Anatomía y Función

Respiración
Circulación
Excreción
Osmoregulación
Reproducción

Respiración

Primaria: arcos branquiales y epitelios

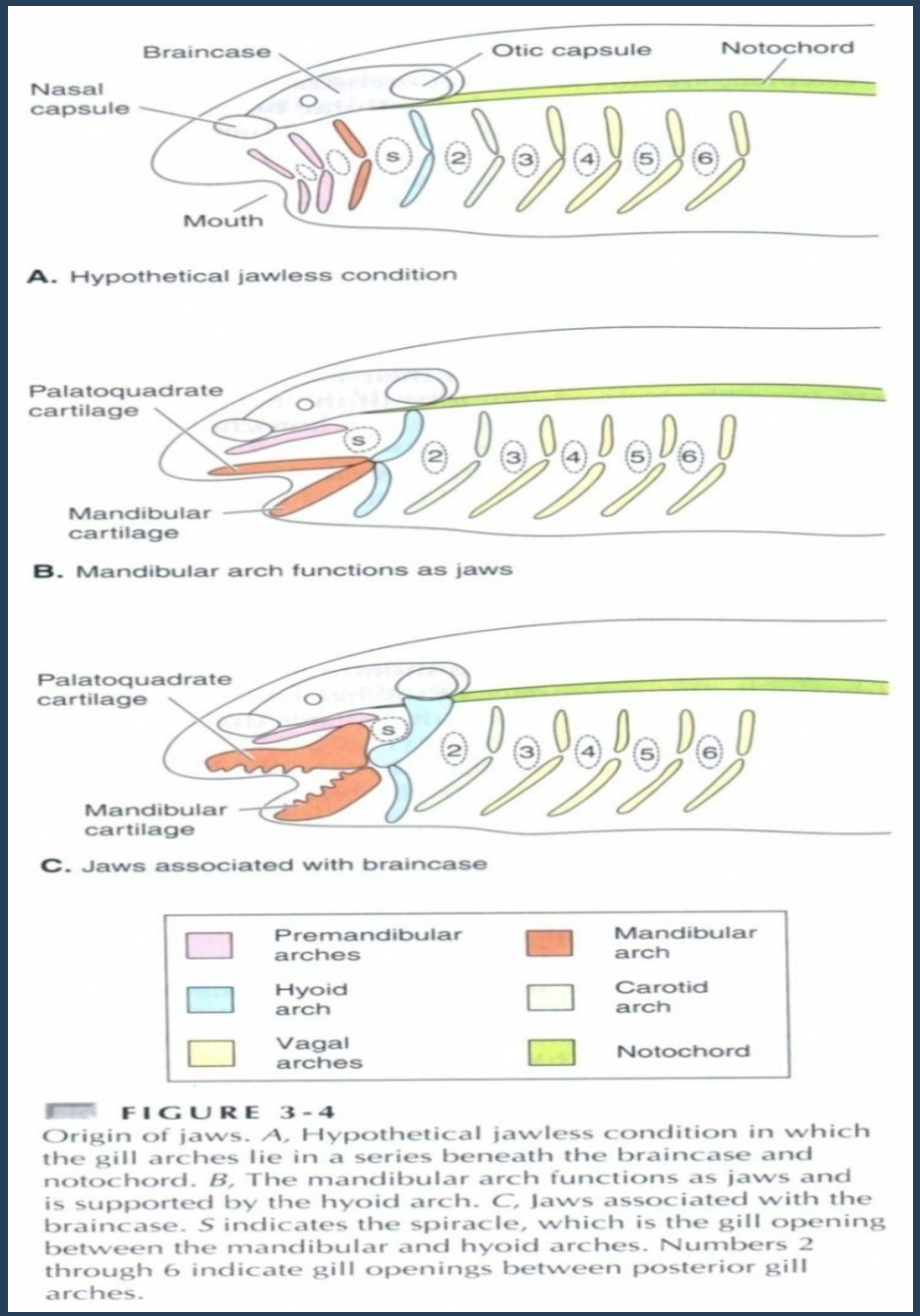
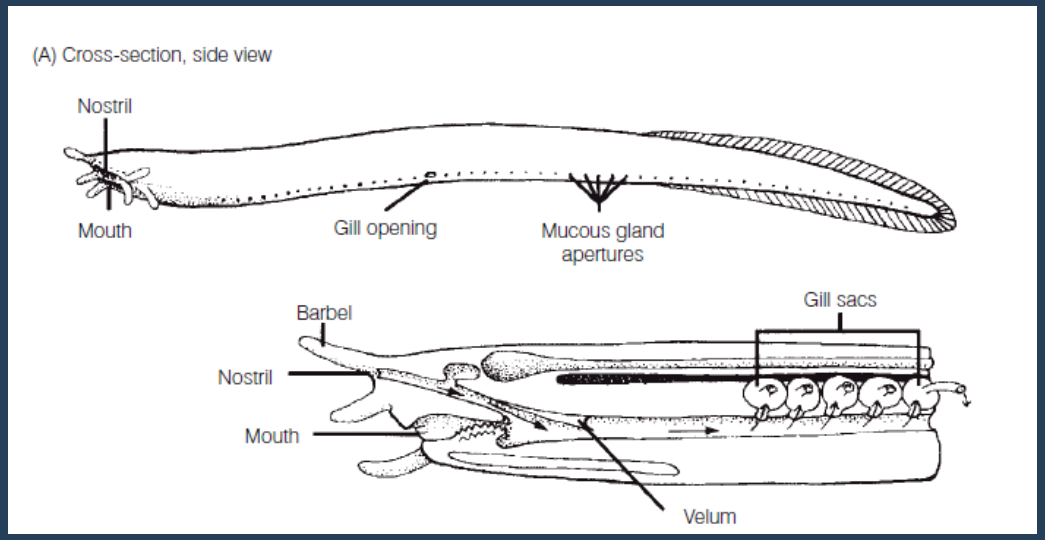


FIGURE 3-4
Origin of jaws. *A*, Hypothetical jawless condition in which the gill arches lie in a series beneath the braincase and notochord. *B*, The mandibular arch functions as jaws and is supported by the hyoid arch. *C*, Jaws associated with the braincase. *S* indicates the spiracle, which is the gill opening between the mandibular and hyoid arches. Numbers 2 through 6 indicate gill openings between posterior gill arches.

Respiración

Agnatos: branquias en bolsillos

Mixinas



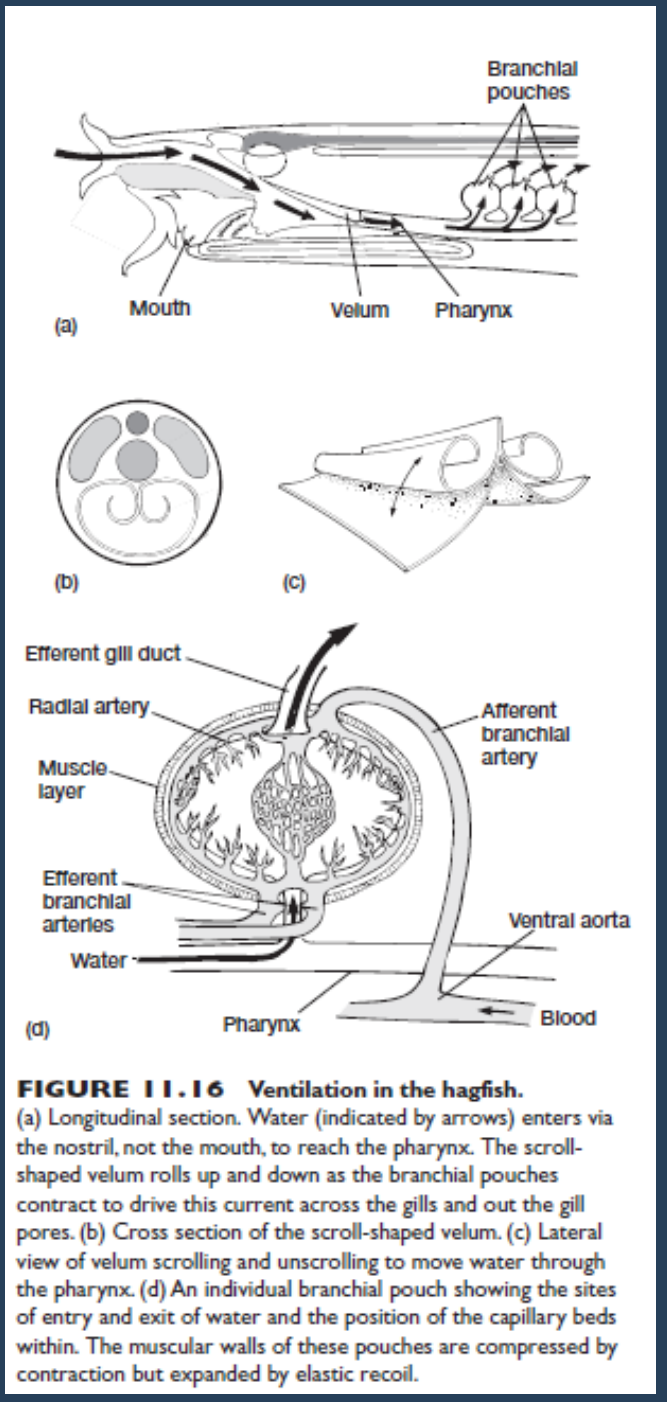
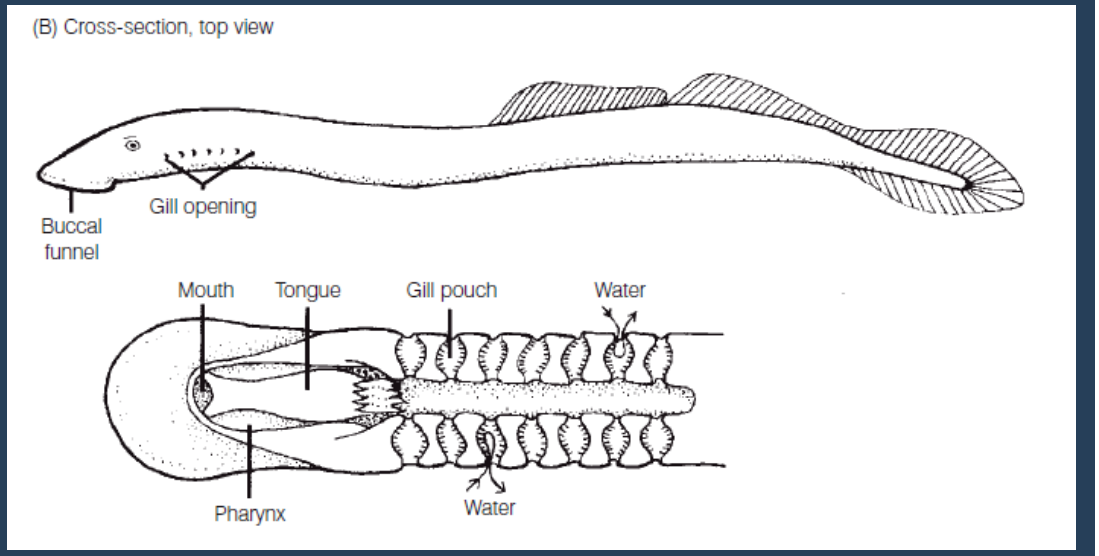


FIGURE 11.16 Ventilation in the hagfish.
(a) Longitudinal section. Water (indicated by arrows) enters via the nostril, not the mouth, to reach the pharynx. The scroll-shaped velum rolls up and down as the branchial pouches contract to drive this current across the gills and out the gill pores. (b) Cross section of the scroll-shaped velum. (c) Lateral view of velum scrolling and unscrolling to move water through the pharynx. (d) An individual branchial pouch showing the sites of entry and exit of water and the position of the capillary beds within. The muscular walls of these pouches are compressed by contraction but expanded by elastic recoil.

Respiración

Agnatos: branquias en bolsillos

Lampreas



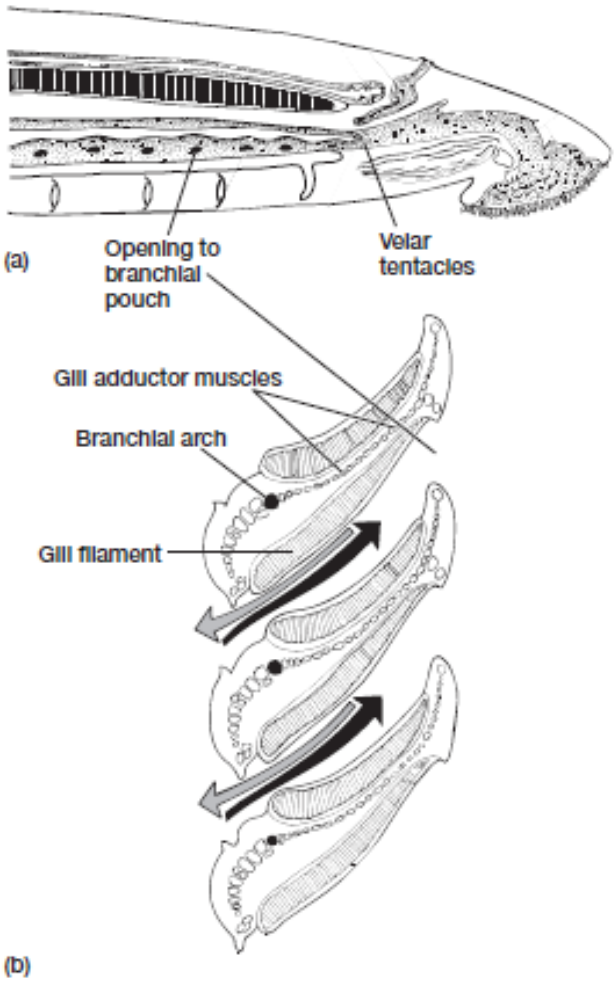


FIGURE 11.15 Ventilation in the adult lamprey. (a) Longitudinal section. Because the adult lamprey's mouth often is attached to prey, water must alternatively enter as well as exit via pharyngeal slits. Thus, gill ventilation in the lamprey, unlike most fishes, is tidal. (b) Frontal section of three gill arches. Double arrows indicate tidal flow of water: black, inflow; gray, outflow.

After Mallatt.

Respiración

Condríctios

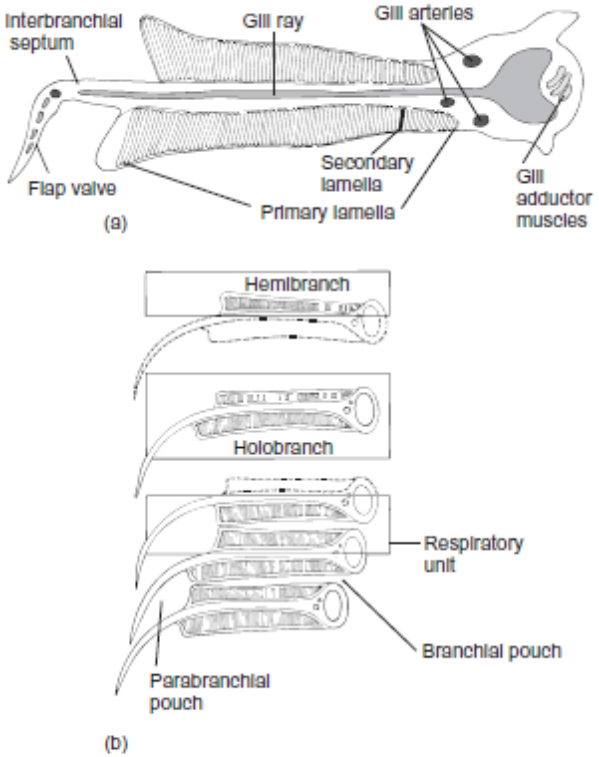


FIGURE 11.17 Shark gill. (a) The interbranchial septum has banks of lamellae supported by gill rays and a medial branchial arch. (b) Structural units include a hemibranch and a holobranch as well as a functional respiratory unit.

(a) After Mallatt.

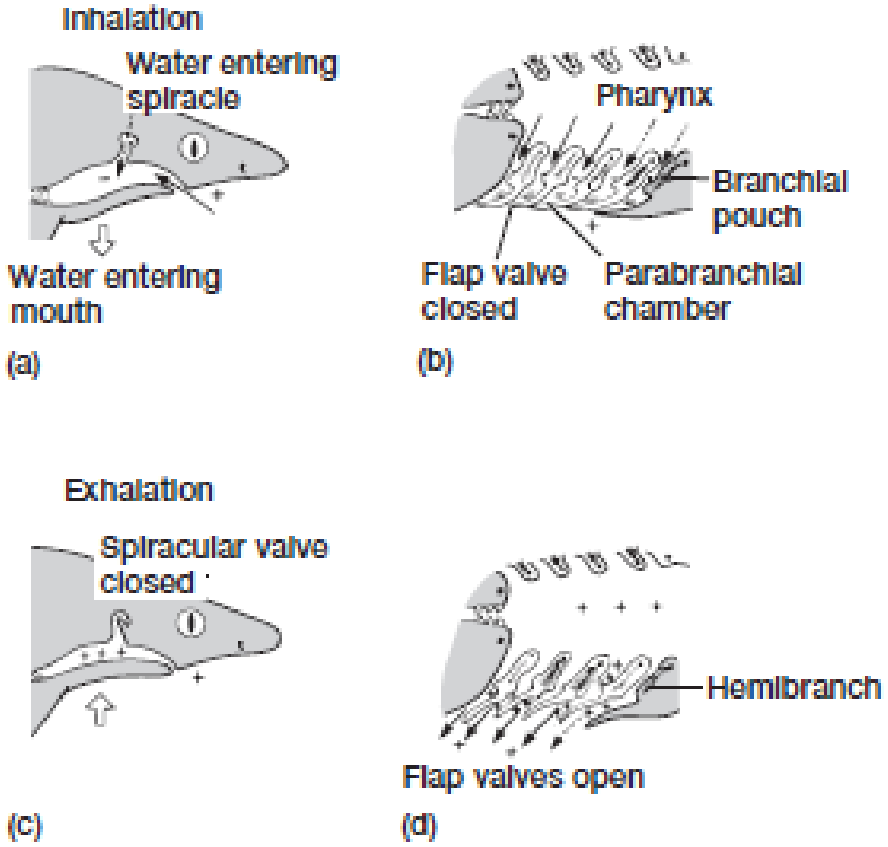
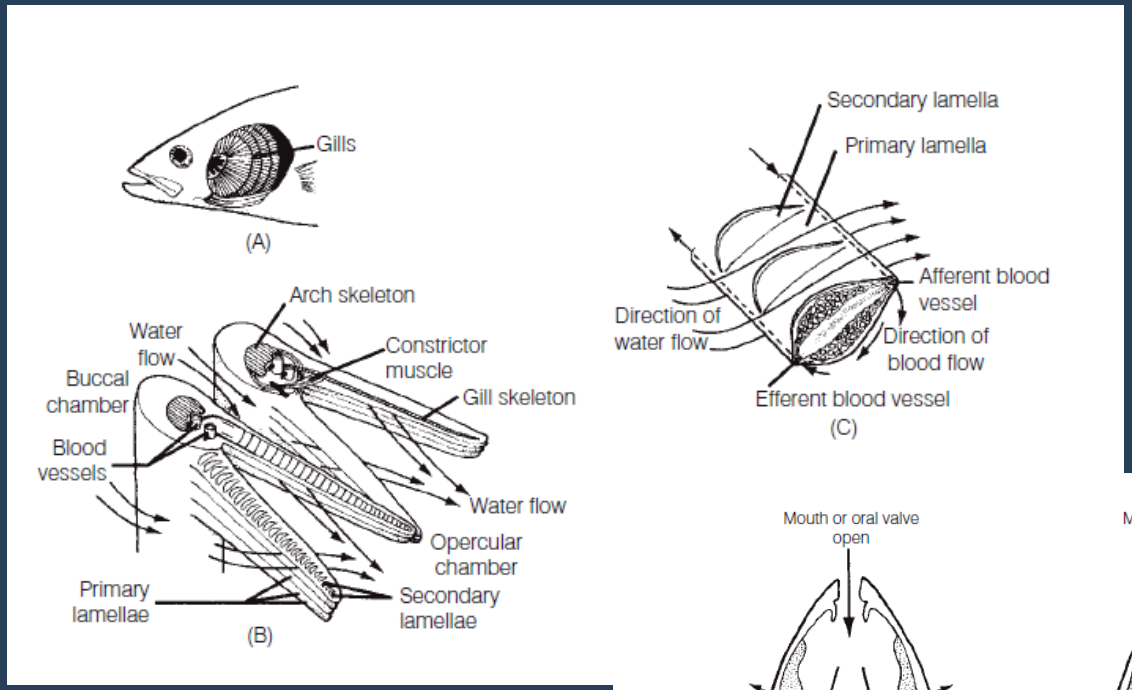
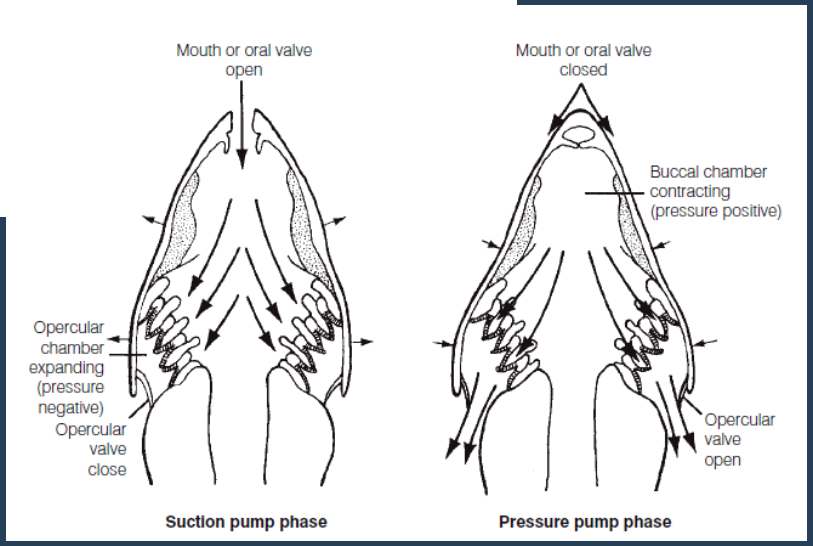


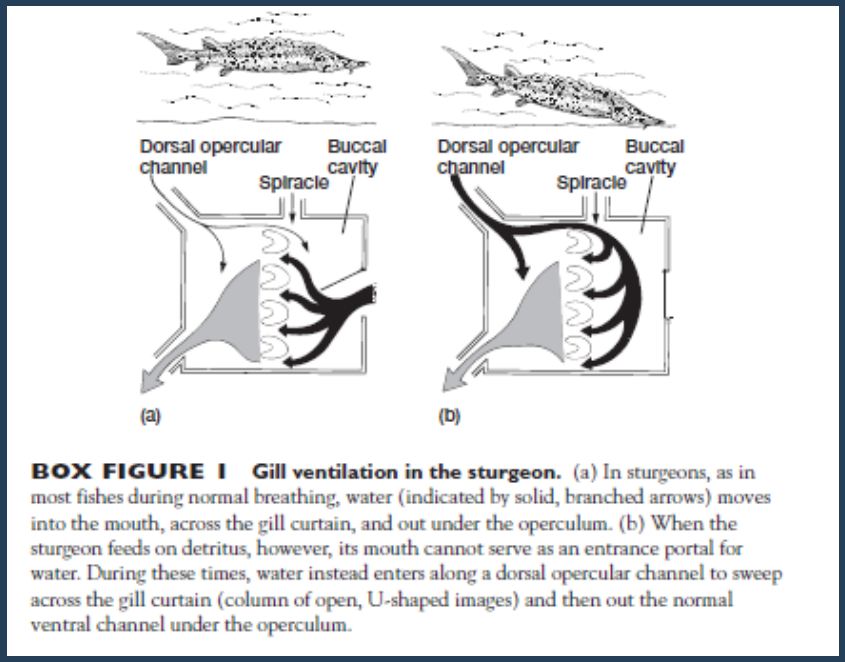
FIGURE 11.18 Gill ventilation in a shark. Lateral (a,c) and frontal (b,d) views. Relative positive and negative pressures are indicated by + and −, respectively. The ventilation mechanism consists of a buccal pump that draws water in and forces it across the gill curtain and out. Notice that the flap valves close during inhalation and that relative pressures are always lower in the parabranchial chamber than in the pharynx. Thus, water moves unidirectionally across the gills in a pulsing but continuous flow.

Respiración

Peces óseos







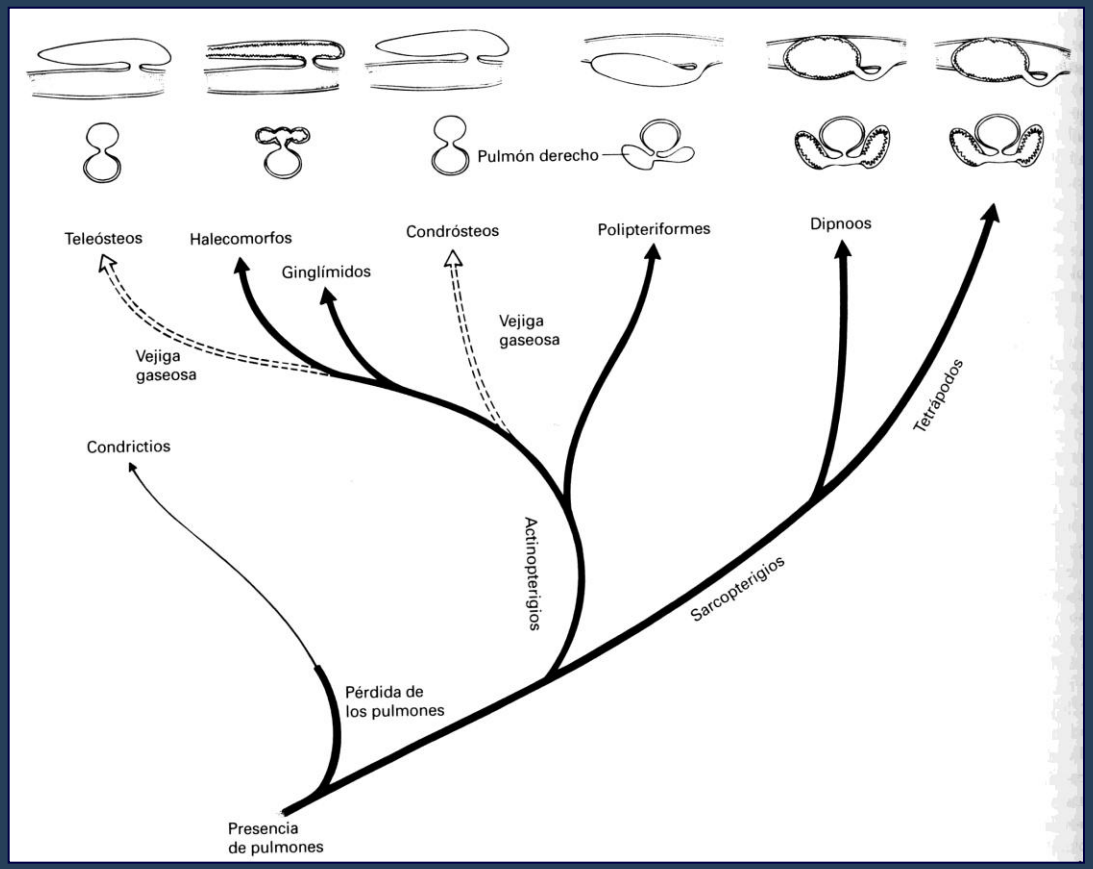
BOX FIGURE 1 **Gill ventilation in the sturgeon.** (a) In sturgeons, as in most fishes during normal breathing, water (indicated by solid, branched arrows) moves into the mouth, across the gill curtain, and out under the operculum. (b) When the sturgeon feeds on detritus, however, its mouth cannot serve as an entrance portal for water. During these times, water instead enters along a dorsal opercular channel to sweep across the gill curtain (column of open, U-shaped images) and then out the normal ventral channel under the operculum.

Acipenser

Respiración

Respiración aérea (característica primitiva en osteíctios)

Evaginaciones del tubo digestivo:
•Pulmones o vejiga natatoria modificada en Sarcopterygii y Actinopterygii ancestrales
•En Polypteriformes, ventrales, pares y de pared lisa.
•En Dipnoos, dorsales con conexión ventral: *Neoceratodus*: fusionados; *Lepidosiren* y *Protopterus*: ligeramente unidos



Respiración

Diversidad de adaptaciones a respiración aérea en Teleosteos: aprox. 67 orígenes independientes

"Vejiga natatoria" secundaria: respiración aérea

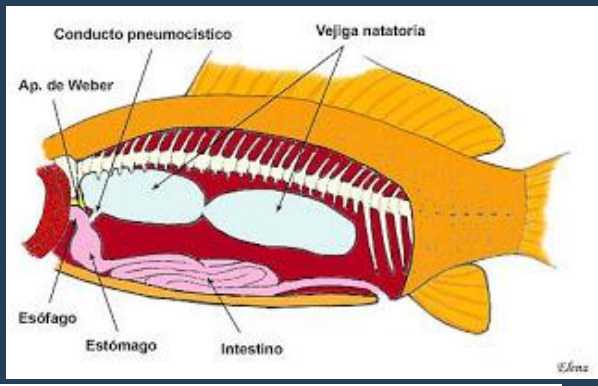
Arapaima (Osteoglossiformes)

Hoplerythrinus (Characiformes)

Respiración

Gymnotiformes: Hypopomidae usan las branquias para respirar aire

Gymnotiformes: Gymnotidae cavidad posterior de la vejiga natatoria (*Gymnotus*), epitelio bucal especializado (*Electrophorus*)



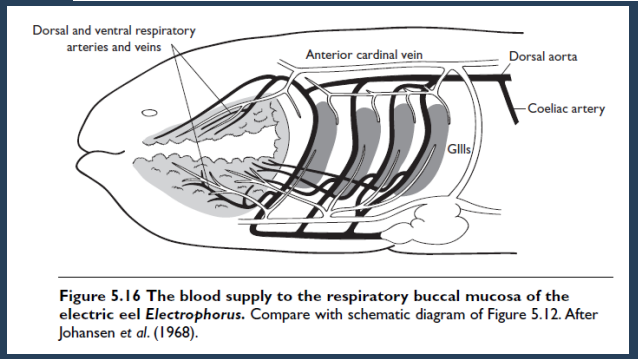


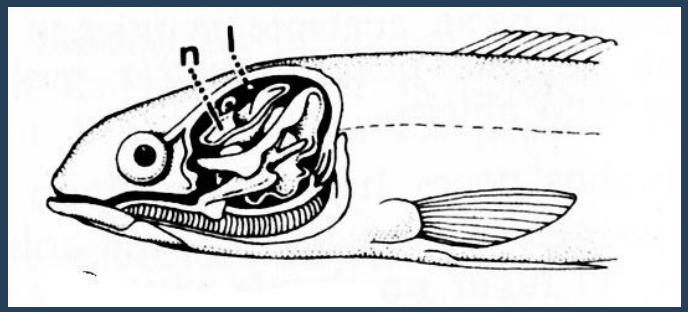
Figure 5.16 The blood supply to the respiratory buccal mucosa of the electric eel *Electrophorus*. Compare with schematic diagram of Figure 5.12. After Johansen *et al.* (1968).

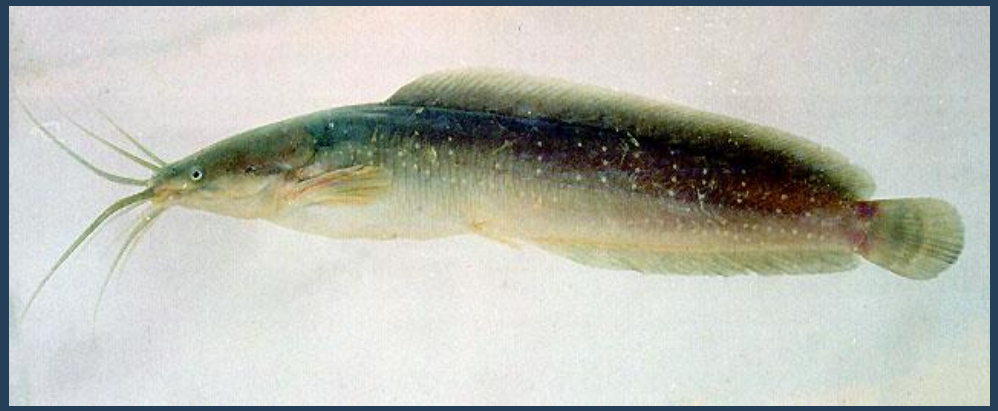
Respiración

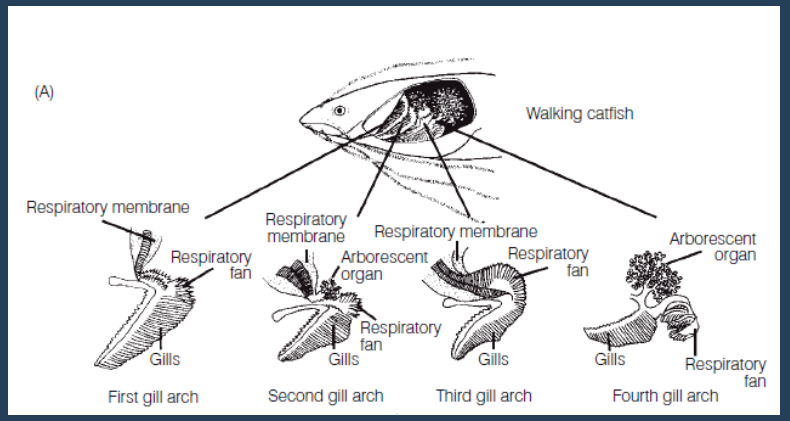
Epitelio: larvas o adultos en baja actividad o temperatura y en peces anfibios

Respiración

Betta (Anabantiformes): cavidad sobre las branquias, láminas plegadas







Clarias (Siluriformes): cavidad branquial modificada, desarrollo a partir de los arcos branquiales 2 y 4, estructura arborescente (árbol branquial)

Respiración

Synbranchus marmoratus (Synbranchiformes): cavidad bucal y branquial plegada

Cyprinus (Cypriniformes): paladar

Respiración

Hypostomus (Siluriformes): estómago

Callichthydae (Siluriformes): intestino

Hoplosternum

Callichthys

Circulación

<u>Modelo Básico</u>: circuito simple

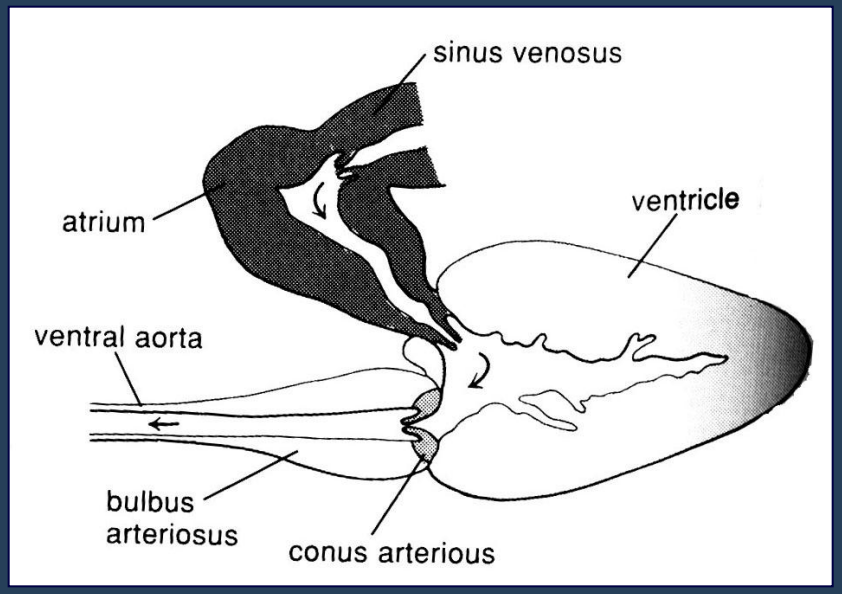
<u>Corazón</u>:

Seno venoso

Atrio

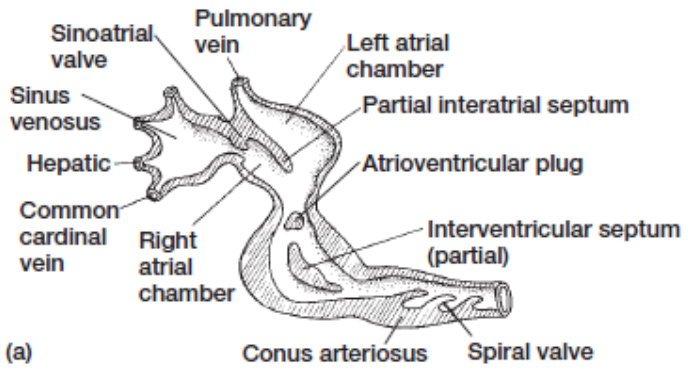
Ventrículo

Bulbo arterioso (tejido elástico, no muscular)



Sarcopterygii: corazón caudal

Circulación



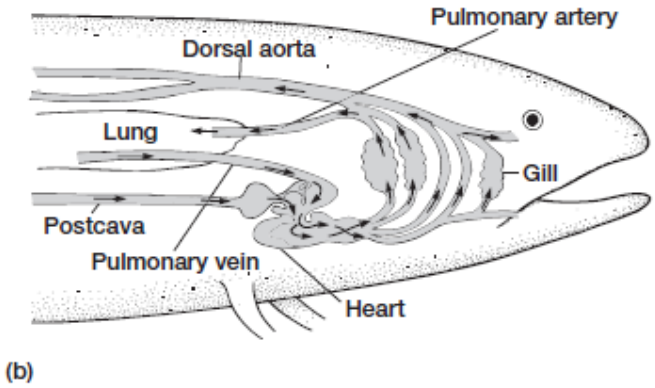
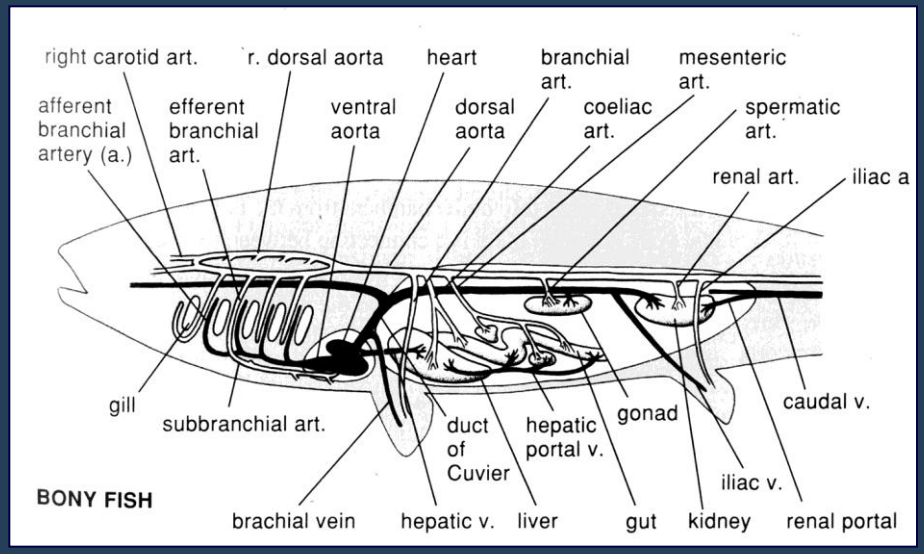


FIGURE 12.29 **Heart of the African lungfish *Protopterus*.** (a) Internal structure of the heart. (b) Path of blood. When the lungfish breathes air, venous blood returning from systemic tissues flows through the heart and tends to be directed to the last aortic arch. The pulmonary artery carries most of the deoxygenated blood to the lung. Blood high in oxygen returning from the lung passes through the heart and then tends to enter the aortic arches without gills. In this manner, blood is shunted directly to the general circulation. Thus, when lungfishes breathe air, they display the beginnings of a double circulation system. The five aortic arches phylogenetically represent the second through the sixth (Roman numerals). The first (II) and last two (V, VI) of these carry gills.

Circulación



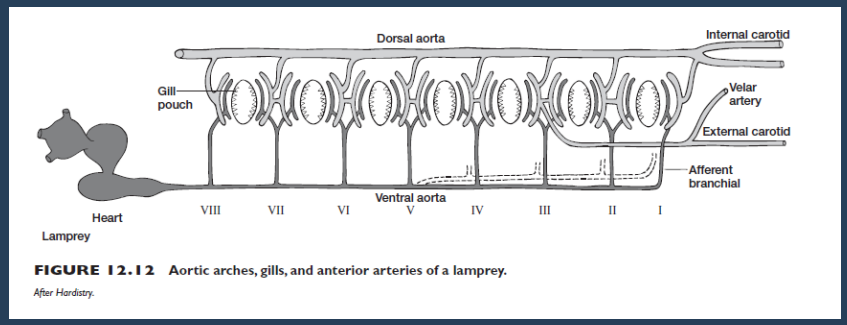


FIGURE 12.12 Aortic arches, gills, and anterior arteries of a lamprey.

After Hardisty.

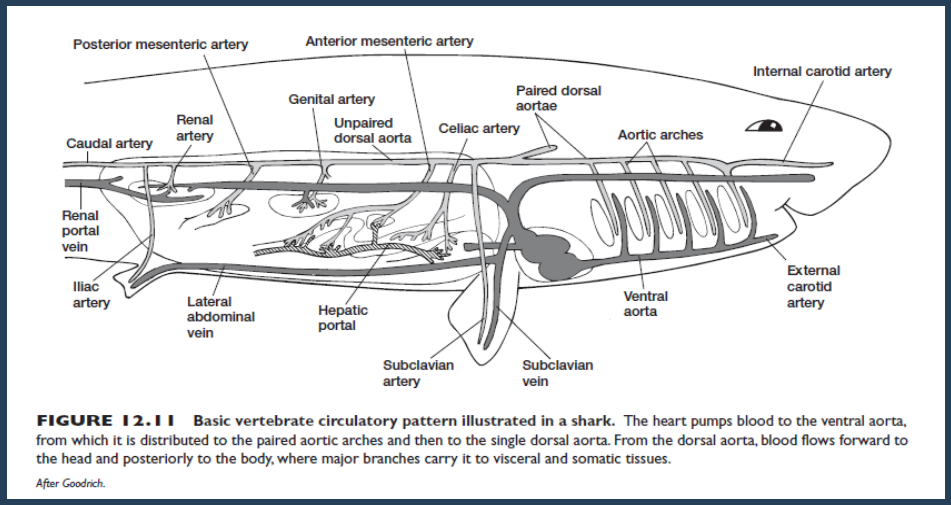
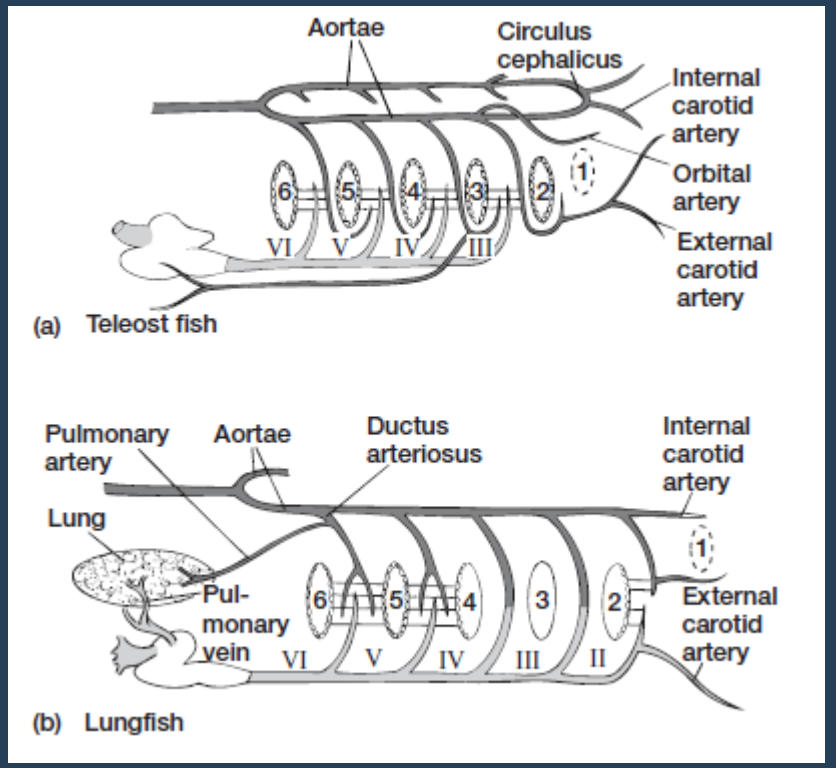


FIGURE 12.11 **Basic vertebrate circulatory pattern illustrated in a shark.** The heart pumps blood to the ventral aorta, from which it is distributed to the paired aortic arches and then to the single dorsal aorta. From the dorsal aorta, blood flows forward to the head and posteriorly to the body, where major branches carry it to visceral and somatic tissues.

After Goodrich.



Circulación

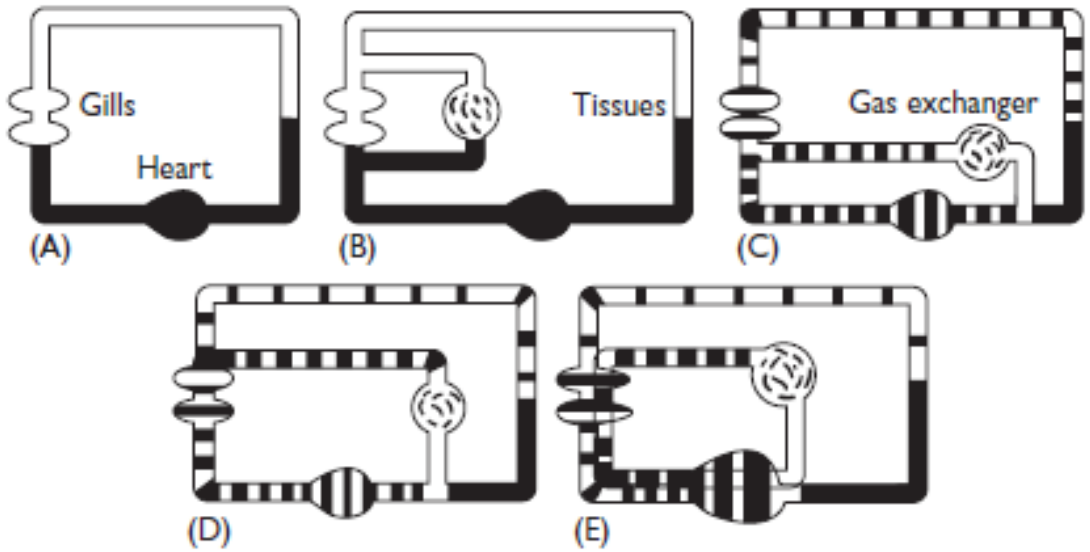
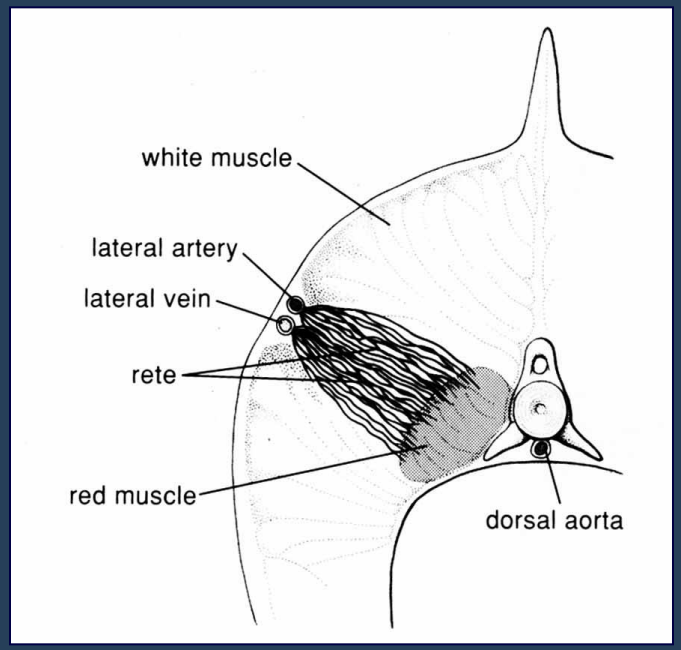


Figure 5.15 Different circulatory patterns in various air-breathing fishes. Black: low blood O_2 content; white: high O_2 content. (A) Normal fish gaining oxygen from gills in water; the gills are in series with the tissues of the systemic bed. (B) Fishes using the opercular chambers or buccal mucosa as airbreathing organs (*Clarias, Saccobranchus*). (C) Fish using the opercular or pharyngeal mucosa as the air-breathing organ (*Electrophorus, Anabas, Periophthalamus*). (D) Swimbladder used for respiration (holosteans). (E) Lung-like swimbladder, partial division between pulmonary and branchial circulation (lungfishes). After Johansen (1970).

Circulación

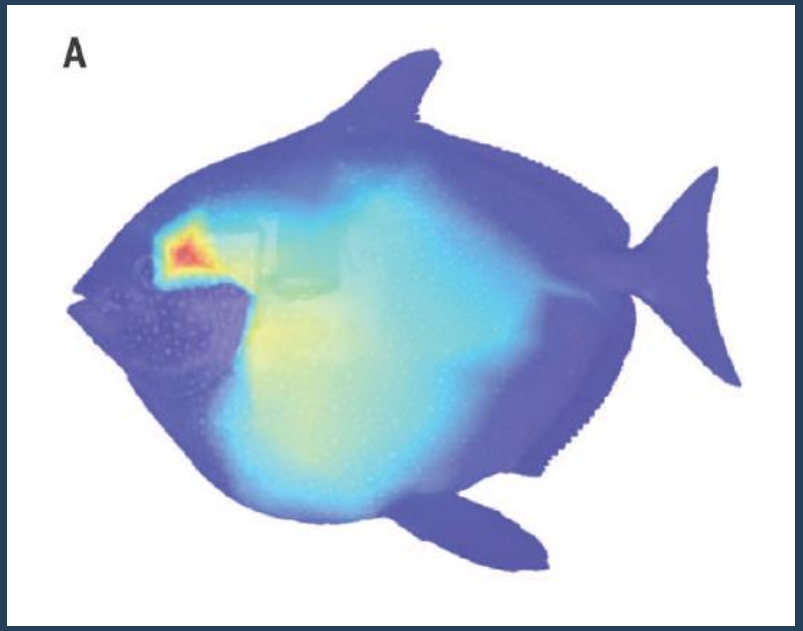
Redes Coroides: conservación del calor

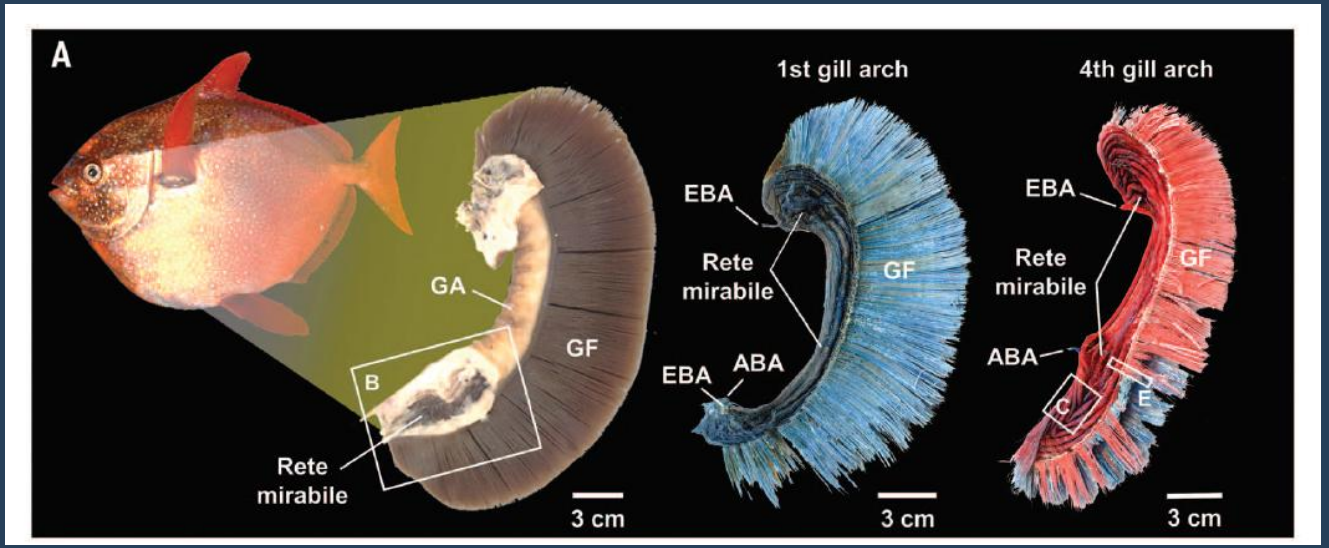


Xiphidea e Istiophoridae: Cerebro y ojo

Circulación

Lampris

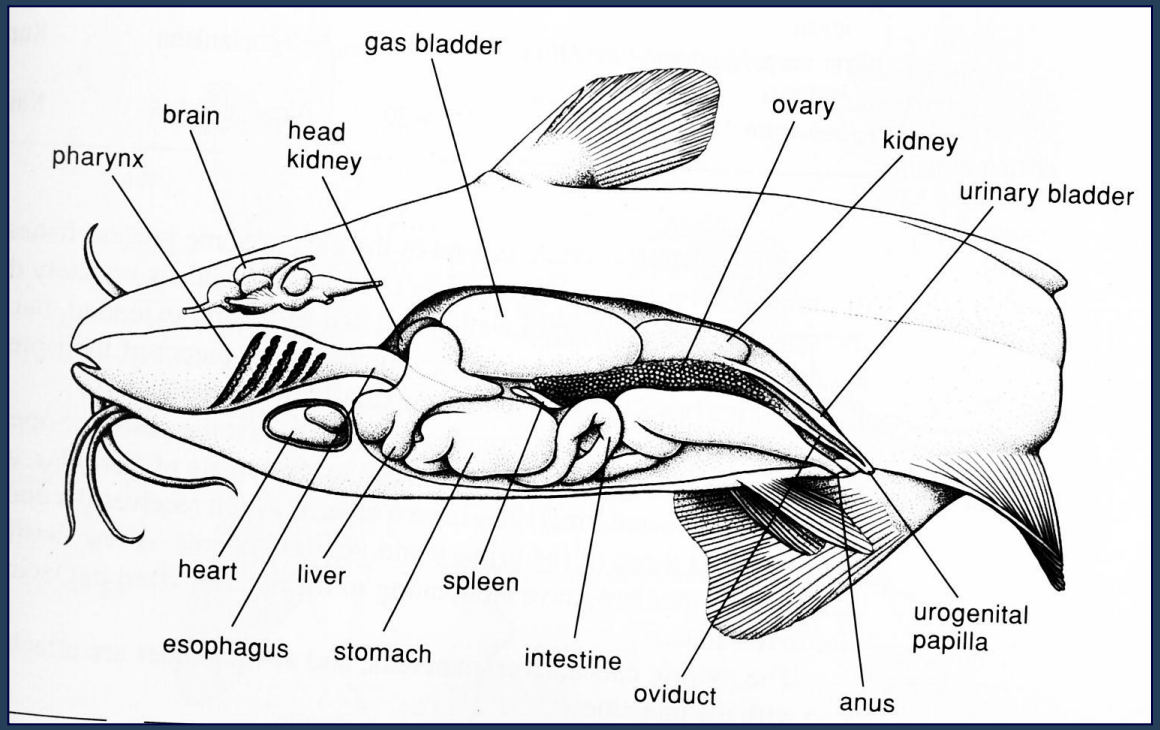




Excreción

Riñon

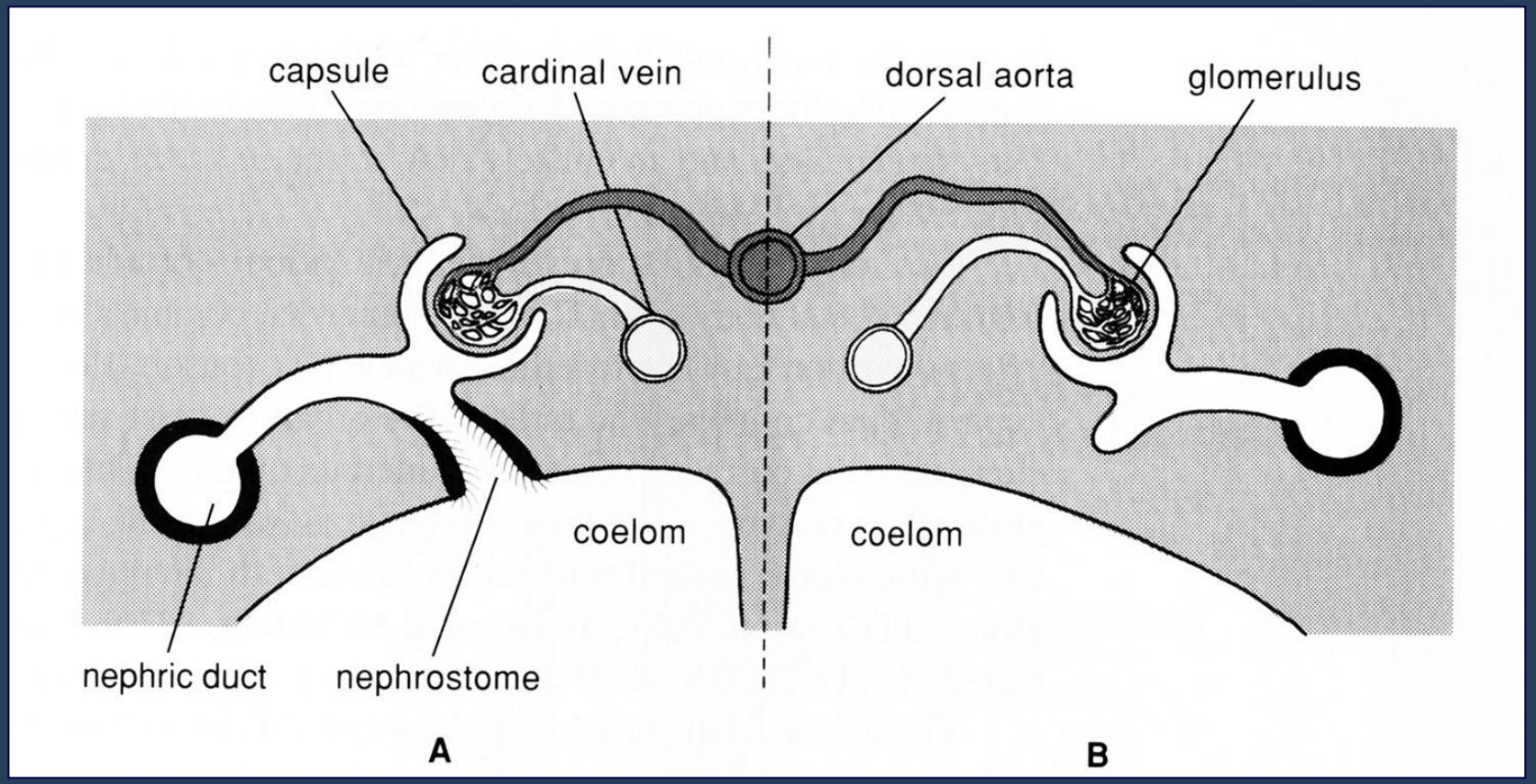
Dos funciones primordiales: mantener concentraciones de iones
mantener bajos niveles de sust. tóxicas



Latimeria: riñón impar ventral
Amia: también riñón caudal
Teleosteos: gran variabilidad

Excreción

La unidad estructural del riñón es el nefrón, compuesto por el corpúsculo renal y el túbulo.

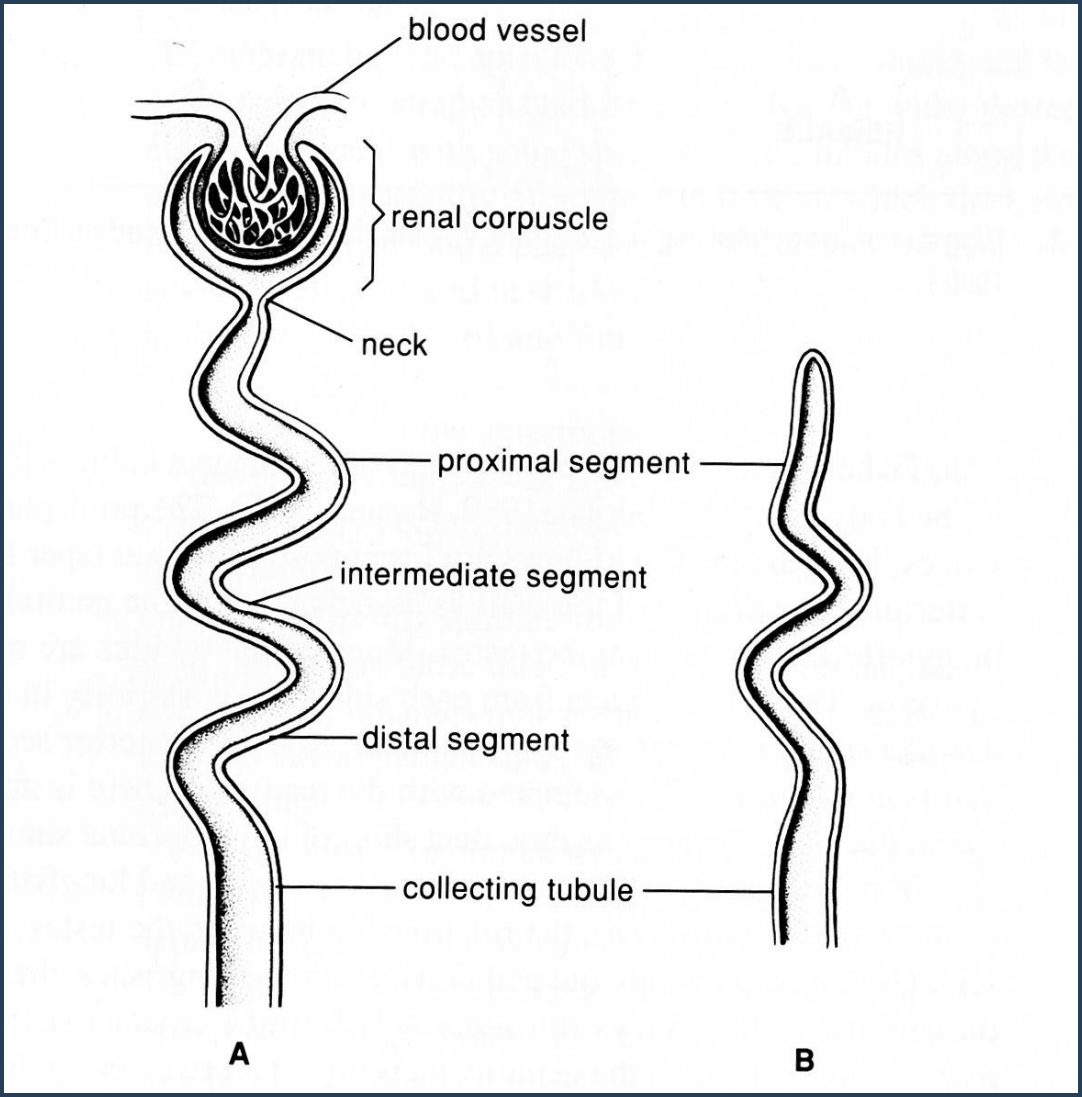


Pronefros

Opistonefros

Excreción

Nefrón glomerular o aglomerular



Excreción

En todos los peces óseos la orina es conducida al exterior por el conducto de Wolff (ureter primario).

Distintas tendencias en lo que se refiere a la comunicación entre el sistema de conducción de orina y el sistema de las gónadas masculinas.

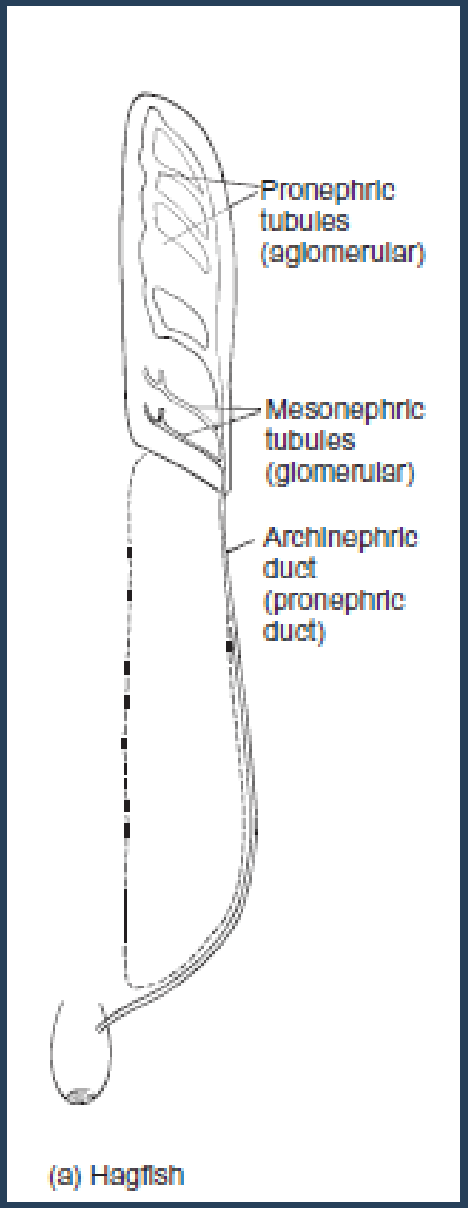
En Acipenseriformes, *Amia y Lepisosteus*, los testículos envían conductos seminíferos a lo largo de todo el riñon. Desde allí pasan al conducto de Wolff.

En *Polypterus* y *Lepidosiren*, la conexión es solo en la parte caudal del riñon.

Además en los pulmonados los ductos llegan separados y desembocan en una cloaca (en *Protopterus* se unen antes de llegar a la cloaca). Existiendo una vejiga urinaria en este grupo.

En Teleósteos el conducto deferente secundario está completamente separado del conducto de Wolff y desemboca en el exterior por el poro genital o en el segmento terminal impar del ureter, la uretra.

Excreción



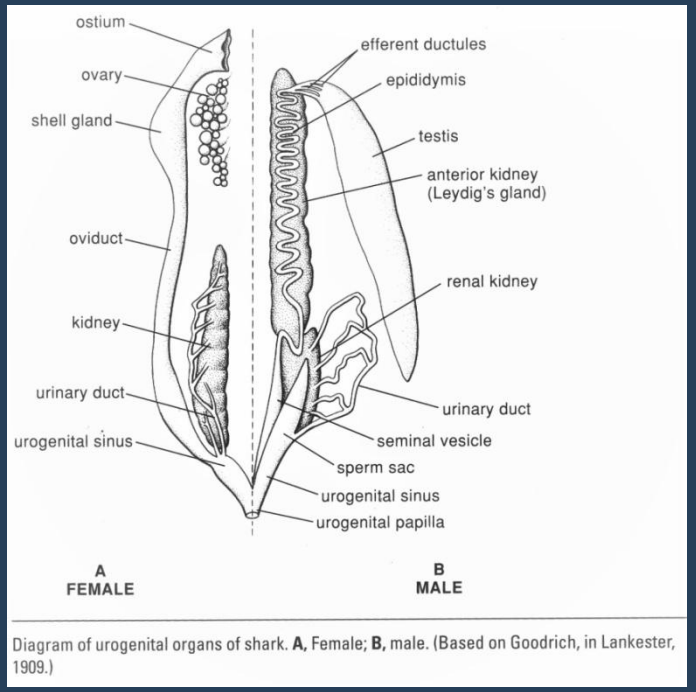
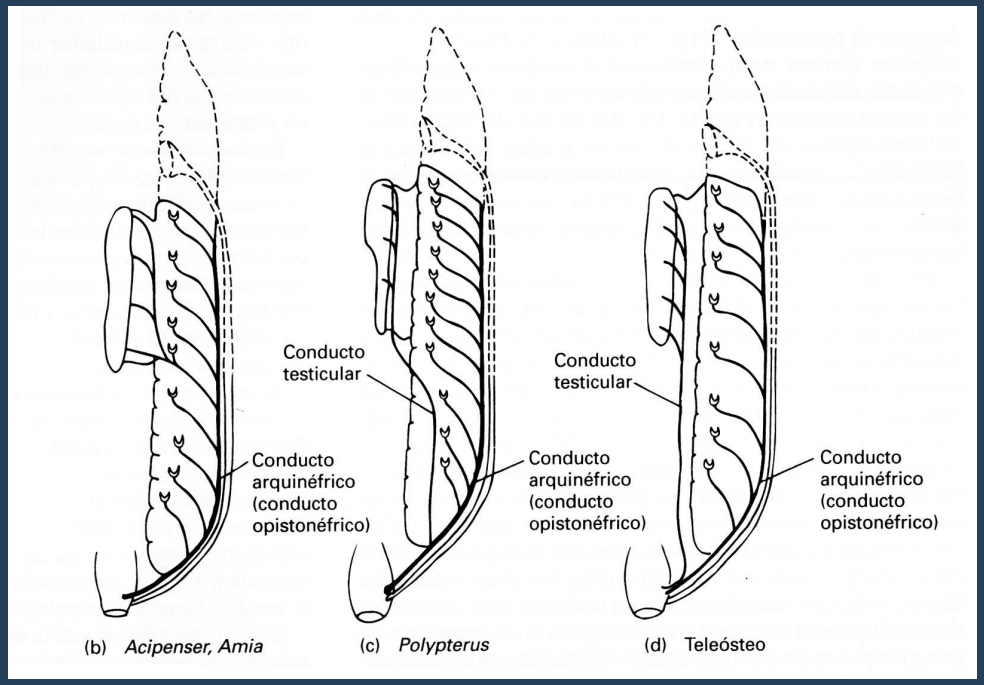


Diagram of urogenital organs of shark. **A,** Female; **B,** male. (Based on Goodrich, in Lankester, 1909.)



Excreción

Función del riñon

Desde el punto de vista funcional, el riñón presenta dos partes histológicas distintas: excretora (posterior)
hematopoyética (anterior).

El amonio es la forma en que los peces excretan los residuos metabólicos del metabolismo de las proteínas.

En los Sarcopterygii se excreta urea.

Osmoregulación (balance de sales y agua): Riñon
Branquias
Piel

Osmoregulación

Peces dulceacuícolas

Presión osmótica interna > externa

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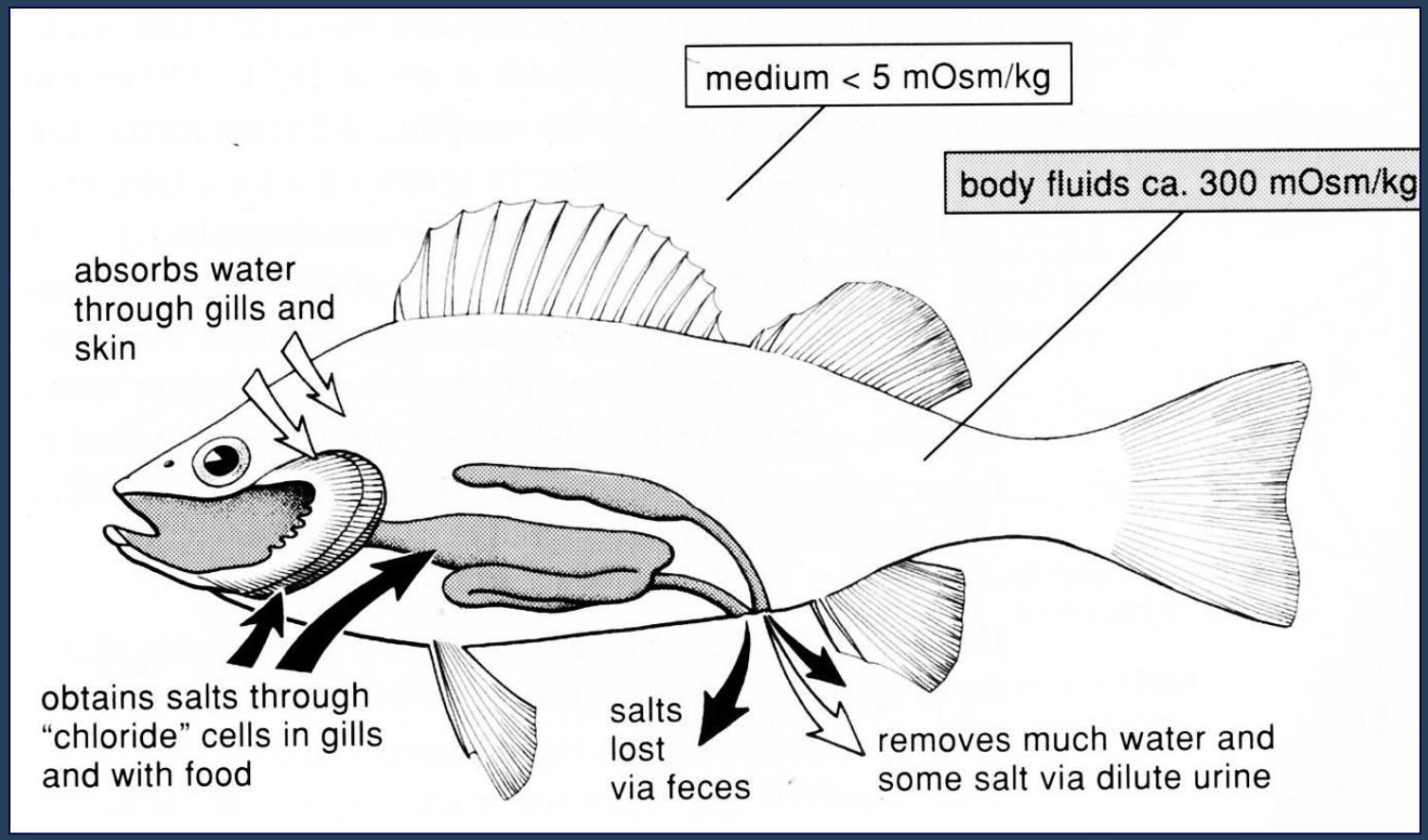
Agua tiende a entrar al cuerpo y las sales a salir
(piel, branquias, mucosas bucales e intestinales)



Osmoregulación

Peces marinos

Presión osmótica interna < externa

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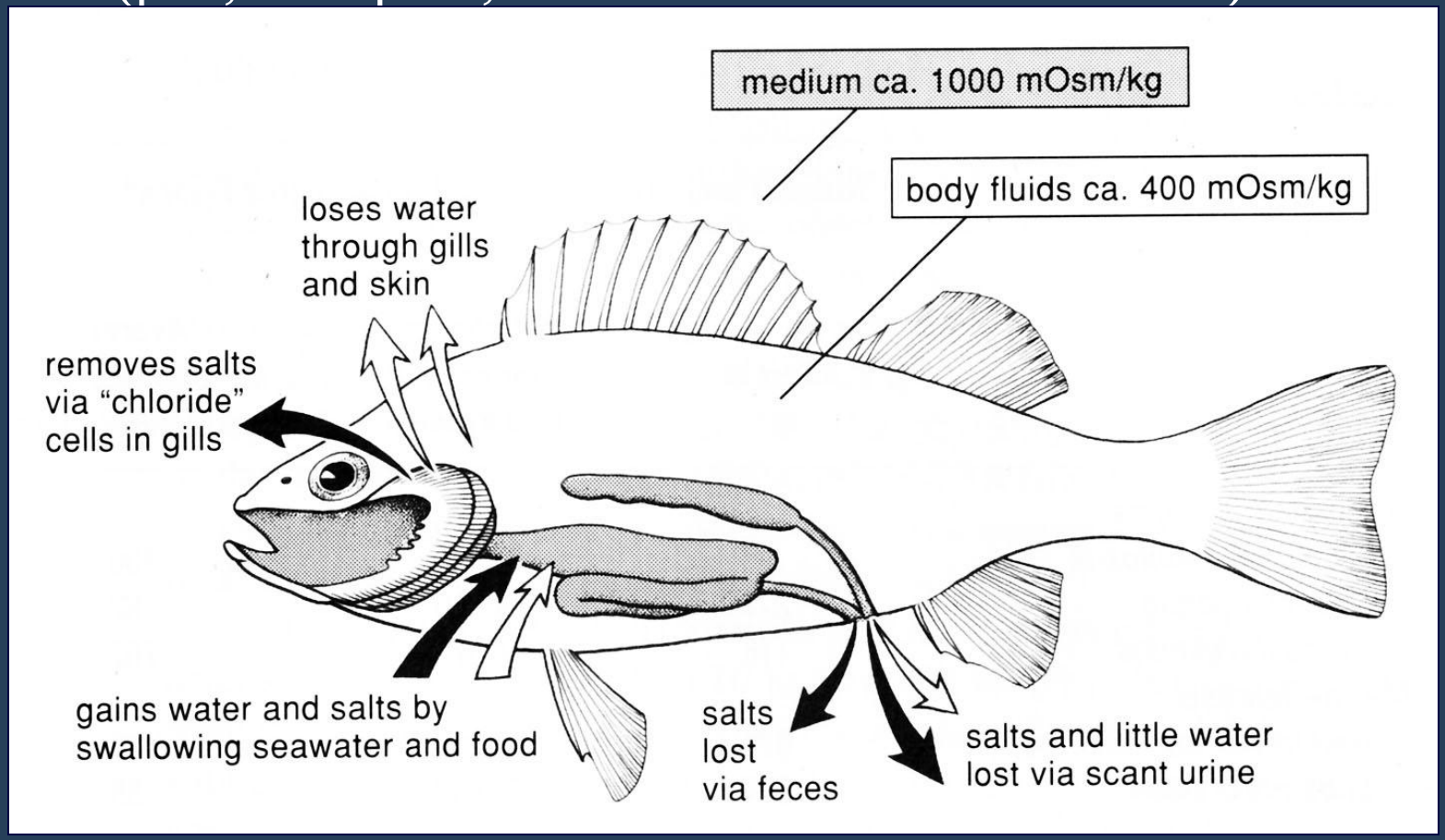
Agua tiende a salir del cuerpo y las sales a entrar
(piel, branquias, mucosas bucales e intestinales)



Osmoregulación

Debido al alto contenido de urea la sangre es osmóticamente similar al medio

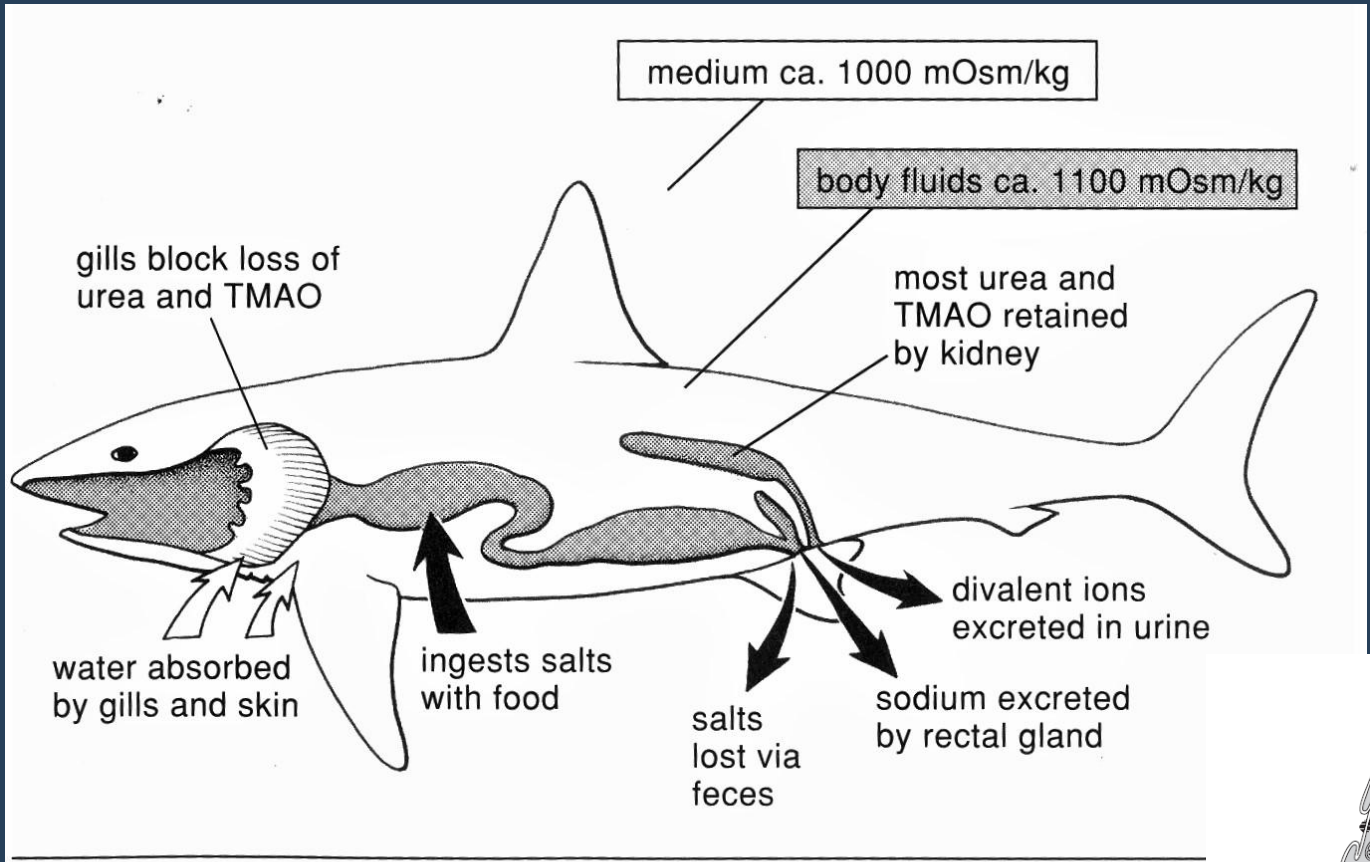


Diagram summarizing osmoregulation of salt-water elasmobranch.

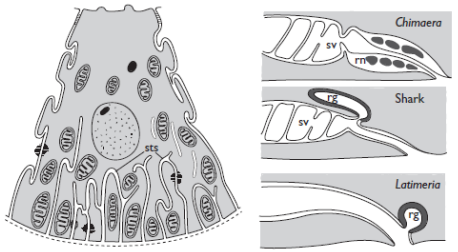


Figure 6.14 The salt-secreting rectal gland. Left: schematic ultrastructure of a rectal gland cell in *Latimeria*. sts: smooth tubular sytem. Right: rectal glands (rg) in elasmobranchiomorphs and *Latimeria*. In Holocephali, the rectal gland tissue forms nodules (rn) in the rectal wall; sv, spiral valve. After Lagios (1979).

Osmoregulación

Peces diádromos

Muy versátiles en su ajuste osmótico. Presentan riñones glomerulares que pueden ajustarse a las diferencias en los volúmenes de orina debido a la diferencia en salinidades; también poseen branquias y mucosas bucales (glándulas de sal) capaces de soportar tanto el ingreso como la secreción de algunos iones contra los gradientes de difusión

Cambios en la actividad endocrina generalmente simultáneos o preceden cambios en los mecanismos de balance

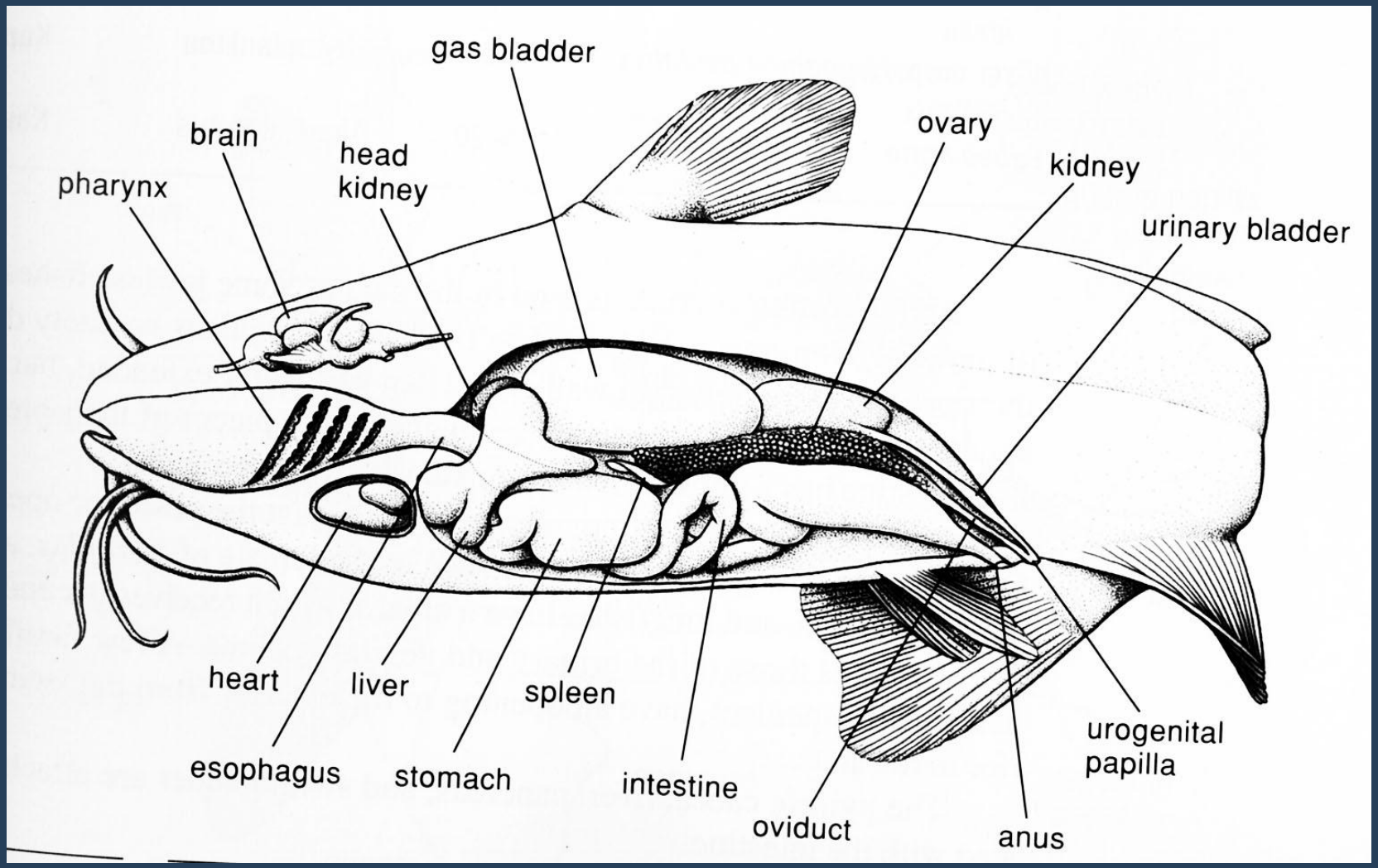
Glándula pituitaria, tiroides y gónadas están a cargo de cambios fisiológicos al respecto, previos o durante la migración

Aumento en actividad tiroidea ha sido reportada en el salmón en la migración río abajo, posiblemente para facilitar procesos energéticamente costosos de excreción de sal en el agua marina

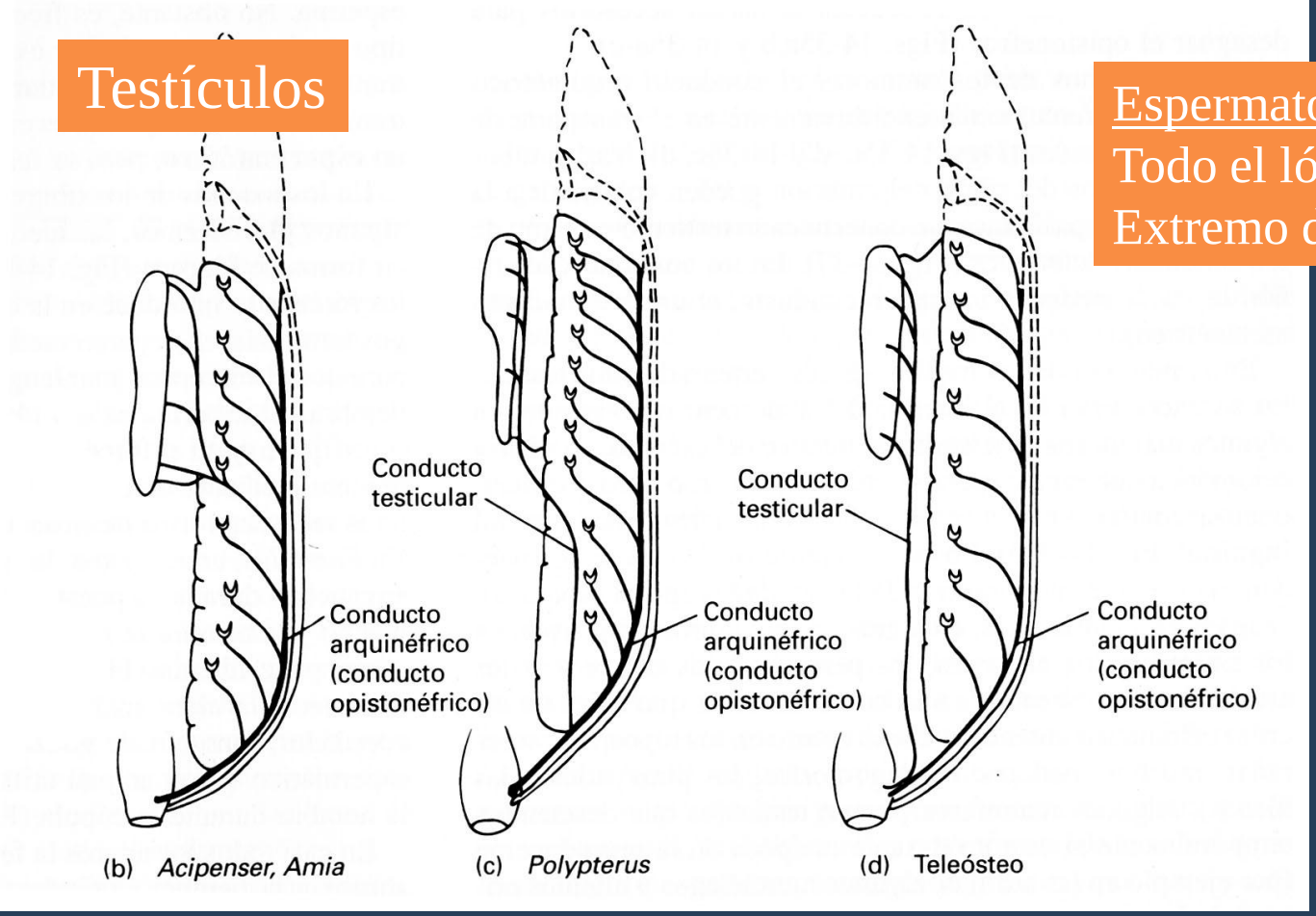
Cambios pituitarios y gonadales generalmente inducen cambios en el comportamiento: preferencia por agua dulce en peces adultos y por lo tanto en los tiempos de migración

Reproducción

Gónadas



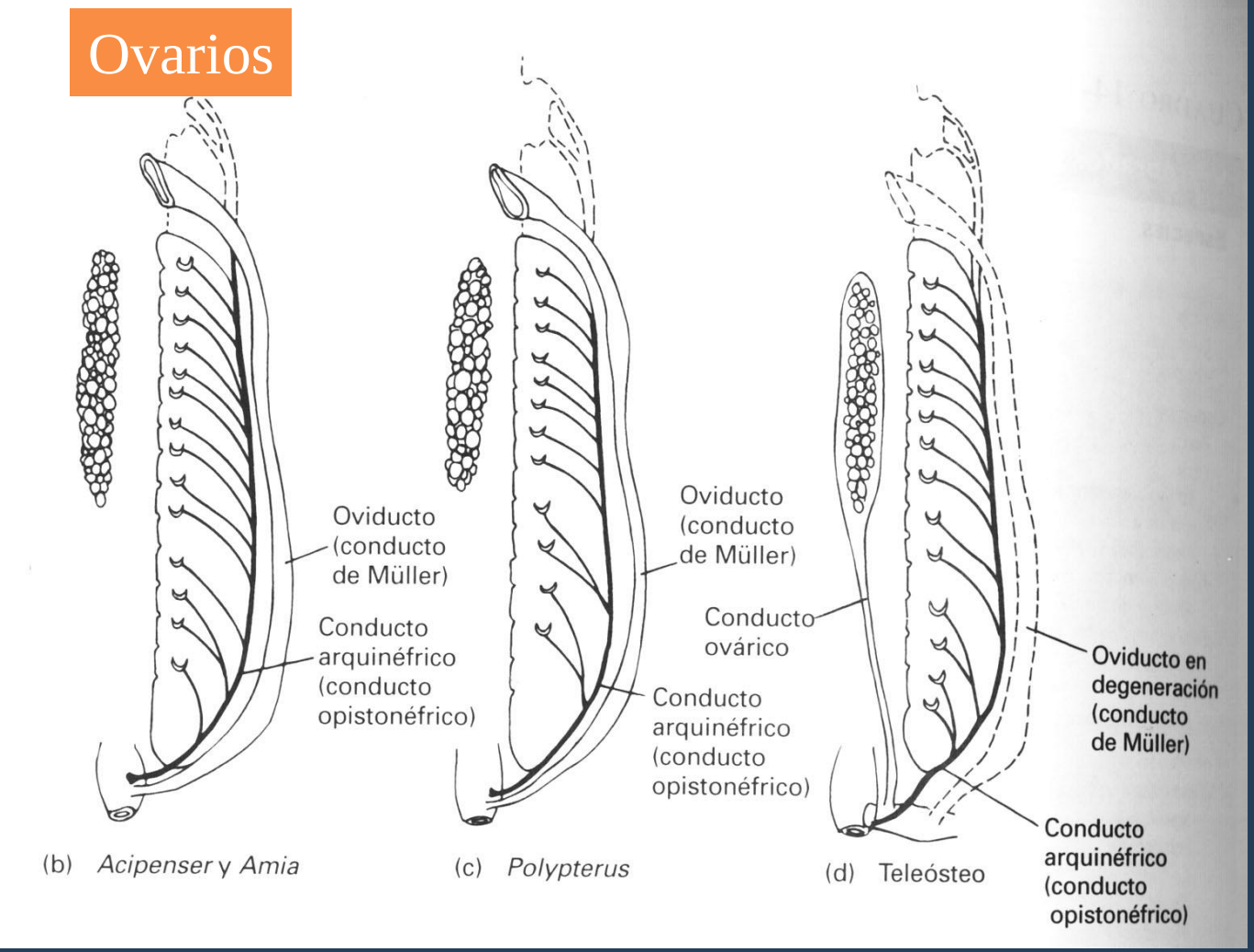
Testículos



Espermatogénesis
Todo el lóbulo
Extremo distal (Atheriniformes)

Espermatozoides
Cabezas redondeadas de 2 a 5 micras
Núcleo grande y pocas mitocondrias
1 o 2 flagelos
En Dipnoos, *Latimeria*, Polypteriformes y Acipenseriformes: cabezas más estilizadas con acrosoma.

Ovarios



Gymnovárica
Sarcopterygii
Polypteriformes
Condrósteos
Amia
Teleósteos + basales

Cistovárica
Lepisosteus
Teleósteos

Óvulos desde pocos milímetros a varios centímetros