

Fish in the Aquaponic System

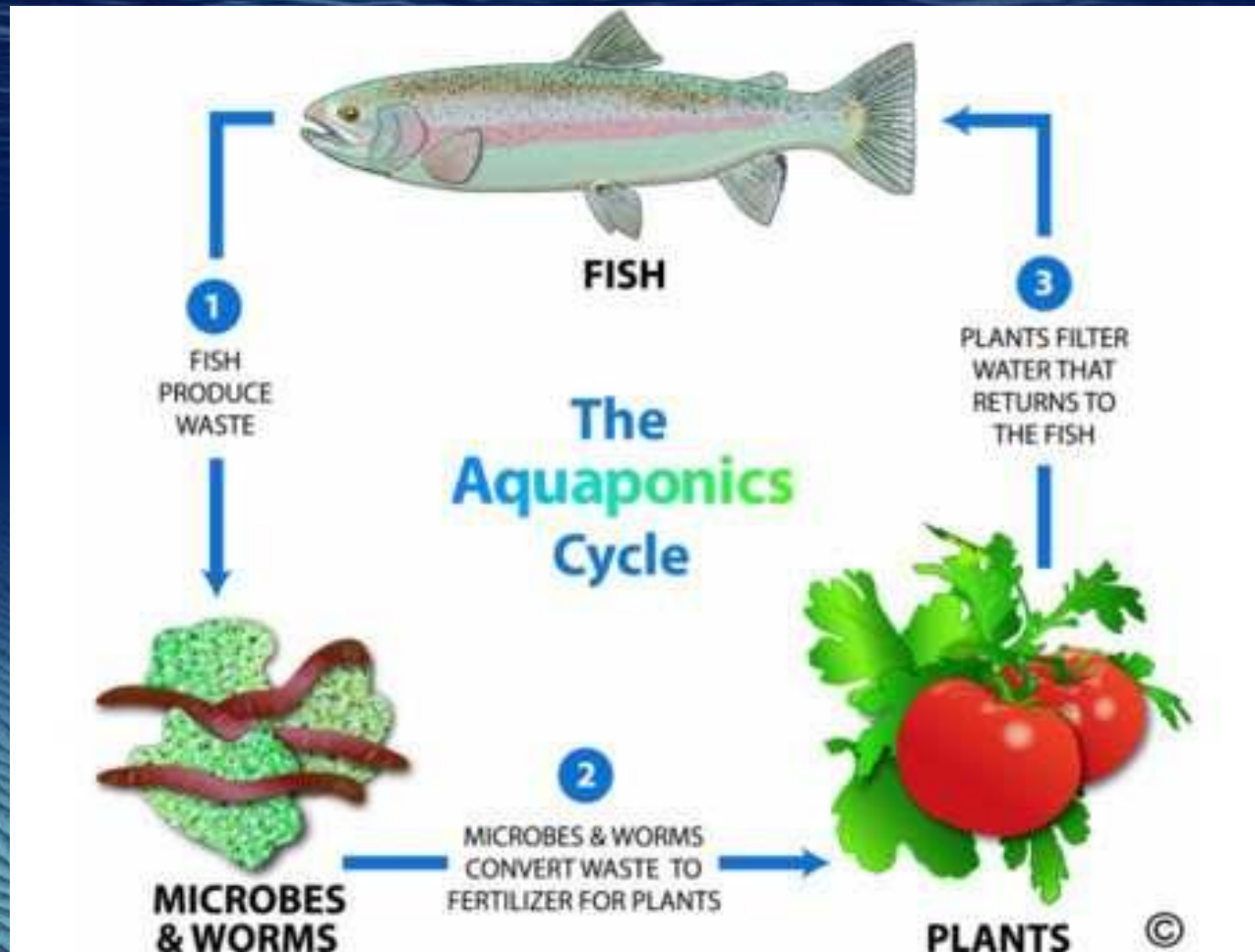
**Go Fish Workshop
July 31, 2022**



Photo courtesy of Dr. Clyde Tamaru

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Basic function: Provide nutrients for the plants



Fish of choice - Tilapia

- Primary fish for the aquaponic systems
- Native to African continent and Middle East
- Lots of species (HI import permits)
- Can be fed low protein diets (cheaper)
- Can tolerate a wide range of water quality parameters
- Easy to raise
- Good fish to eat



Photo courtesy of Dr. Clyde Tamaru

Catfish

- Channel catfish in continental U.S., Chinese catfish in Hawaii
- Good food fish
- Tolerates poor water quality
- Can stock at very high density
- Excellent for novice aquaponic growers
- Solid waste is much finer, dissolves completely in water so filtration strategy must fit with species
- Aggressive, carnivorous, and must be fed to satiation or they become cannibalistic



Trout



- Many aquaponic growers on continental US use salmonids like trout, one commercial grower in Kula, Maui
- Carnivorous and requires high protein pellet diet
- Does not tolerate poor water quality
- Must be raised in low temperatures

Carp

- Native to Eastern Europe and Asia
- Currently the most widely-cultured freshwater fish (tilapia is next)
- Tolerant to low DO and poor water quality, and can survive in wide temperature ranges
- 8-10 month to harvest post-hatch (1.5 lbs)
- Omnivores, multiple species with different trophic niches (bottom, middle and top of water column)
- Requires hatchery to produce fingerlings
- Bony, low market value



A word about the “nonfish” prawn



- Can be integrated into a system in separate growing tanks, but cannot be cultured at high density due to cannibalism
- Detritivores will help to consume some solid waste and plant matter

Fish selection – Others??



Goldfish

Dependent on:

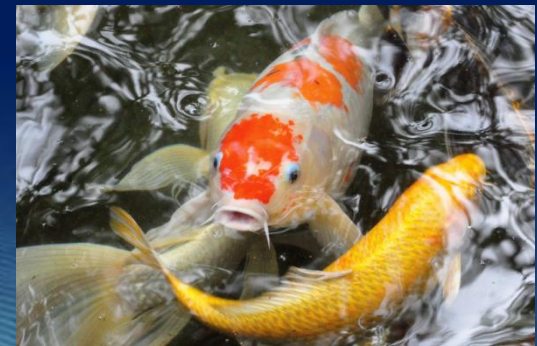
- Size of fish tank
- Do you want to eat the fish, i.e., human consumption?
- Plant type & density (e.g. Ten guppies can grow one head of lettuce)



Guppy



Red Pacu



Koi

Polyculture

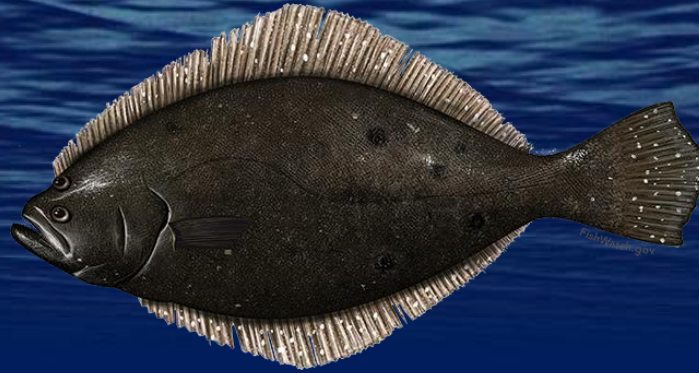
When two (or more) species are used

- Must know they are compatible
- Schooling vs solitary animals may have different growth effects



Photo courtesy of Dr. Clyde Tamaru

Fish Anatomy



What makes a fish a fish???

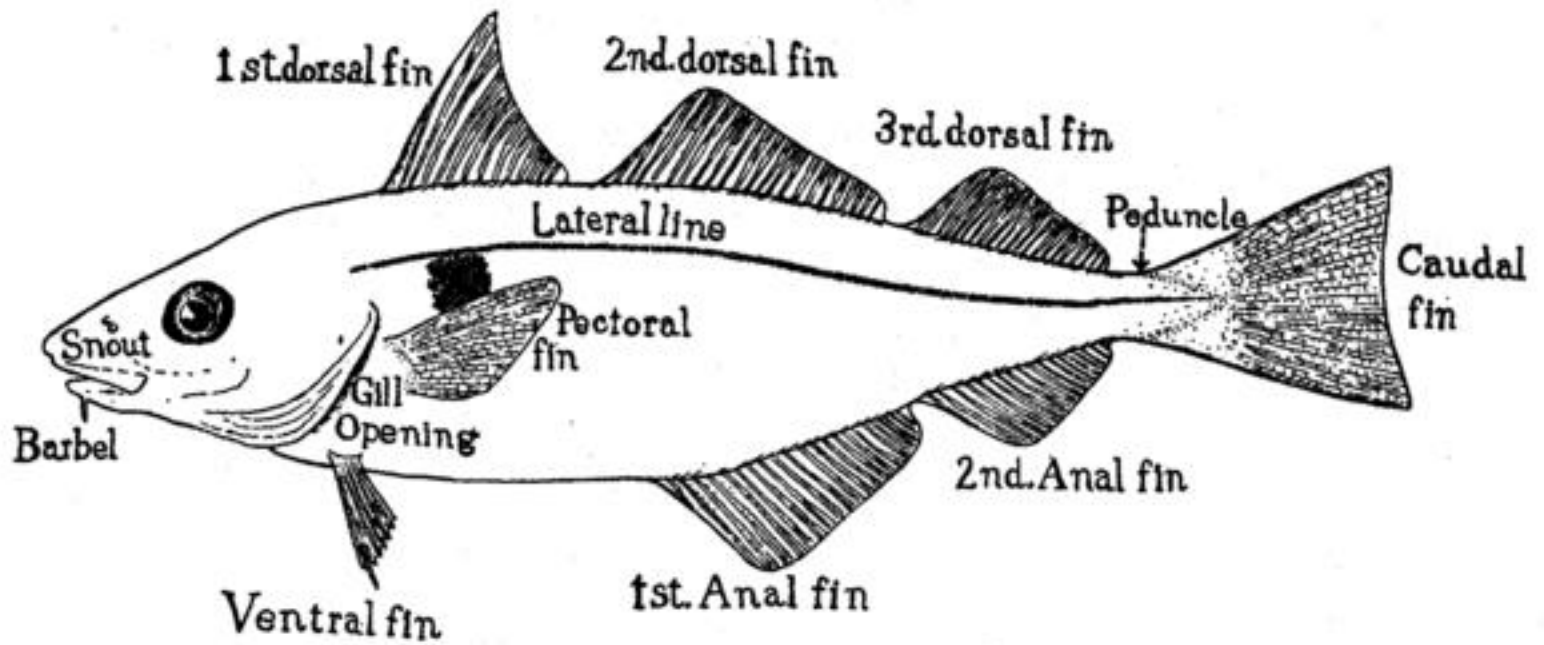


Mola mola – Ocean Sunfish



Schindleria brevipinguis – Stout Infantfish

- Vertebrates
- Live in aquatic environments
- Fins
- Gills
- Lateral Line System





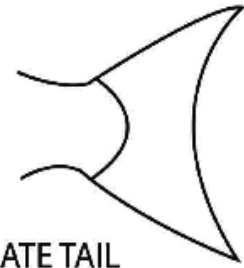
HETEROCERCAL TAIL

- Fast swimmer
- Constantly moving



FORKED TAIL

- Fast swimmer



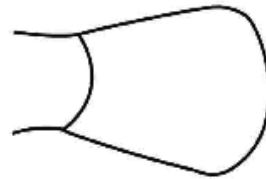
LUNATE TAIL

- Long distance swimmer



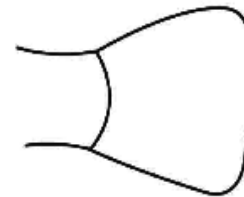
POINTED TAIL

- Slow swimmer
- Bottom wriggler



ROUNDED TAIL

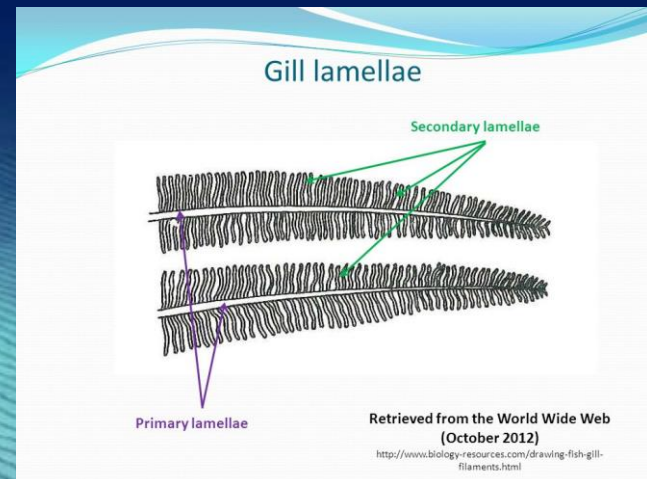
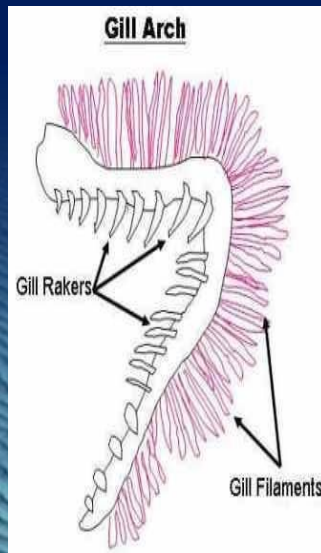
- Good at turning
- Fast for short distances



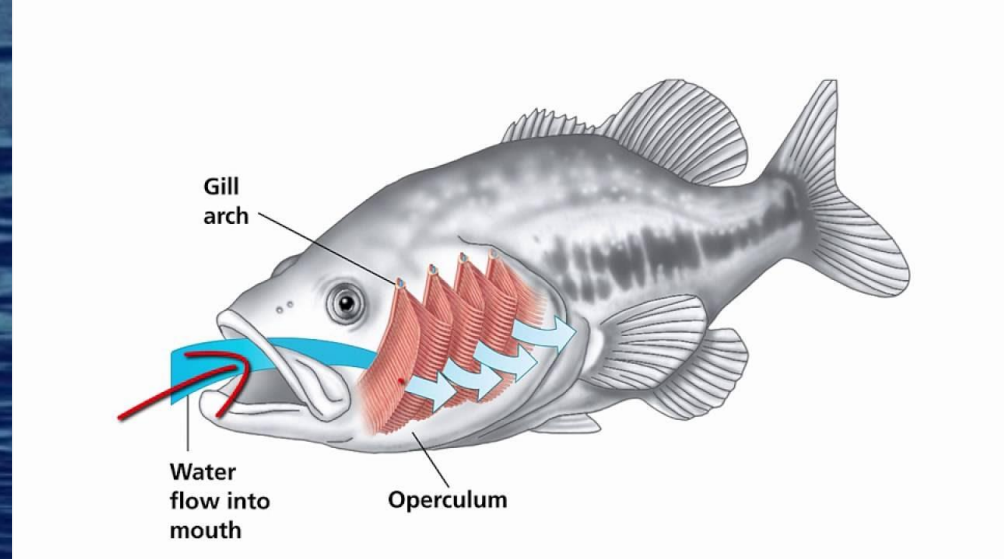
TRUNCATE TAIL

- Good at turning
- Slower swimmer

Fish Gills



Respiration

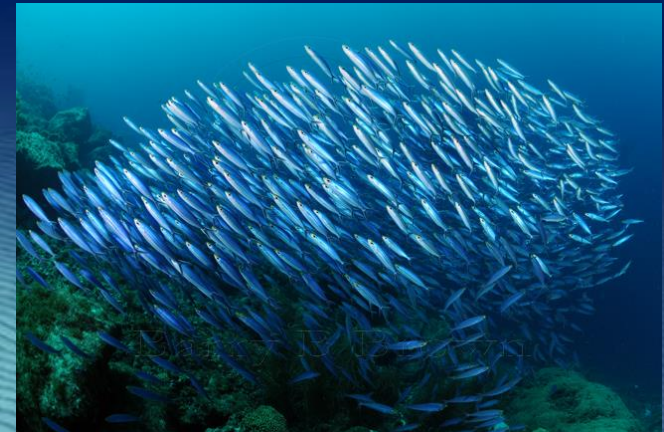
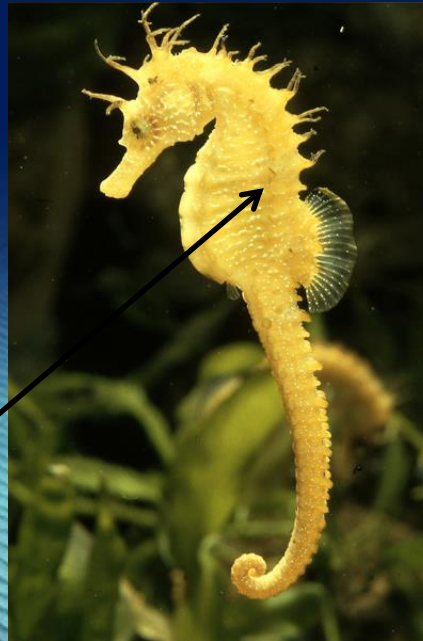
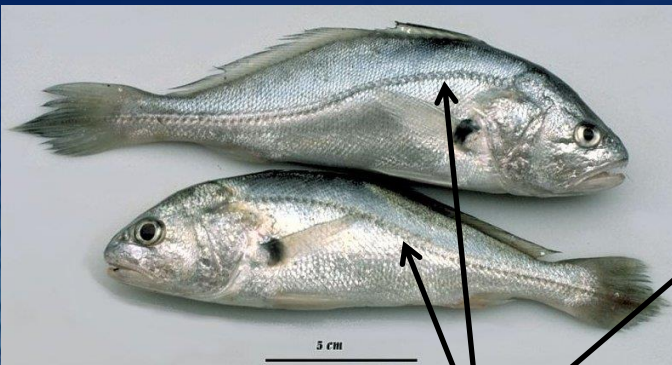
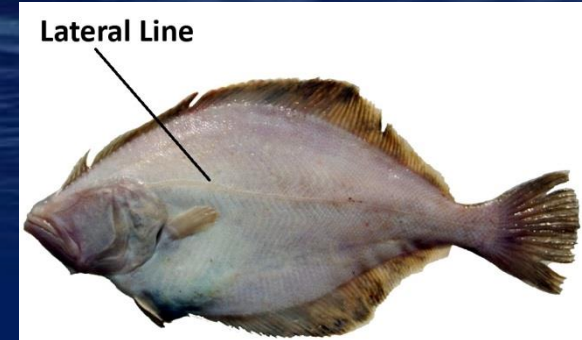
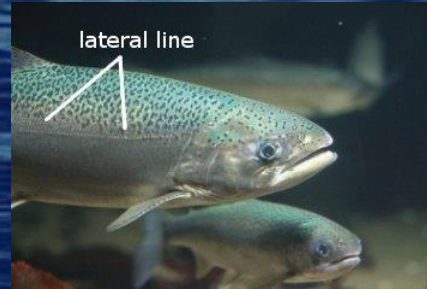


- Fish extract oxygen from water into blood via filaments on gills, then release CO_2 across gill surface
- Ammonia is also released into water at gill surface
- Many fish are considered “air breathers” and can partially or mostly extract oxygen from atmosphere via swim bladder or skin (catfish)

Lateral Line System

Detection

- Movement
- Vibration
- Pressure gradients
- Orientation
- Schooling



Mouth types



Terminal



Superior



Inferior (Sub-terminal)



Protrusible



Sucker



Elongated



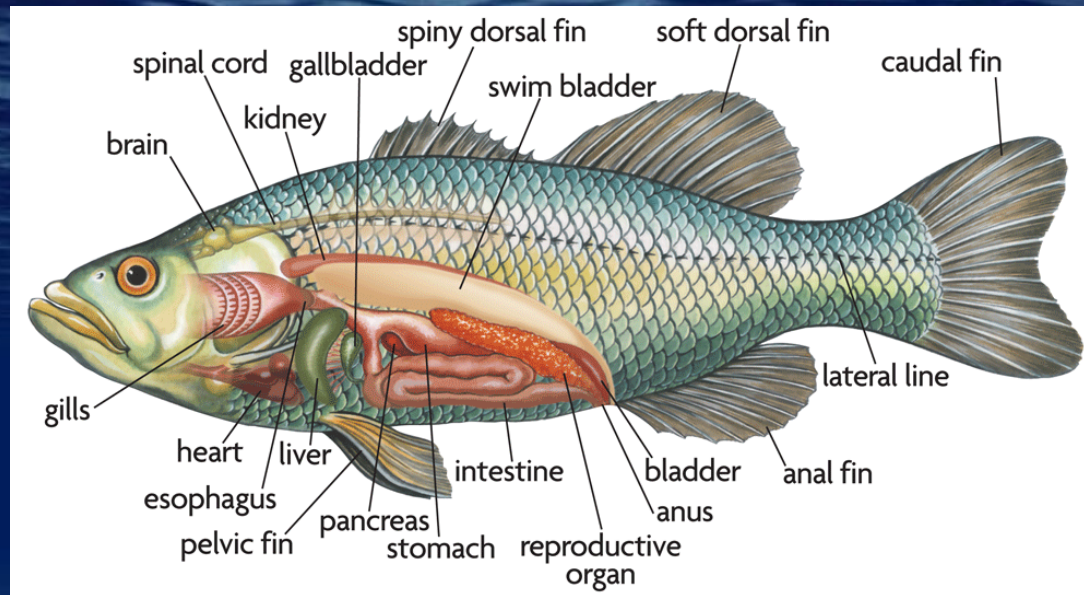
Beak

Fish External Anatomy



- **Body temperature is the same as environment (poikilotherm).**
- **Fins: movement (balance, turning, propulsion)**
- **Scales: protection, usually covered in slime (scale-less fish have extra slime)**
- **Eyes: lens more spherical than tetrapods (4 limbed) to collect light underwater**
- **Vent: opening on bottom of body where solid/liquid waste is expelled and reproductive organs (genital papilla-urogenital pore in males and oviduct in females)**
- **Sensory organs (lateral line and barbels): smell, taste, touch, pressure, and electrical fields**

Internal Anatomy



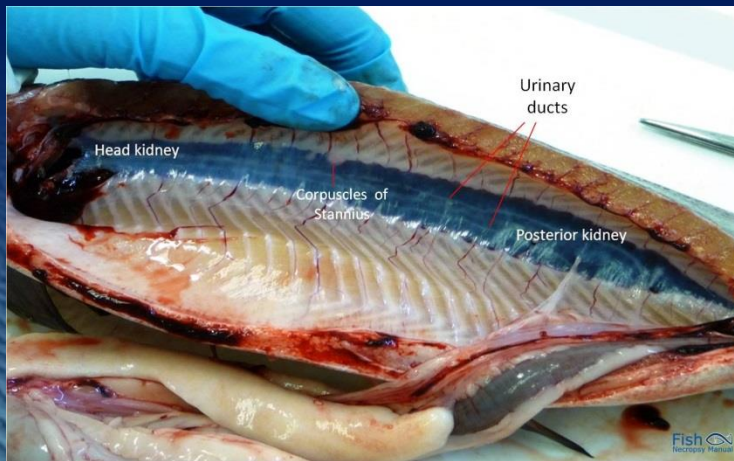
Primary Differences between species:

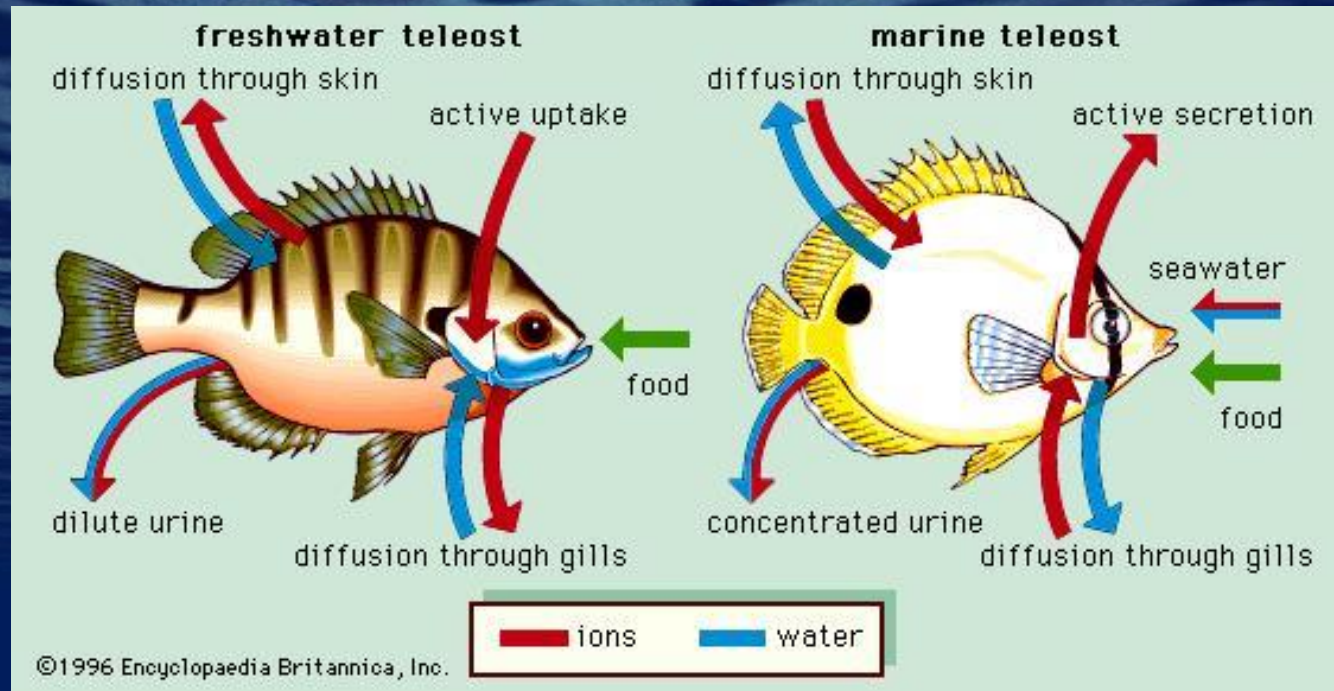
- **Kidney**
- **Intestine**
- **Swim Bladder**

Internal Anatomy

Species differences: Kidneys

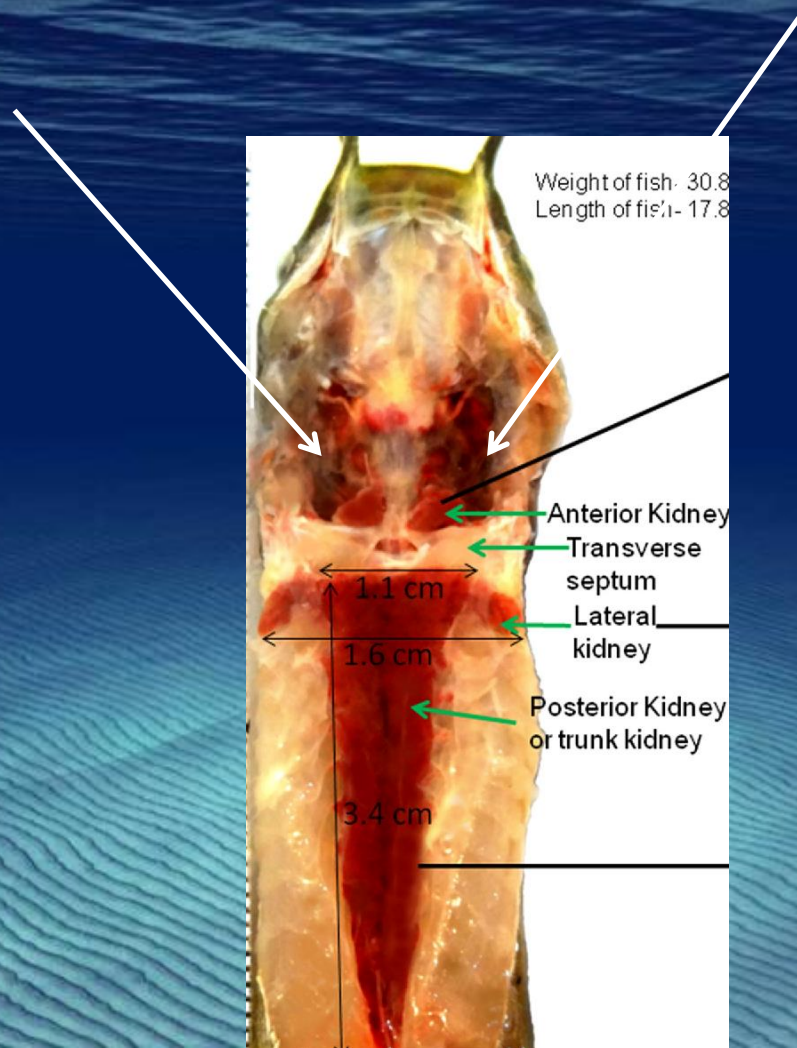
- All one organ or split into anterior (head) kidney and posterior (hind) kidney



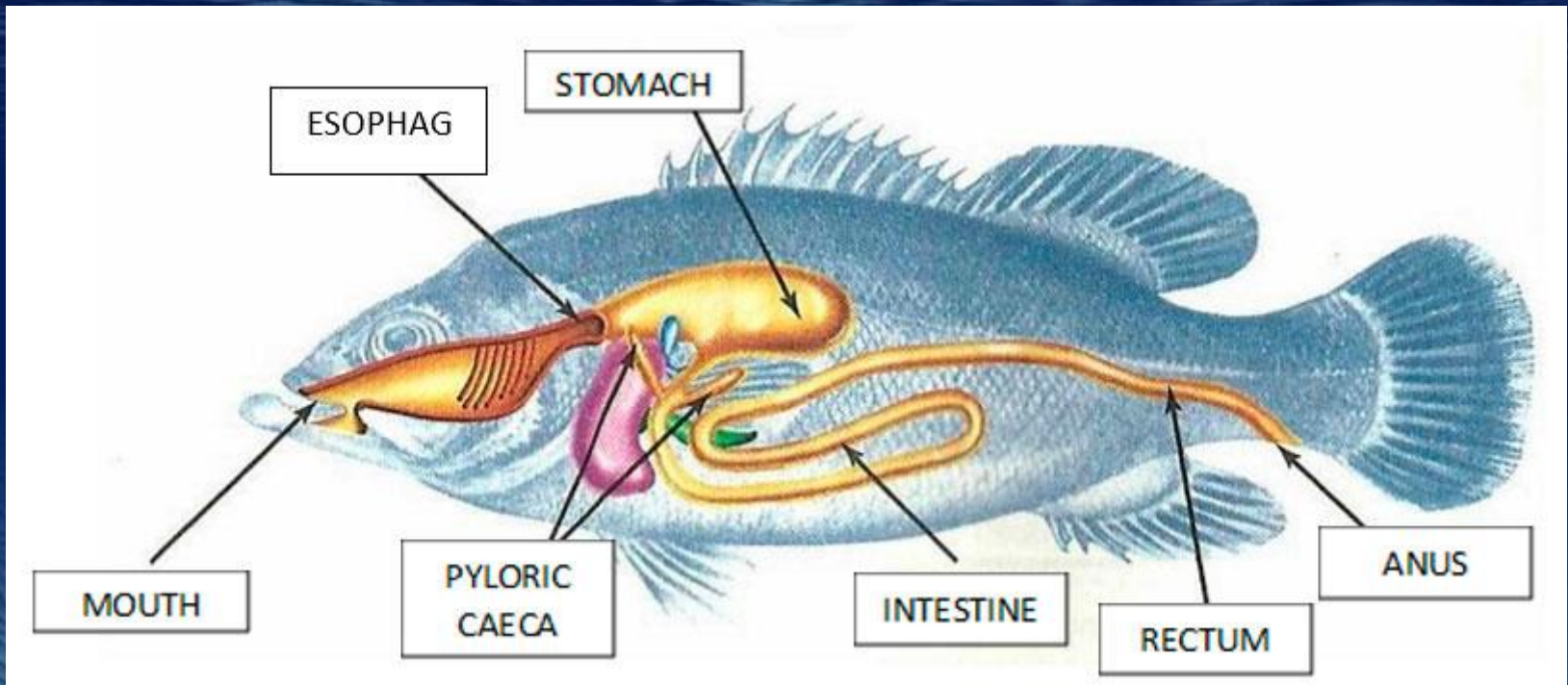


- Ammonia is released in solid and liquid waste (vent) as the kidney produces dilute urine in FW and concentrated urine in SW
- In freshwater, fish do not actively drink. In seawater, fish's physiology changes and they continuously drink water and excrete ions to maintain internal balance (Osmoregulation)

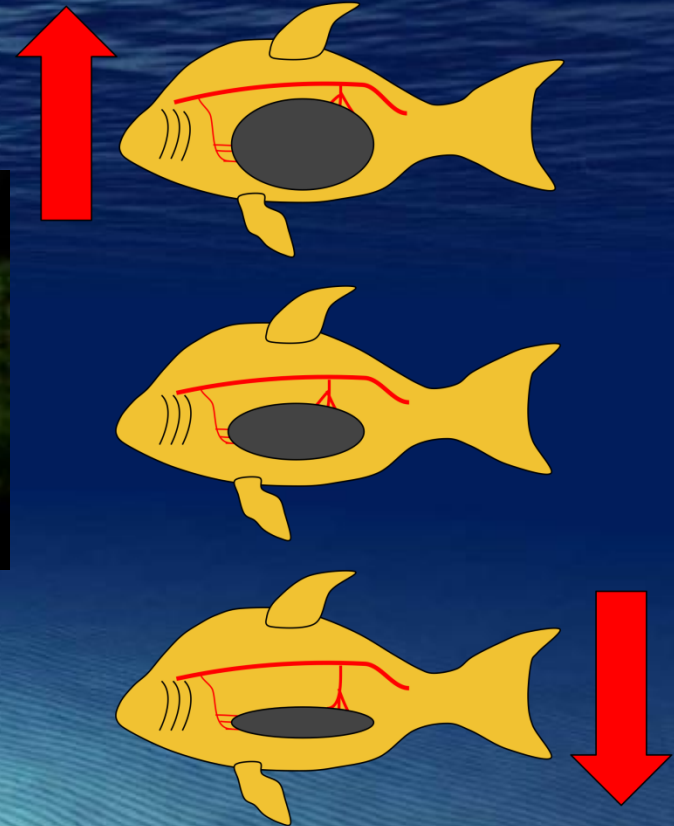
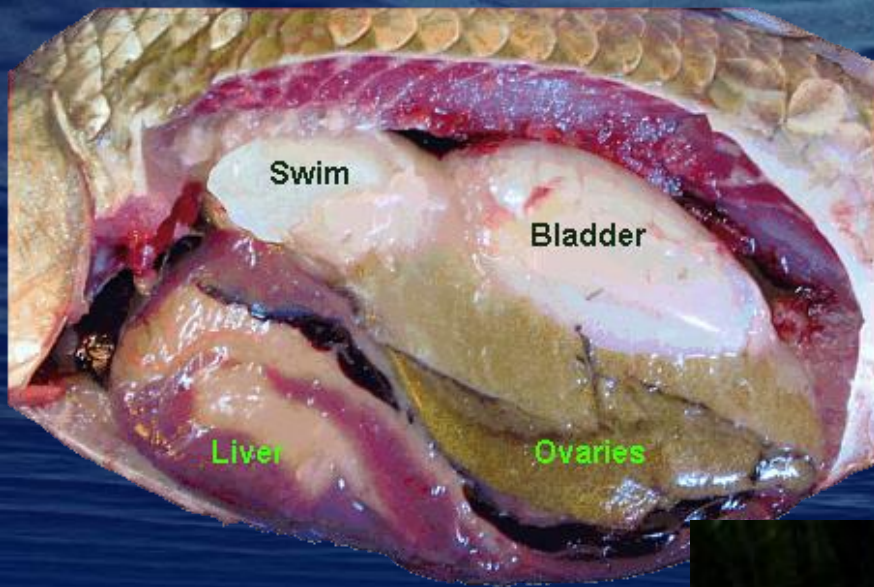
Head (Anterior) Kidney = Immune Function



Digestive system



Swim Bladder



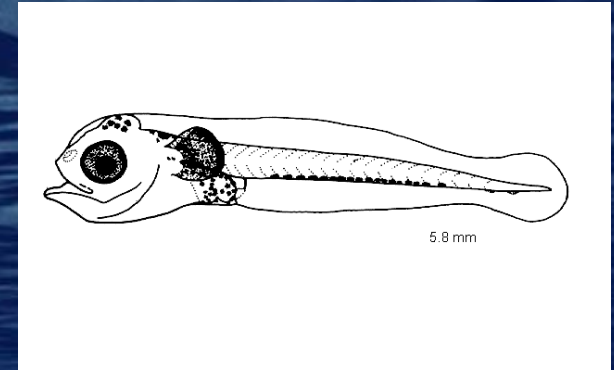
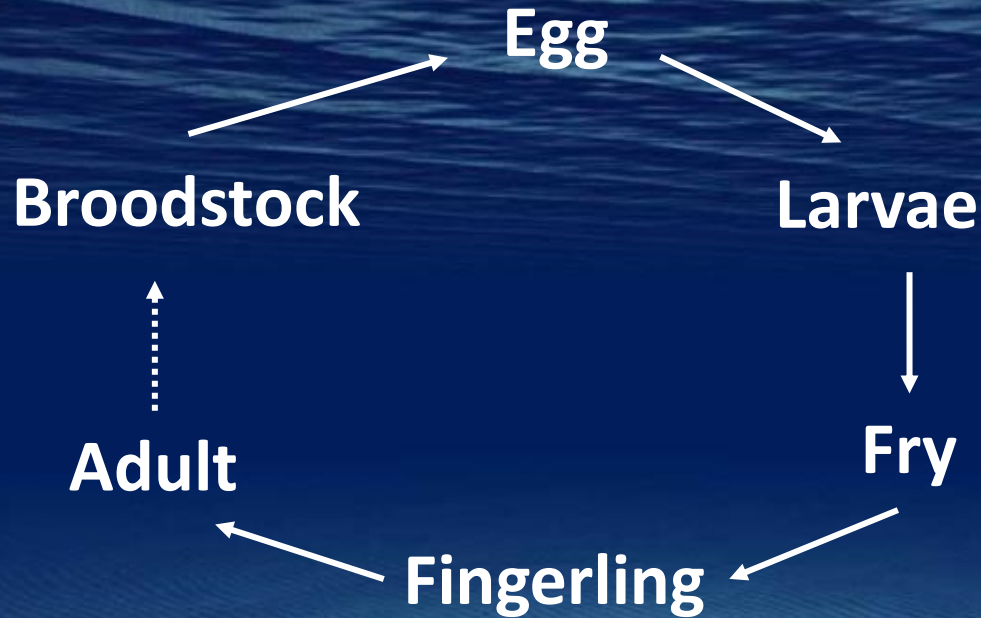
- One or two chambered
- Buoyancy
- Additional oxygen
- Sound production

Reproduction



- Vast majority of fish (>95%) are oviparous and lay eggs and fertilize externally
- Most species disperse fertilized eggs into water, but some lay nests and provide parental care and protection
- Fish sex is complicated and some species are hermaphroditic; gender is elastic
- Tilapia are nest layers

Life Stages



Maximizing all stages of growth depend on maintaining optimal water quality and nutritional needs

Life Stages

Eggs: can be very delicate, susceptible to microorganisms (Tilapia – female protected)



Larvae: Yolk-sac fry – need not feed



Fry: following yolk-sac absorption, begin to swim to eat





Life Cycle

- **Fingerlings:** transition from fry to fingerling is rapid; feeding rates decrease from 40% to 10% body weight (BW) per day
- **Adults:** grow out period varies between species and feeding regime (6-12 months)
- **Brood stock:** Adults selected for specific traits to breed for next generation(s)

Stocking Density: How many fish do I need?

Low (1-5 kg/m³) vs. high (10-20 kg/m³)

0.5 - 1 lb/5 – 10 gal. vs. 2 to 4 lbs/5 – 10 gal.

- Lower density means cleaner water but less plant production
- All depends on fish biomass and feeding rates

Avoid overfeeding!



Acclimating fish to the system

- New fish arrivals
 - Water chems differences
 - Avoid stress
- Gradual addition of system water to bag
- When water parameters are same (pH, Temp), net fish from bag/hauling tank to system.



Do not put hauling/bag water into your system!

Fish Feeds and Nutrition

- Commercial feeds based on dietary needs of specific fish species and life stage
- You are primarily paying for the protein content
- Fry Stage Feeds can be upwards of 50%, whereas adults are 30% Protein
- Lipids (listed as crude fat) for proper development
- Carbohydrates (crude fiber)



Fish Feeds and Nutrition



- Pellets are designed to float, sink or be neutrally buoyant
- Store feed in cool, dry place (<70°F; <50% relative humidity) and use quickly (do not store large quantities)
- Overfeeding is most common management error; can have quick detrimental effect



Fish Health Management

- Observe behavior and appearance every day before and after feeding
- Maintain good water quality
- Stock fish at appropriate densities
- Do not overfeed



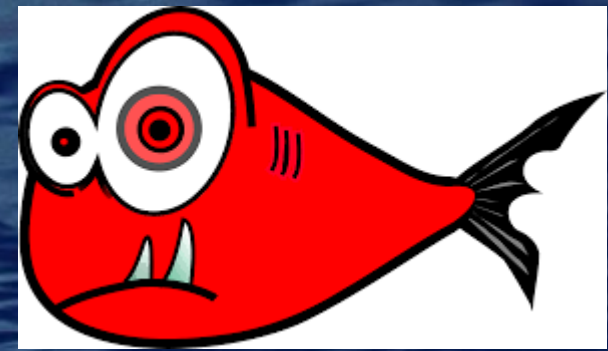
Fish Health Management



Healthy fish exhibit:

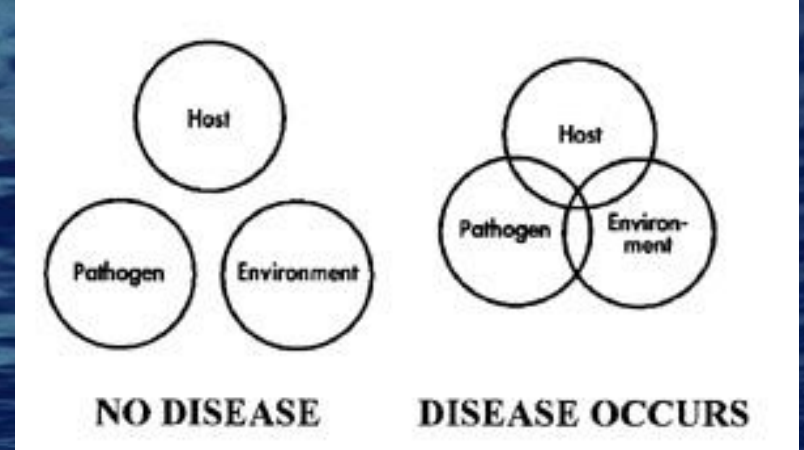
- strong appetite
- graceful swimming patterns (no lethargy)
- no marks or growths, red blotches or streaks on body
- no rubbing/scrapping on bottom or side of tank (flashing)
- no breathing from surface (piping)
- have clear shiny eyes (not white or cloudy)

When Fish are Stressed



- A physiological response to sub-optimal conditions
- Poor water quality (temperature, ammonia, pH, etc.) are stressors
- Prolonged stress reduces immune system function, affects health, can lead to secondary diseases and ultimately stunt growth (stop eating) and lead to mortalities

Fish Health Management



- Do not introduce animals/plants from the environment
- Typically bacteria/virus/fungi are always present and infect fish opportunistically when stressors are introduced
- If one or few fish appear to be sick, isolate them in a separate tank (not connected to system) and observe/contact extension agent or fish health expert
- Treatments often cannot be used for fish in aquaponics as they will affect plants

Avoid disease by maintaining a healthy environment



Mahalo!