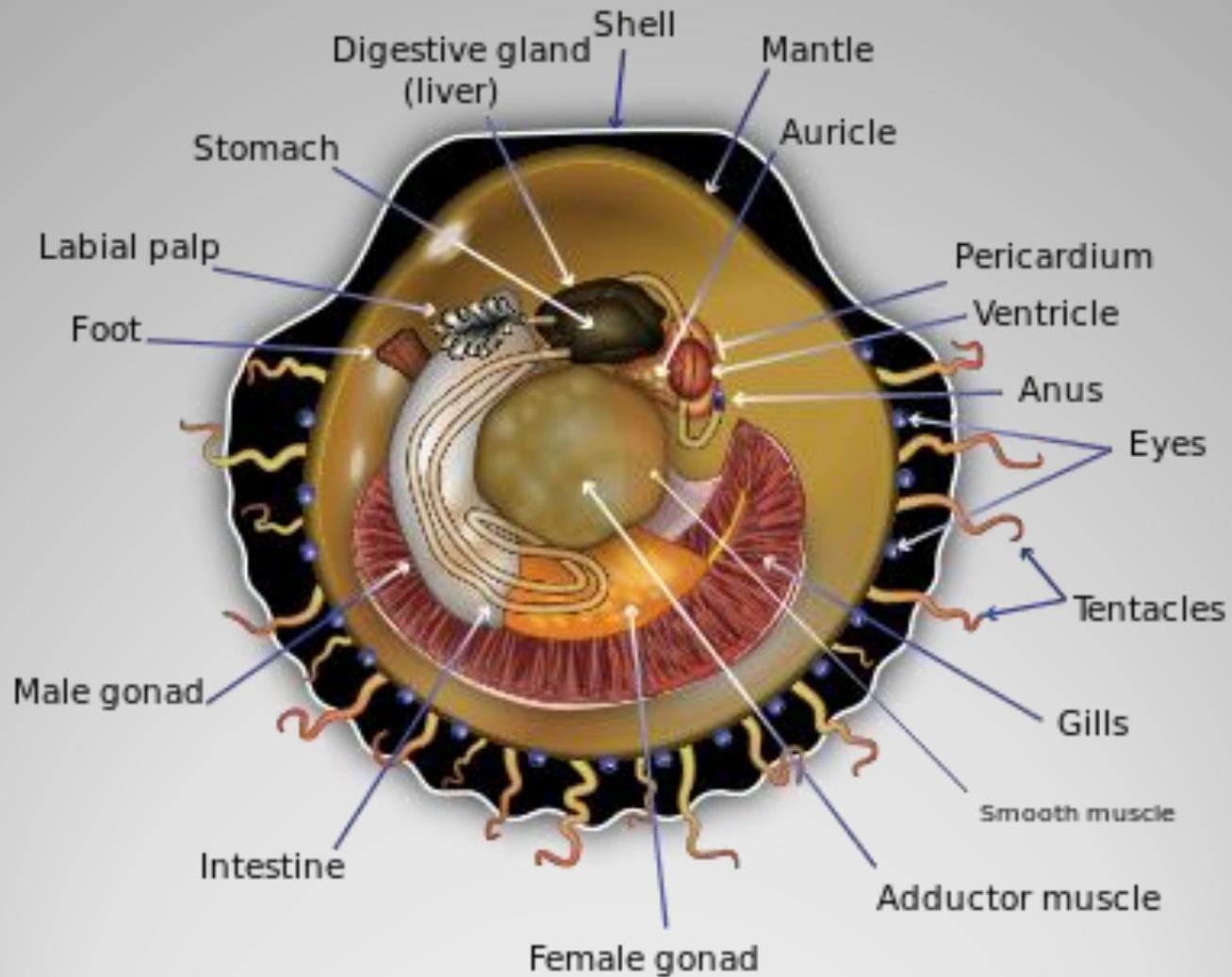


The **nervous system** of the clam has a pair of ganglia for each main region of the body. The head ganglia correspond to the double but fused “brain” of other animals. They lie on each side of the mouth, joined by a commissure that runs around the esophagus. They send nerves to palps, anterior shell muscle, and mantle. From each head ganglion a connective runs ventrally to the ganglia which supply the muscles of the foot. Two connectives also run from the head ganglia to the visceral ganglia, which send nerves to the digestive tract, heart, gills, posterior shell muscle, and mantle.

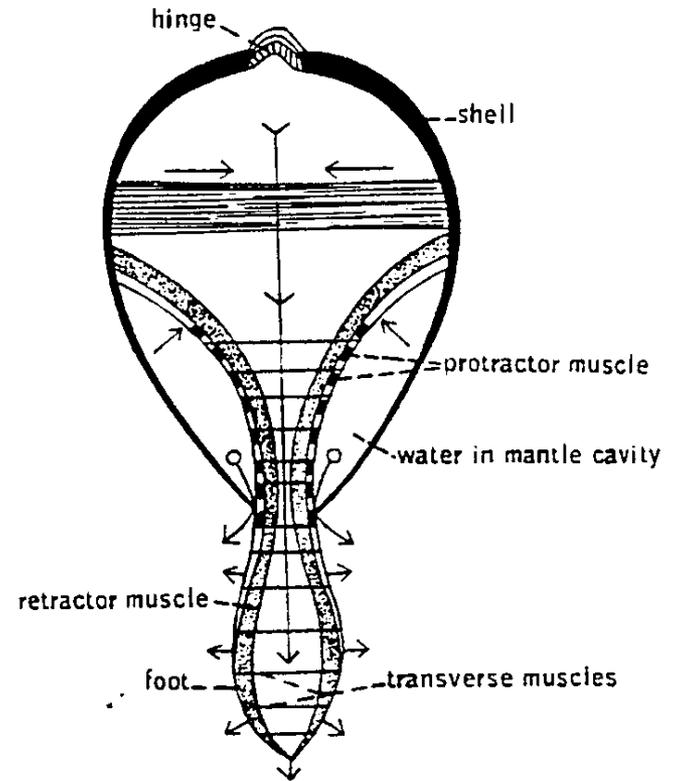
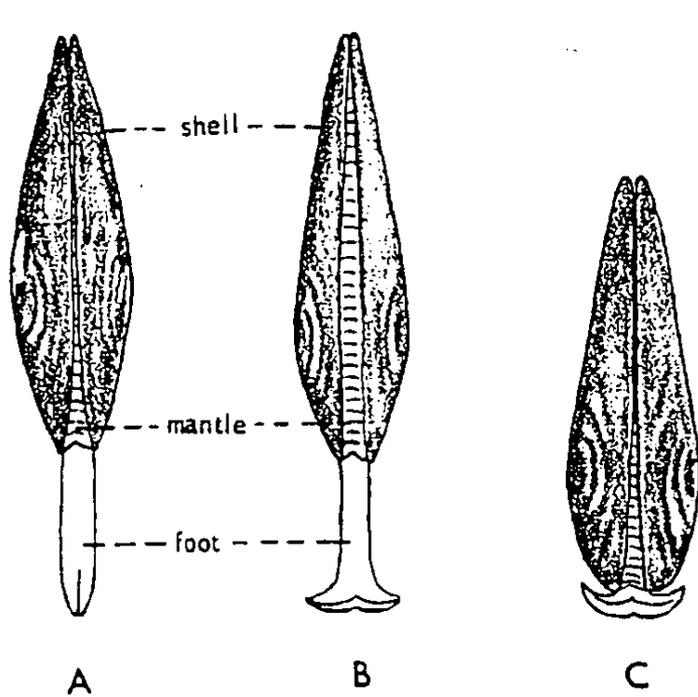
Clam Nervous System



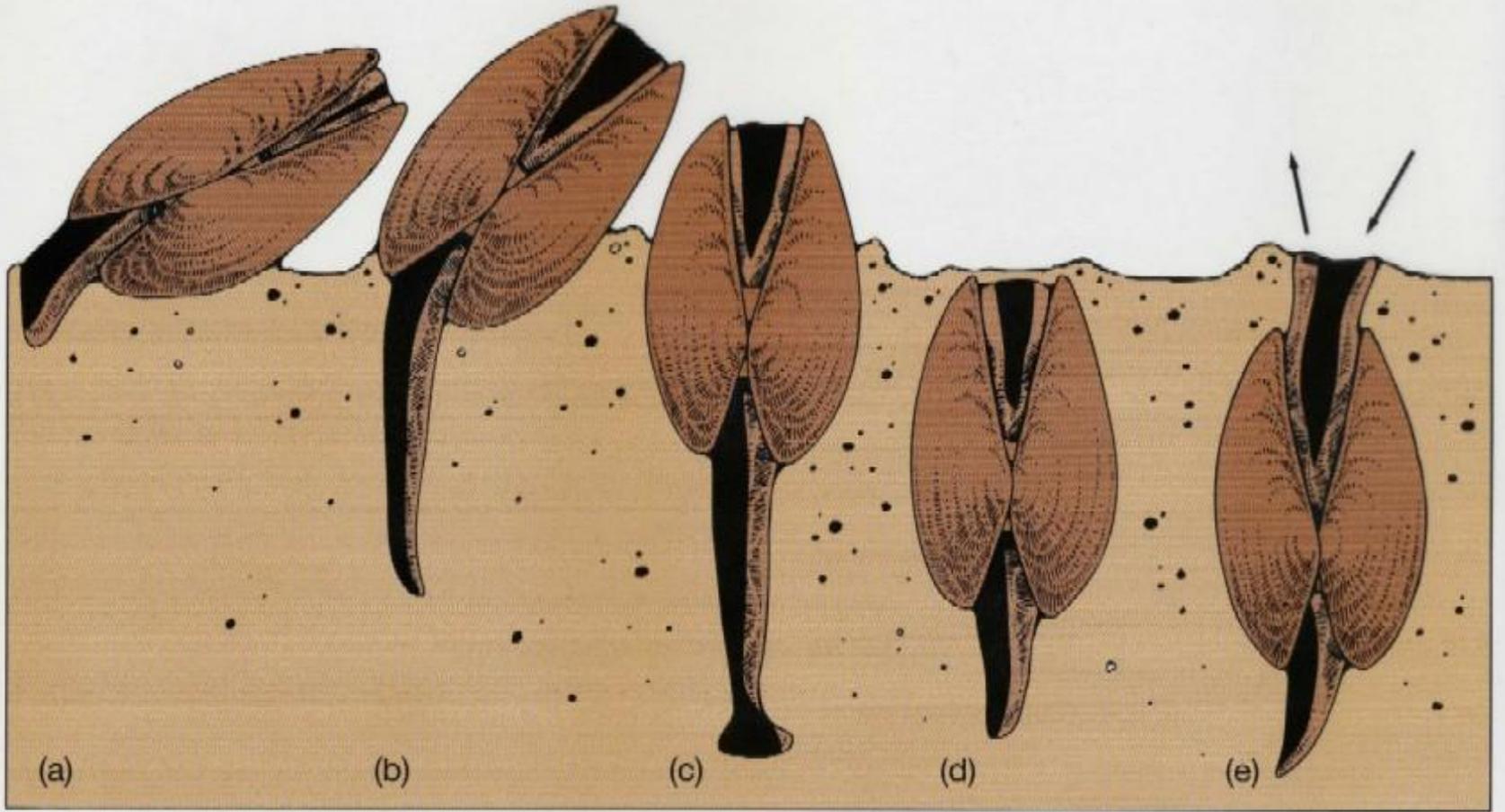
Soft shell clam



Scallop anatomy



Locomotion



Digging

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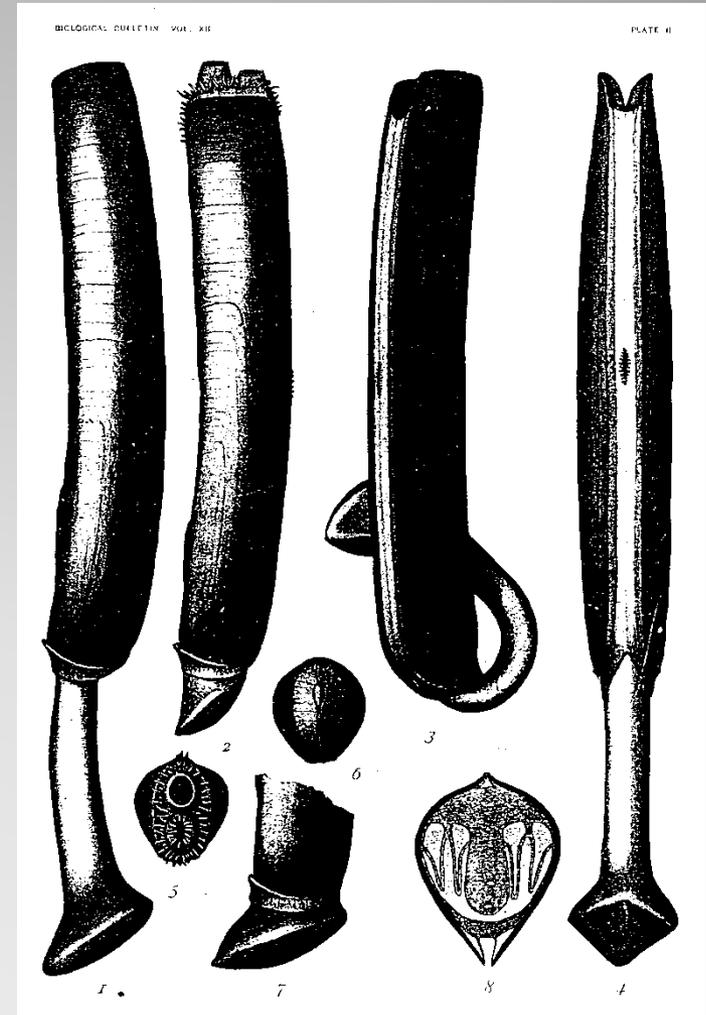
Digging (Jellybean clam)



Digging In (Pismo clam)



Other bivalve movement



The Locomotion King!

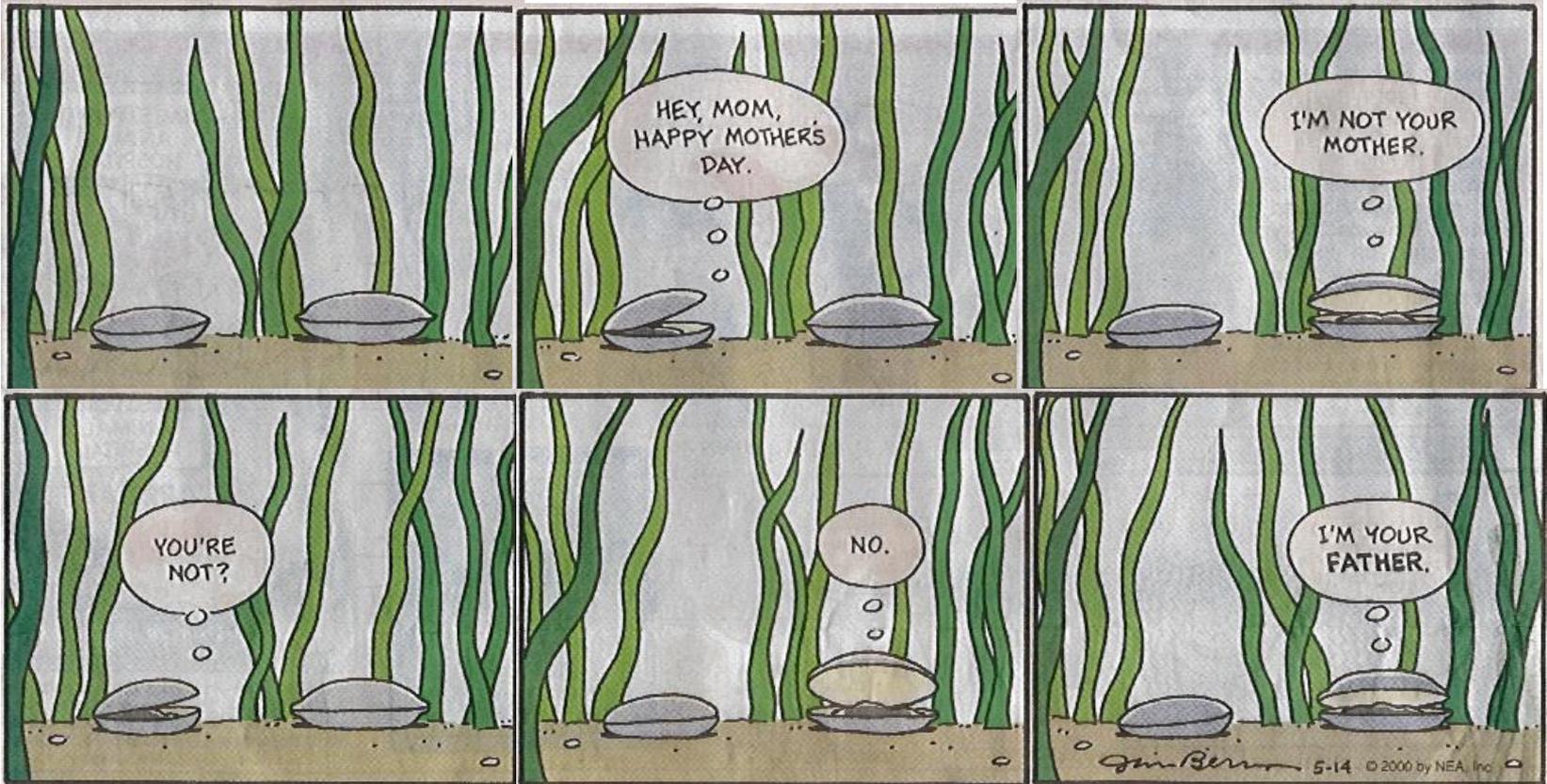


Swimming then Burrowing

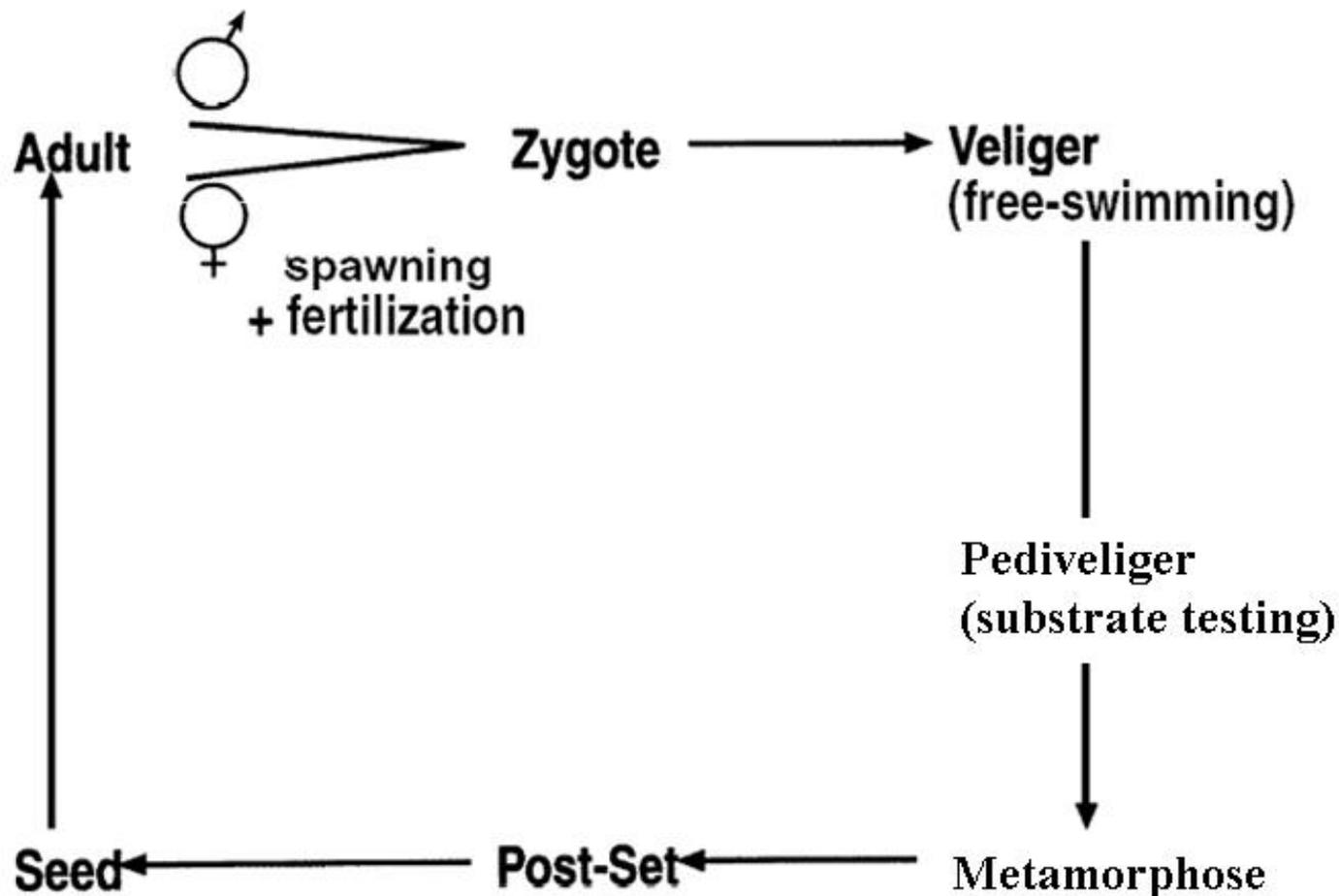


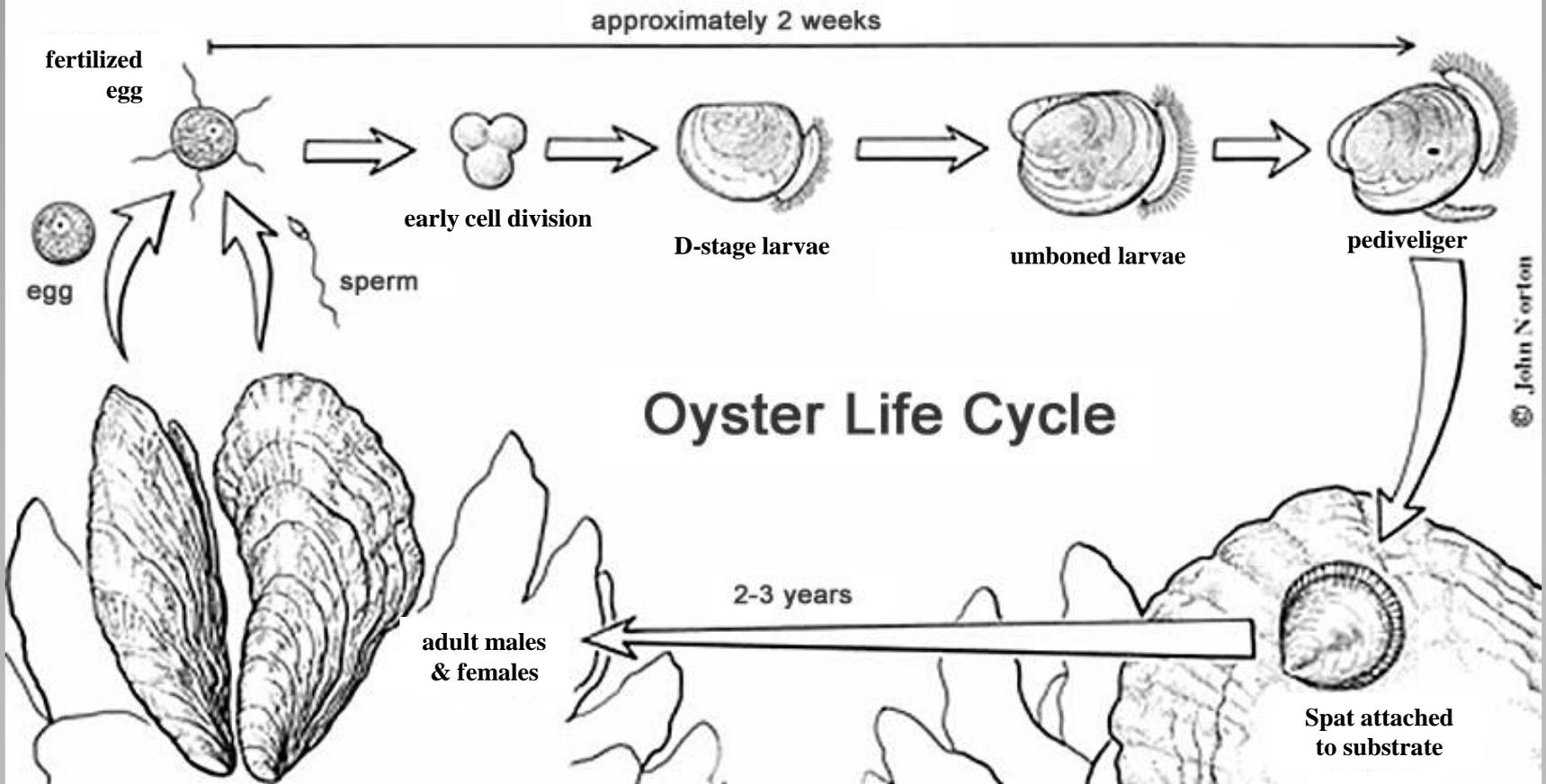
Walking?

Reproduction in Bivalves



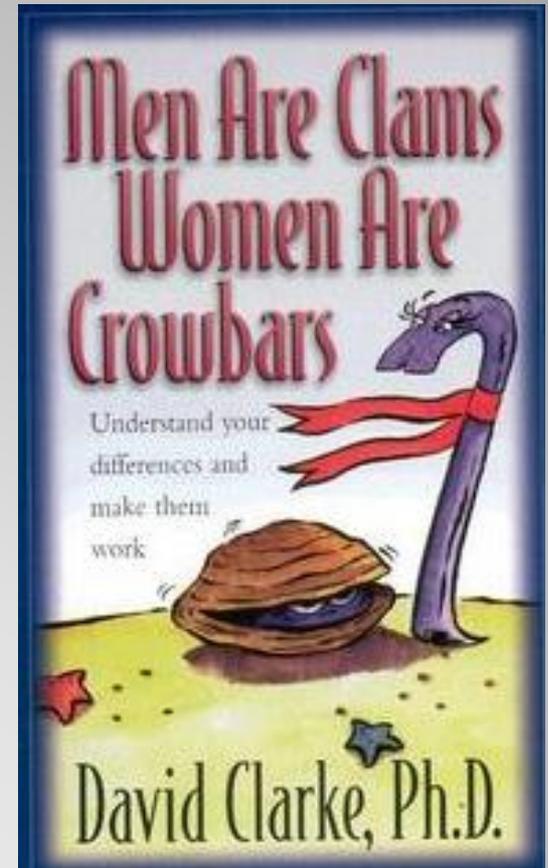
Life Cycle of Clams





Oyster Reproduction

- Commonly separate sexes in the bivalves (dioecious)
 - although hermaphroditism (monoecious) occurs
 - e.g. bay scallop



Shellfish Gender

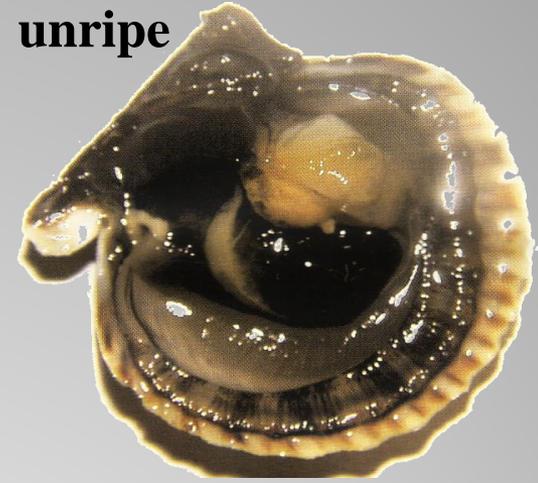
- Protandric
 - Protandry - development of male organs before female to avoid self-fertilization.
- Most begin life as males and then may change over to female
- As they grow, proportion of functional females in each size class increases
 - Females occur in larger (older) animals
- However, if the number of males is too low, some of the older females may change back to males!

Oysters & Quahogs

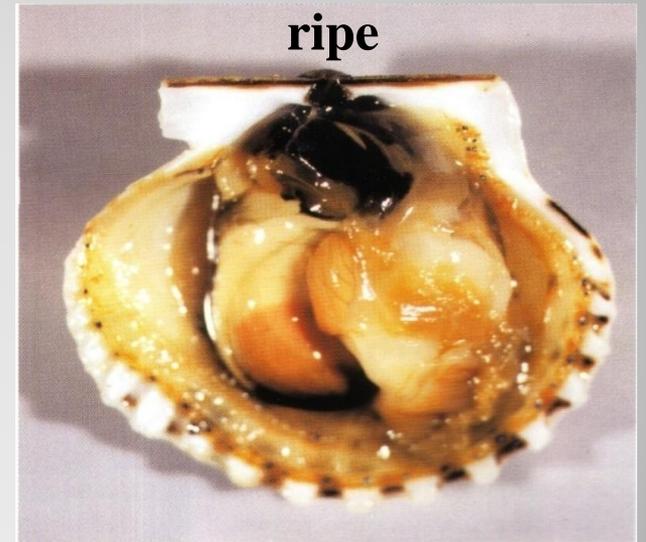
- Sex is unknown until observed spawning
 - Except bay scallops

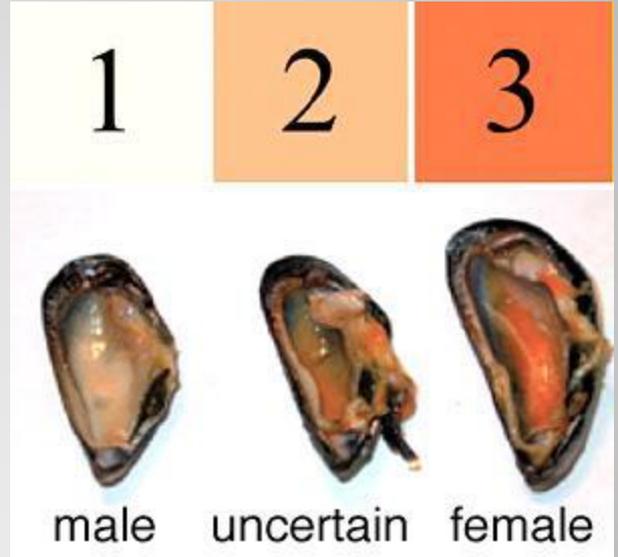
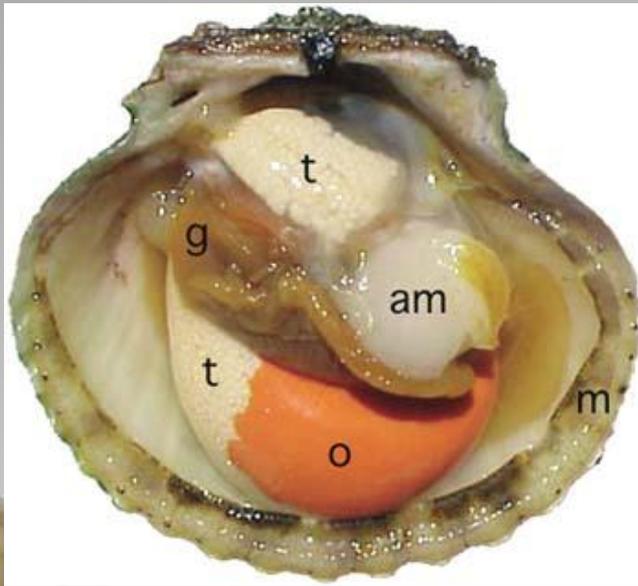


unripe



ripe

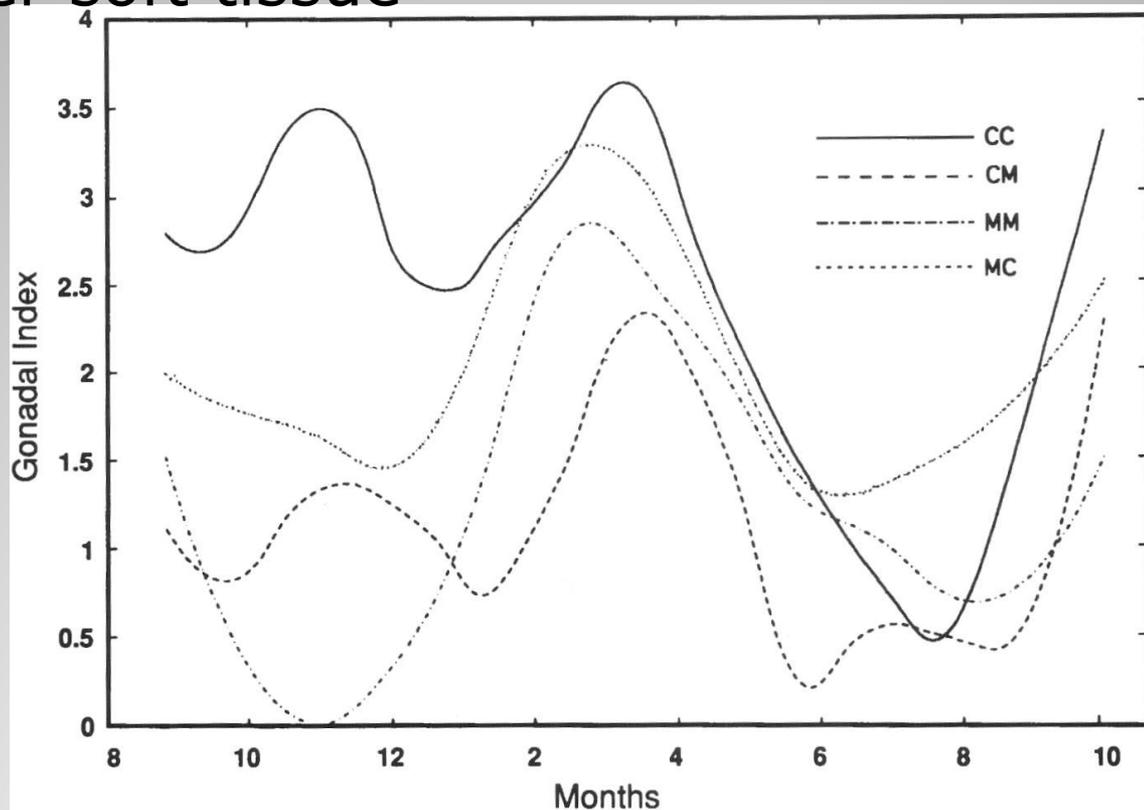




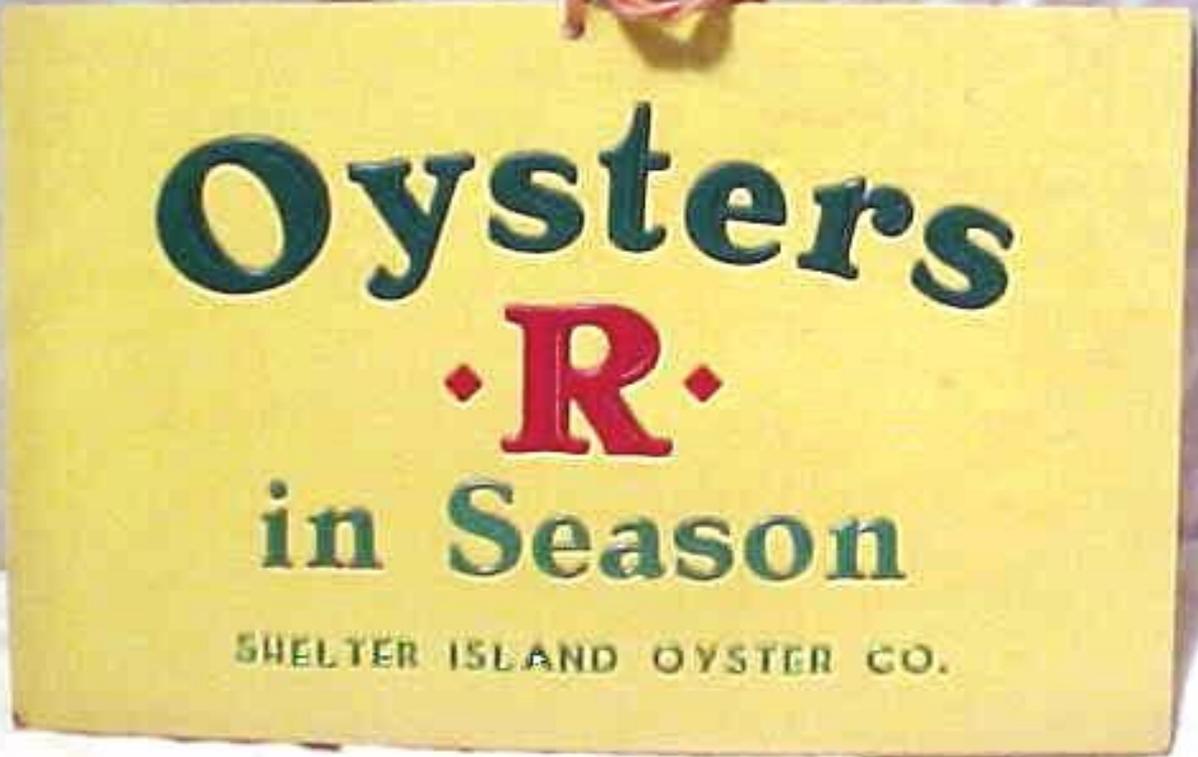
Gonad Anatomy

- Gonad Index

- Size of the gonad relative to the size of the other soft tissue



Gonad Index of Quahogs

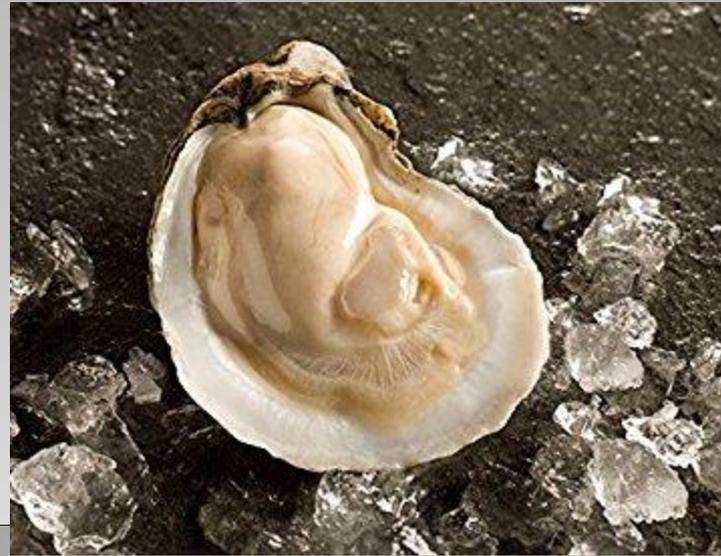


Oysters

• R •

in Season

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Meat Quality

- Larvae
 - Free-swimming babies during the first 2-3 weeks of the bivalve's life
- Metamorphosis
 - When an larvae transforms to their adult body shape
- Settlement (Setting)
 - When a metamorphosing shellfish occupies it's adult-type of habitat
- Spat/Seed
 - Spat - A juvenile bivalve after it has settled onto a location
 - Farmers call this "seed" when they purchase it to place on their farm
- Recruitment
 - When the current pulse (cohort) of larvae settle into a location

Shellfish Terminology

