

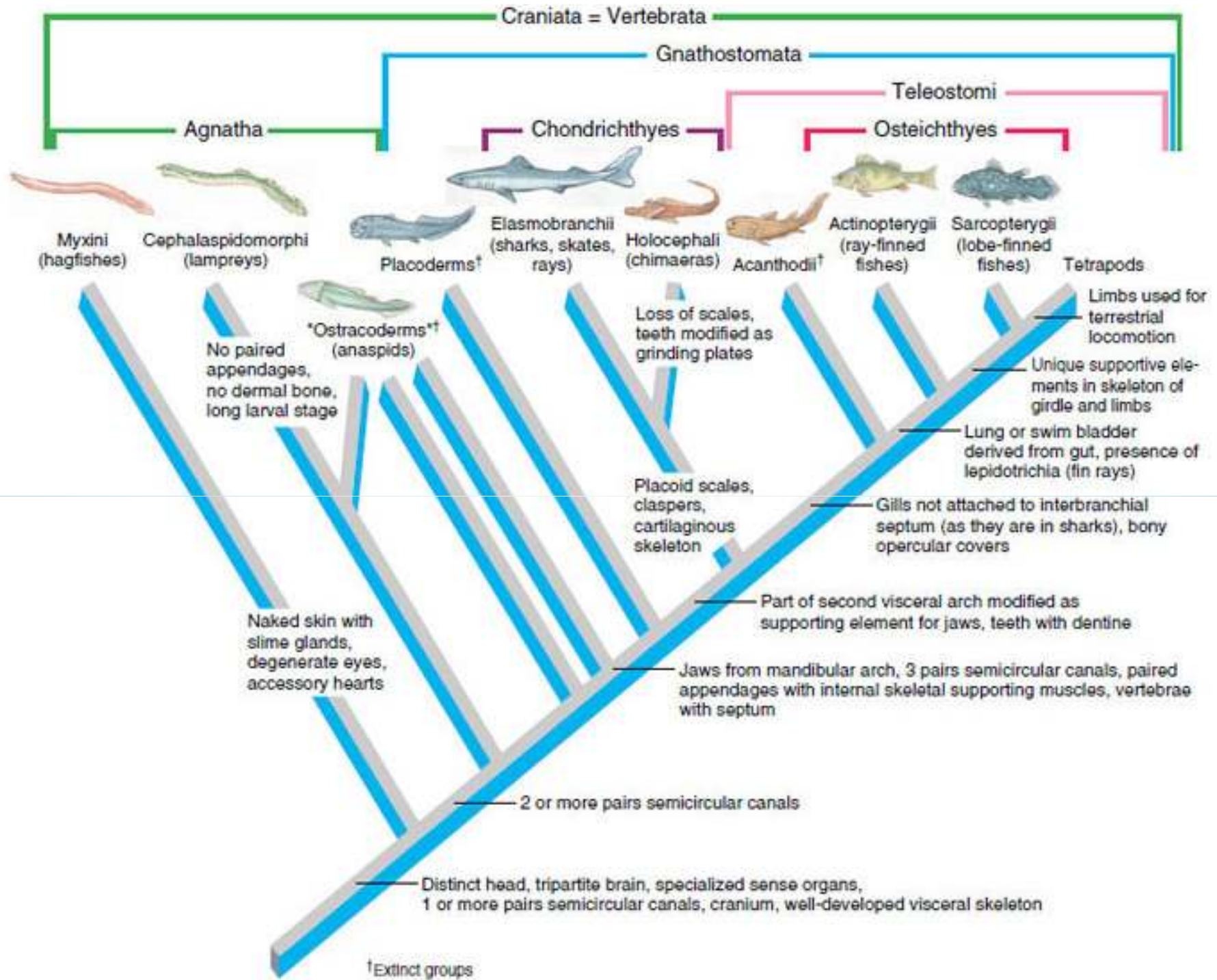
The background is a light blue gradient with several white, stylized bubbles of various sizes scattered across it. The bubbles have a slight shadow and a highlight, giving them a 3D appearance. The overall aesthetic is clean and aquatic.

FISH AND FISHES

SUBPHYLUM VERTEBRATA

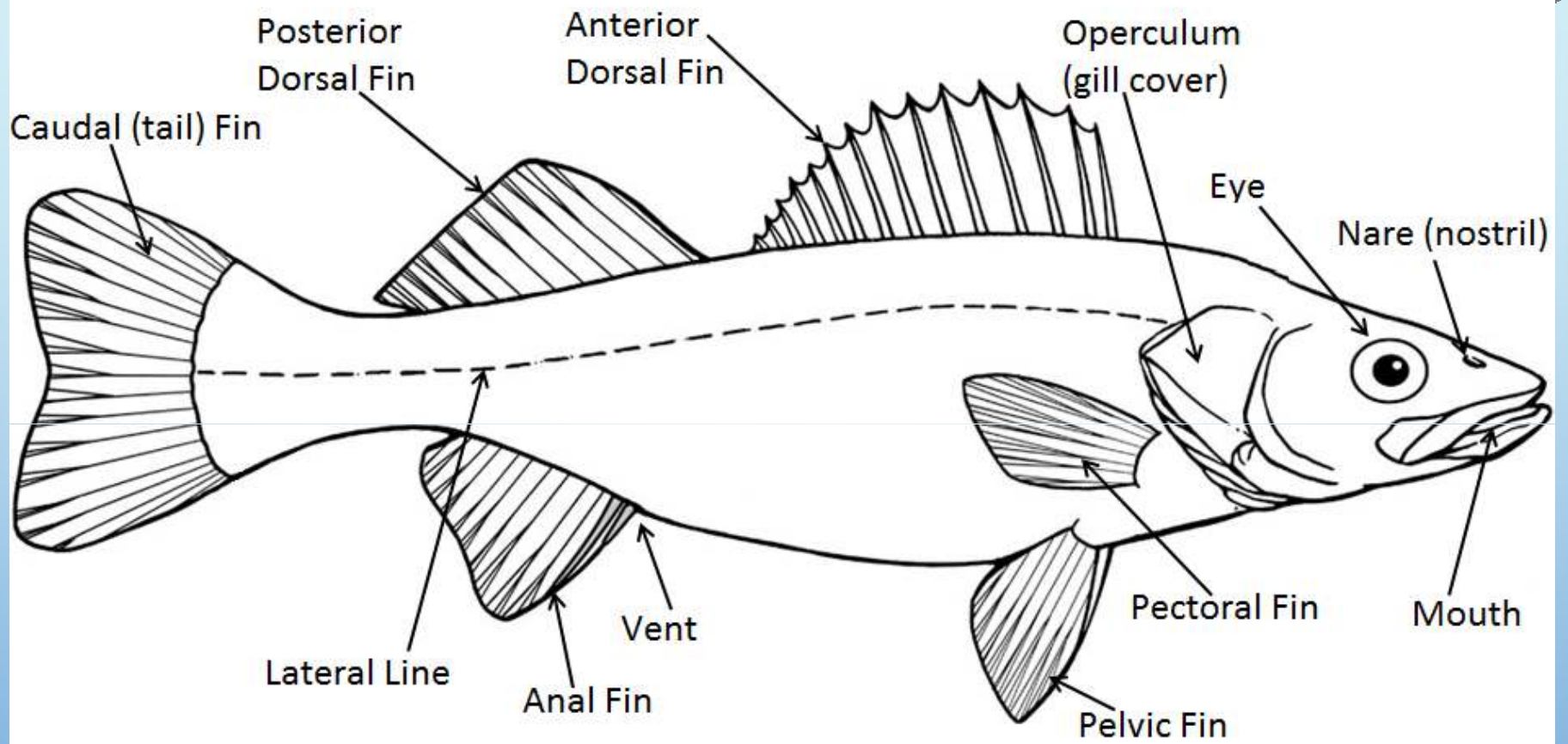
FUN FACTS

- 24,600 LIVING SPECIES
 - THAT'S MORE THAN TERRESTRIAL ANIMALS!
- EARTH IS 70% WATER BUT LESS THAN .1% OF THE WATER ON THE PLANET IS FRESHWATER
 - 41% OF FISH SPECIES ARE FRESHWATER
 - WHAT DOES THIS TELL US?



KEY CHARACTERISTICS: WHAT MAKES A FISH, A FISH?

1. AQUATIC
2. VERTEBRATE
3. GILLS
4. PAIRED LIMBS (FINS)
5. SCALES



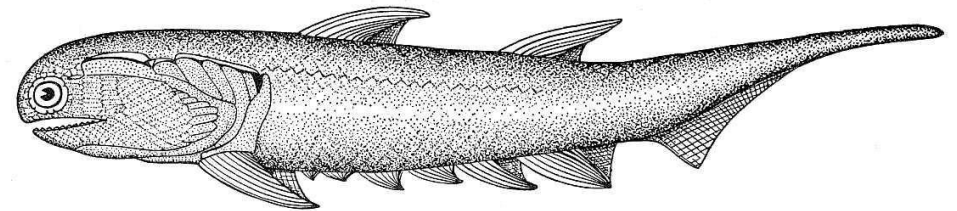
FISH HISTORY

- FISH APPEARED ABOUT 500 MILLION YEARS AGO
 - JAWLESS FILTER FEEDERS
 - BONY PLATES
 - MOSTLY EXTINCT 360 MYA

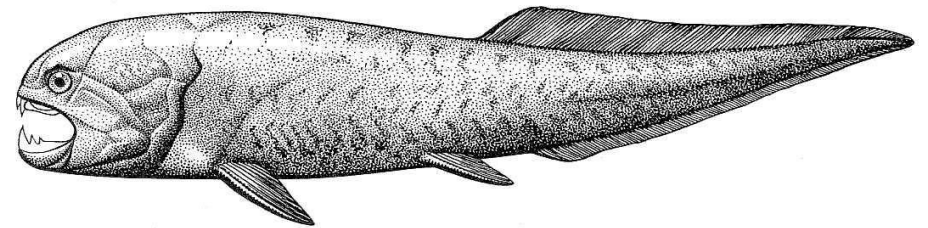


FISH HISTORY

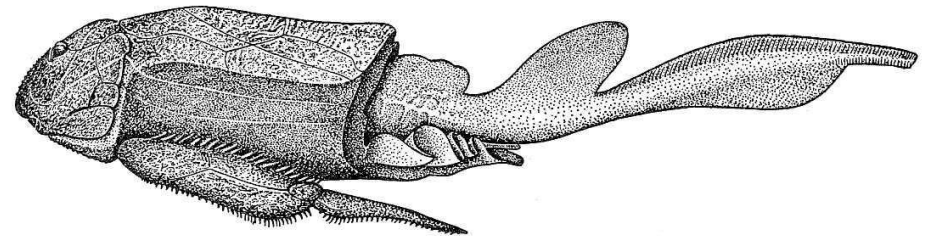
- PAIRED FINS AND JAWS APPEAR
 - GIRDLES COME WITH FINS
 - CARTILAGE
 - SPEED AND POWER



A. *Climatius*



B. *Dinichthys*



C. *Bothriolepis*



FISH HISTORY

- MODERN FISH
 - BONY FISH
 - CARTILAGINOUS FISH
 - THE ADAPTATION OF FINS AND JAWS HAVE MADE THEM SUCCESSFUL



FEEDING AND DIGESTION

- ALL TYPES OF FEEDING STRATEGIES
 - FILTER FEEDING
 - HERRING, WHALE SHARK, PADDLEFISH
 - OMNIVORES
 - CARP
 - HERBIVORES
 - PARASITE
 - LAMPREY



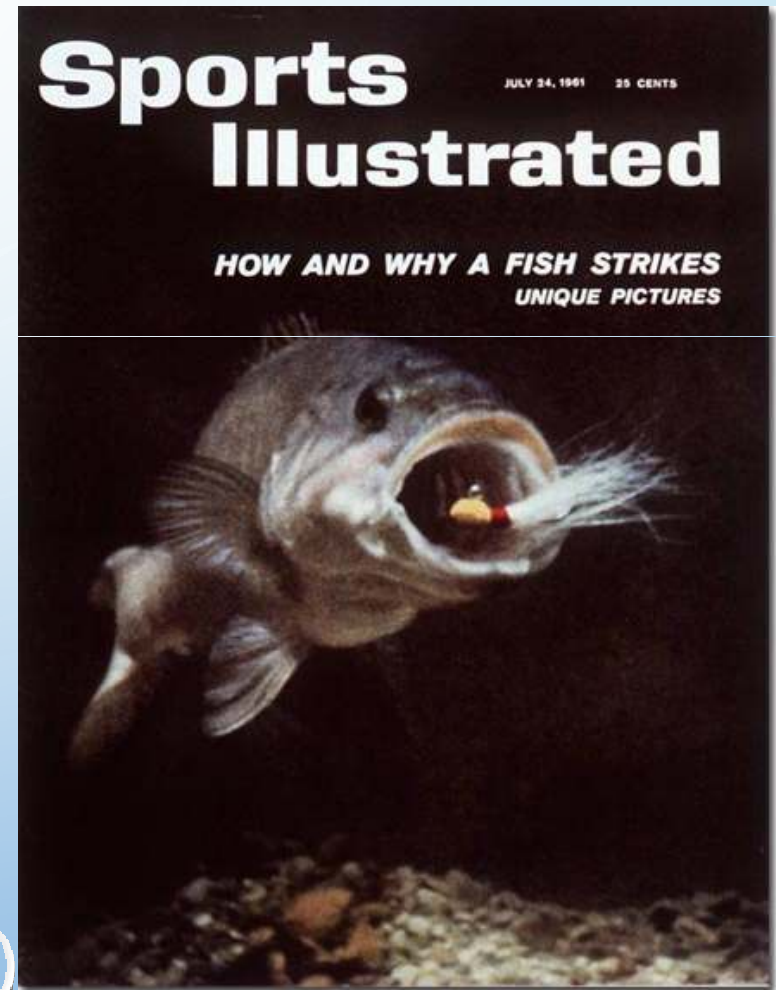
FEEDING AND DIGESTION

- PREDATORS
 - JAWS AND TEETH
 - WHAT ARE TEETH GOOD FOR?



FEEDING AND DIGESTION

- FOOD SWALLOWED WHOLE
 - OPENING MOUTH AND CLOSING OPERCULUM CREATES SUCTION



VIDEOS

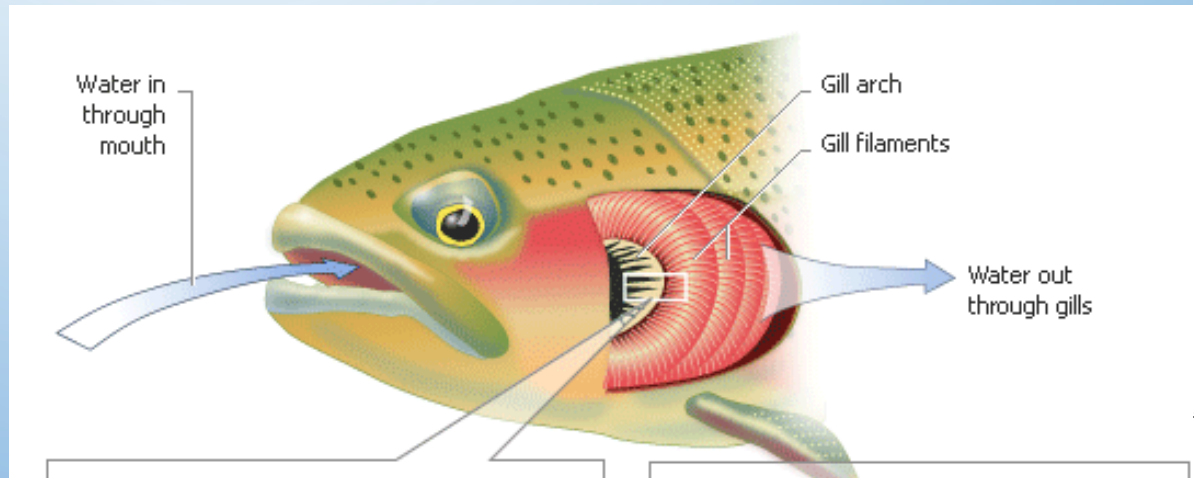
- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/BASKING_SHARK](http://www.bbc.co.uk/nature/life/basking_shark)
- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/EUROPEAN_BROOK_LAMPREY](http://www.bbc.co.uk/nature/life/european_brook_lamprey)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/WORLDS-DEADLIEST-NGS/DEADLIEST-SHARK-SEALS?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/worlds-deadliest-ngs/deadliest-shark-seals?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/FROGFISH](http://www.bbc.co.uk/nature/life/frogfish)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/WEIRDEST-ANGLER-FISH?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/weirdest-angler-fish?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/WORLDS-DEADLIEST-NGS/DEADLIEST-PIRANHAS-EGRET?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/worlds-deadliest-ngs/deadliest-piranhas-egret?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/SHARK_WHALE?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/shark_whale?GC=%2FVIDEO%2FANIMALS%2FFISH)

RESPIRATION DEMO

The background features a vertical blue gradient from light at the top to dark at the bottom. It is decorated with several white-outlined bubbles of various sizes, some with highlights, scattered across the frame. A large, faint, light-colored circular pattern is centered in the upper half of the image.

RESPIRATION

- GILLS: HIGH SURFACE AREA AND BLOOD SUPPLY
- WATER HAS LOW OXYGEN, SO FISH MUST PASS WATER OVER THEIR GILLS CONSTANTLY
 - MOUTH PULLS WATER IN, OVER THE GILLS AND OUT



RESPIRATION

- **SOME FISH HAVE LUNGS**
 - ADAPTED TO LIVE IN AREAS WHERE WATER DISAPPEARS

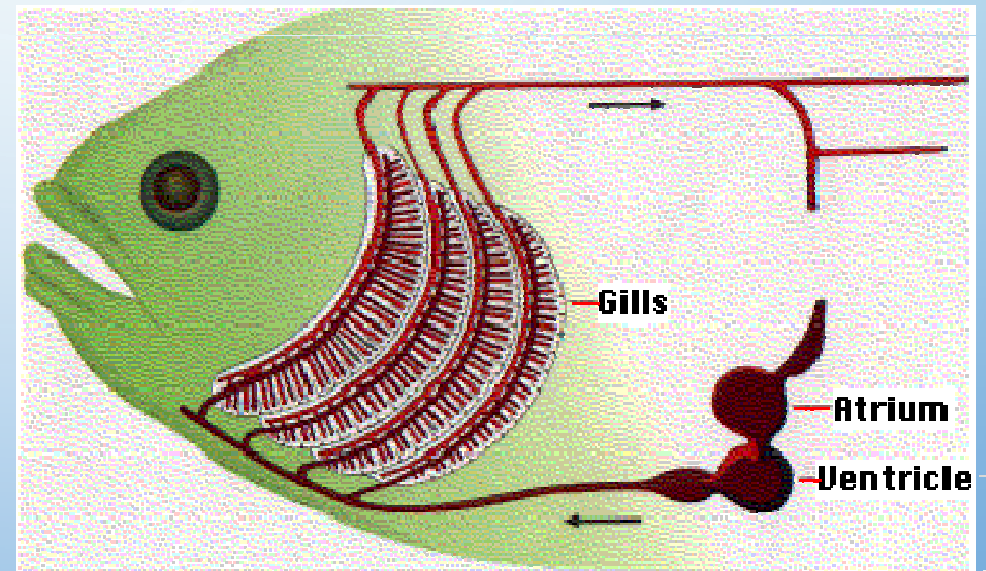
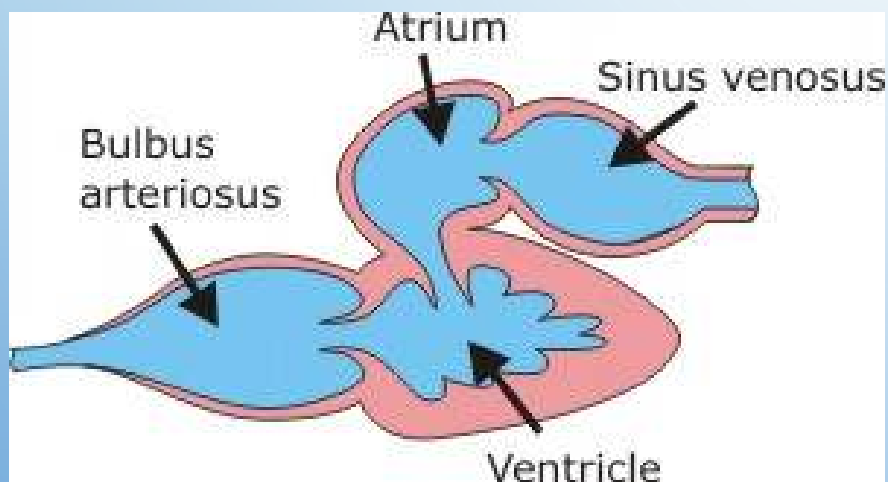


VIDEOS

- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/MUDSKIPPERS?G_C=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/mudskippers?G_C=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/GOBY](http://www.bbc.co.uk/nature/life/goby)

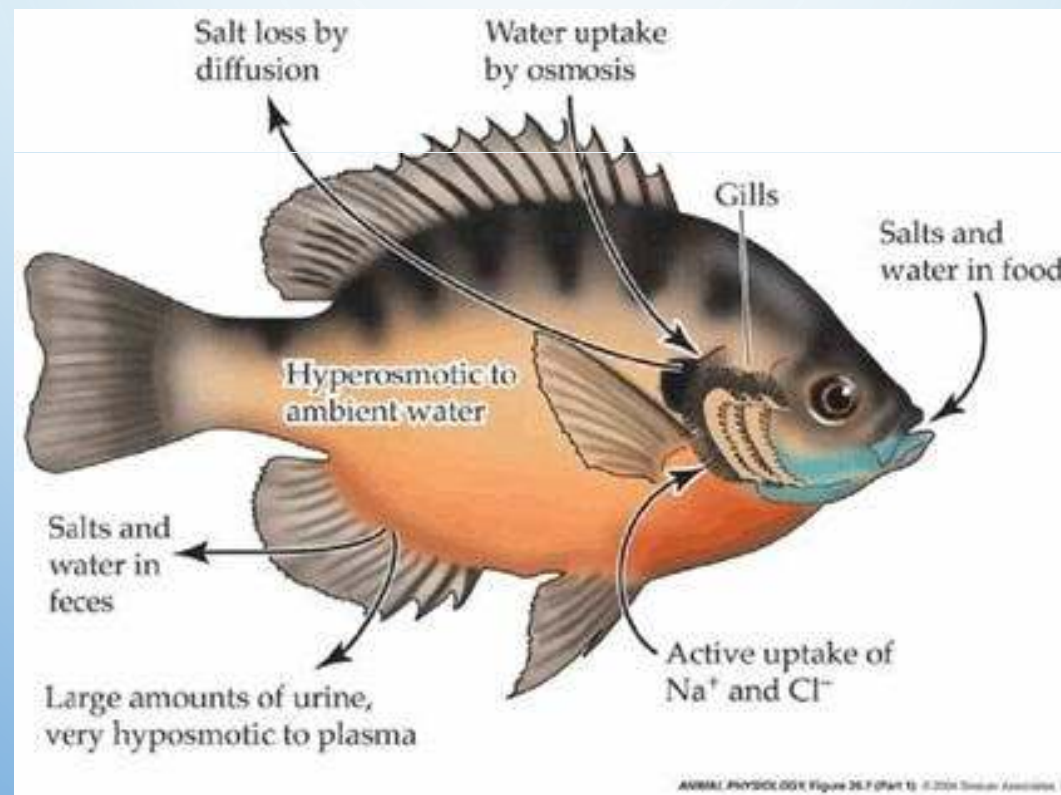
CIRCULATION

- CLOSED SYSTEM
 - BLOOD WITH HEMOGLOBIN
- HEART WITH EXPANDED CHAMBERS



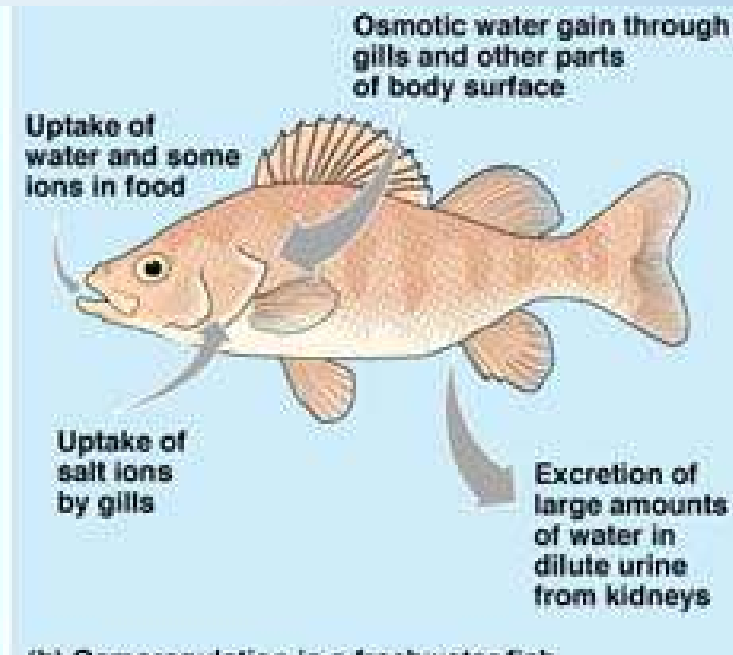
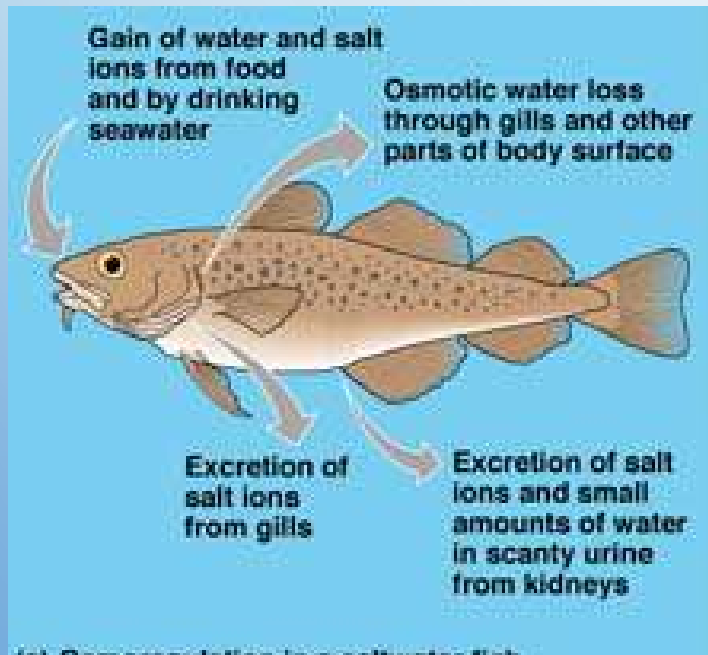
EXCRETION AND OSMOREGULATION

- WASTE (AMMONIA) REMOVES BY GILLS OR KIDNEYS



EXCRETION AND OSMOREGULATION

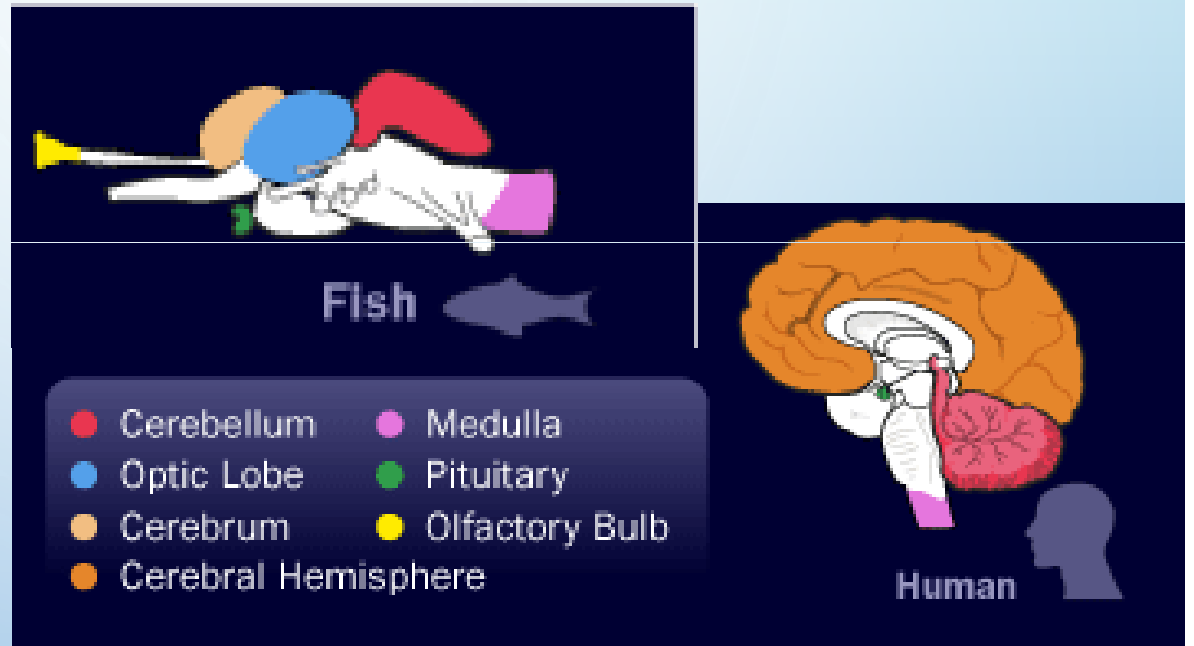
- ALL FISH MUST MAINTAIN WATER BALANCE
 - MARINE FISH- LOSE WATER
 - FRESHWATER FISH- GAIN WATER
- WHAT ABOUT FISH THAT LIVE IN BOTH PLACES?



VIDEOS

NERVOUS AND SENSORY SYSTEMS

- ADVANCED BRAIN
- EXCELLENT SENSE OF TASTE, SMELL AND SIGHT
- WHY THESE SENSES?



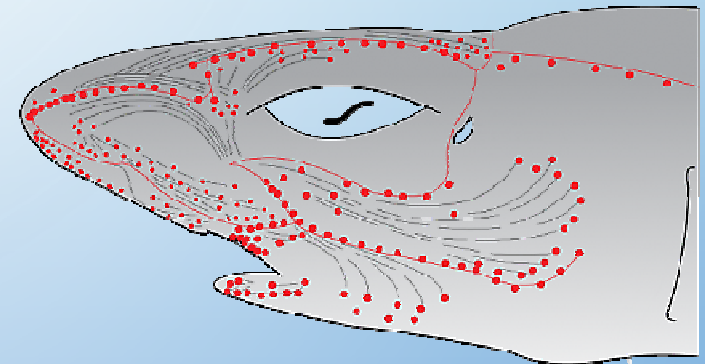
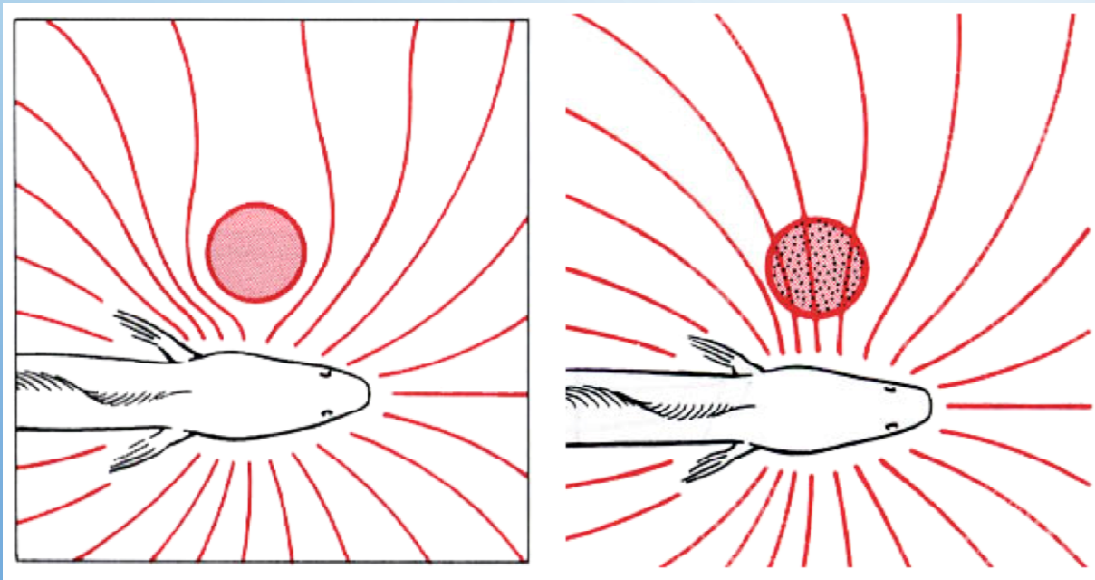
NERVOUS AND SENSORY SYSTEMS

- HAVE INNER EAR
 - EQUILIBRIUM AND BALANCE
 - SENSE VIBRATIONS
- LATERAL-LINE SYSTEM
 - SENSORY PITS DETECT WATER MOVEMENT
 - CURRENT AND VIBRATION



NERVOUS AND SENSORY SYSTEMS

- SOME FISH CAN SENSE ELECTRIC CURRENT
 - SHARKS AND CATFISH



NERVOUS AND SENSORY SYSTEMS

- SOME FISH PRODUCE AN ELECTRIC CURRENT
 - ELECTRIC FISH
 - ELECTRIC EEL
 - ELECTRIC RAY
 - 50 TO 500 VOLTS



VIDEOS

- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/SHARK WHALE?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/shark-whale?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/WORLDS-DEADLIEST-NGS/DEADLIEST-ELECTRIC-EEL?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/worlds-deadliest-ngs/deadliest-electric-eel?GC=%2FVIDEO%2FANIMALS%2FFISH)

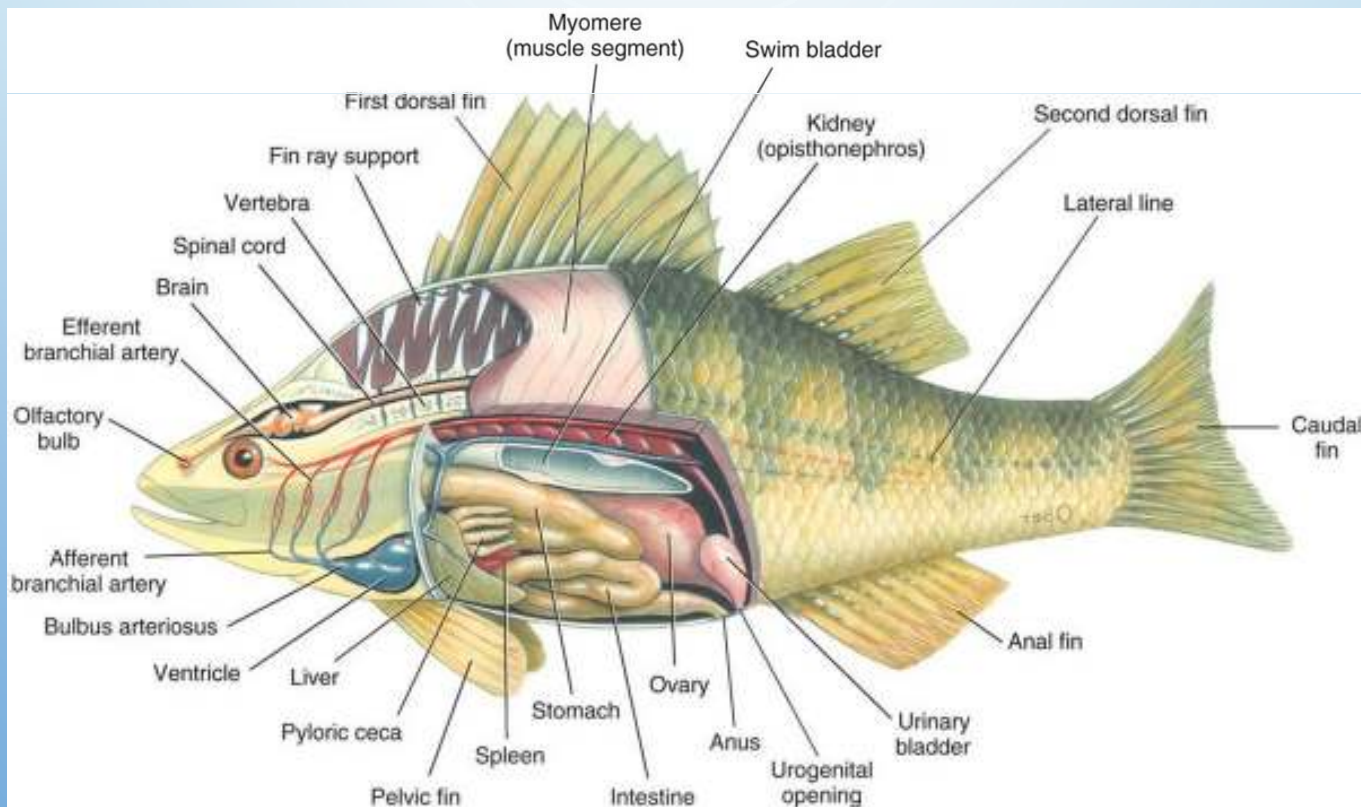
MOVEMENT

- MOVEMENT BY BODY MUSCLES AND FINS
 - MUSCLE BUNDLES ARE IN A ZIG-ZAG SHAPE
 - CONTRACTION CAN AFFECT LARGE AREA
- STREAMLINED BODY
- MUCOUS SECRETIONS



MOVEMENT

- BONY FISH HAVE A SWIM BLADDERS
 - AIR FILLED SAC THAT HELP THE FISH TO FLOAT
 - GASES COME FROM THE BLOOD OR MOUTH



VIDEOS

- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/FLYING_FISH](http://www.bbc.co.uk/nature/life/flying_fish)

REPRODUCTION AND DEVELOPMENT

- INTERNAL OR EXTERNAL FERTILIZATION
 - EXTERNAL: MILLIONS OF EGGS AND NO PARENTAL CARE
 - EXAMPLE: 45 KG (100 LBS) FROM A STURGEON



REPRODUCTION AND DEVELOPMENT

- INTERNAL
 - EGGS DEVELOP INSIDE FEMALE:
GUPPIES
 - LIVE BIRTH: SHARKS
- OTHER ADAPTATIONS
 - MATING IN SCHOOLS –
PHEROMONES
 - NESTS AND BROODING
 - SEA HORSES, CICHLIDS
 - SUNFISH, STICKLEBACKS



VIDEOS

- SPAWNING SALMON
[HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/SALMON SOCKEYE?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/salmon_sockeye?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/TROUT SPAWNING?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/trout_spawning?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/SEAHORSE KNYSNA?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/seahorse_knysna?GC=%2FVIDEO%2FANIMALS%2FFISH)
- [HTTP://WWW.BBC.CO.UK/NATURE/LIFE/CICHLID](http://www.bbc.co.uk/nature/life/cichlid)
- [HTTP://VIDEO.NATIONALGEOGRAPHIC.COM/VIDEO/CICHLID MOVINGYOUNG?GC=%2FVIDEO%2FANIMALS%2FFISH](http://video.nationalgeographic.com/video/cichlid_movingyoung?GC=%2FVIDEO%2FANIMALS%2FFISH) MOUTH BROODING