

Baja



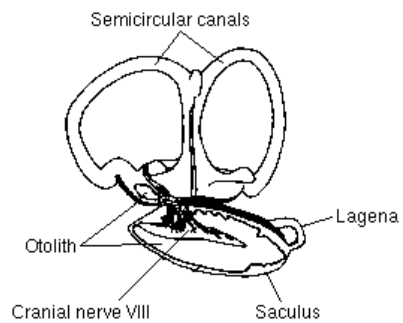
Ichthyology Lecture 5 – Fall 2007 Chapter 6 - Sensory Systems

- Fishes perceive external environment in five major ways
 - 1) Mechanoreception
 - 2) Vision
 - 3) Chemoreception
 - 4) Electroreception
 - 5) Magnetic reception

Ichthyology Lecture 5 – Fall 2007 Chapter 6 - Sensory Systems

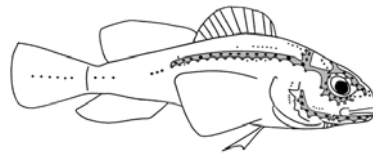
1) Mechanoreception – two major systems

- 1) Inner ear
- 2) Lateral Line System



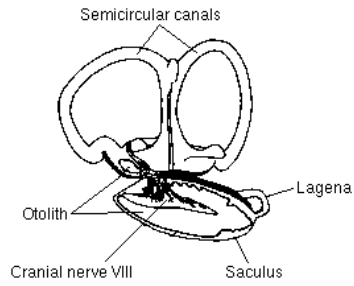
Mechanoreception – two major systems

- 1) Inner ear
- 2) Lateral Line System

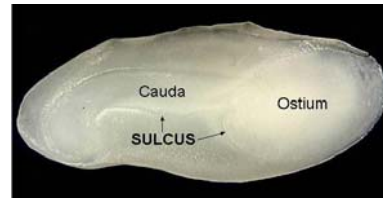


Ear – Balance:

Semicircular canals and utricle - 2 semi canals in lamprey; Hagfish one
 Canals filled w/ fluid (endolymph) and sensory hairs
 Otolith (lapillus) in utricle; on sensory hairs; vert orientation w/ dorsal light reaction

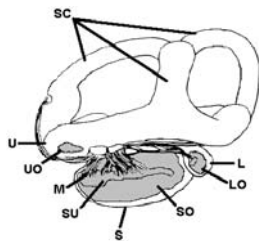


Otolith

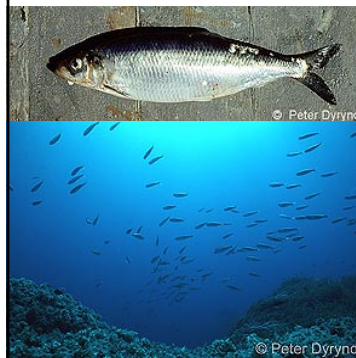


Ear Hearing:

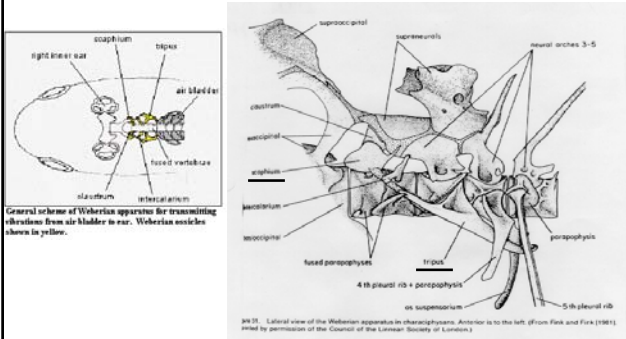
Inner ear; Utricle, saccule and lagena - each contains otolith (lapillus, sagitta and astericus) - lined with hairs;



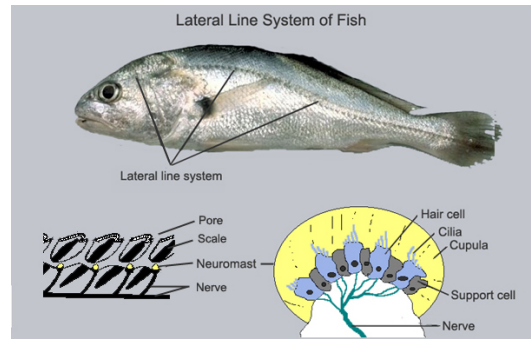
Ear Hearing: Most sound passes through fish
 Density = 1.075 g/ml Fish; 1.026 saltwater; 1.0 freshwater
 Gas Bladder - many extend to ear - Clupeids



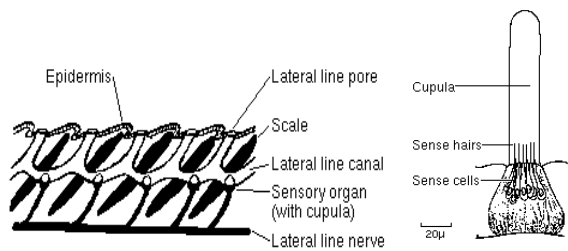
Otophysan (Ostariophysans) - Weberian ossicles - modified vertebrae that connect gas bladder to inner ear - give greatest frequency range and highest sensitivity to Otophysans of all fishes; Cichlids – new discovery
Sharks sensitive to low frequency and erratic pulsed sounds (injured fish)



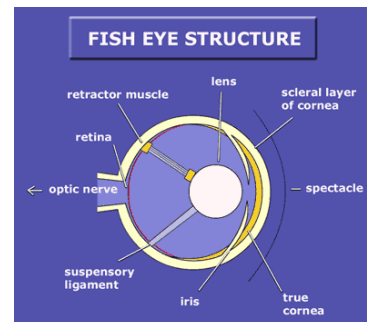
Lateral Line



Mechanoreception – **Lateral Line System** - detect vibrations in water; sound waves displace *neuromasts* (free standing, in skin or dermal bone (cephalic pores); found in all fish;



2) **Vision** - Eyes similar to vertebrates;
Cornea (thinner - light does not have to bend); iris and pupil (elasmobranchs can adjust shape of iris/pupil; teleosts cannot);
Lens (spherical) – move lens to focus; retina (rods and cones are sensory cells);
sclera (outer strong layer); choroid (vascularized between retina and sclera);



Rods - sensitive to low light levels; crepuscular and deep sea species = many rods

Cones - bright light; some Elasmobranchs and most teleosts;

Four types of cones w/ different color reception including ultraviolet and polarized light

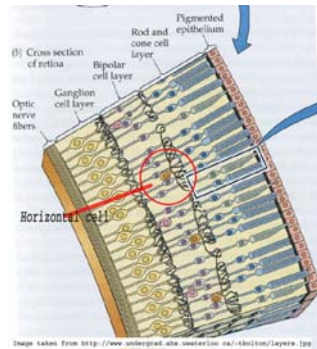
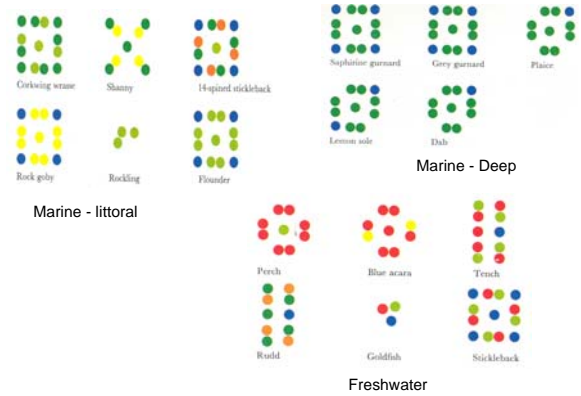


Image taken from <http://www.undergrad.uta.utexas.edu/~/ch010m/layers.jpg>

Cone Arrangements



Weird eyes - some deep sea = elongate tubular eyes; mud skippers - aerial vision (strong curved cornea and flattened lens on retractable stalks); Four eyed fish (Anableps) = simultaneous vision above and below water (two pupils and retina w/ dorsal and ventral sections)

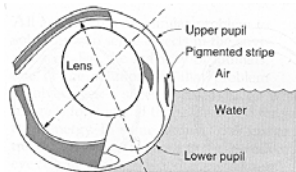


Figure 2.56
Eye of the Anableps. Light from the water passes through the lower pupil and is focused by the powerful elliptical axis of the lens. Light from the air passes through the upper pupil and is focused by the less-powerful flattened axis of the lens (Stzak, 1976).

3) Chemoreception

Chemoreception involves both smell (olfaction) and taste (gustation) - distinction clear in terrestrial but not so distinct in water

Nasal (olfactory) sacs w/ one or two **nares** in jawed fish; Most dead-end so they do not breath through; folded olfactory epithelium - odors bind to receptors; better sense of smell = more folds;

Agnathans = single naris and median olfactory sac; Hagfish connected to gills; Chimeras and lungfish also connected

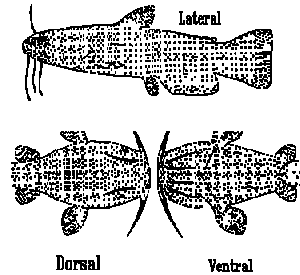
Smell used for homing (Salmon find streams by odor not vision), locate mates (pheromones; deep sea angler fish);

Taste - internal and external taste buds; some catfish have all over body

3) Chemoreception

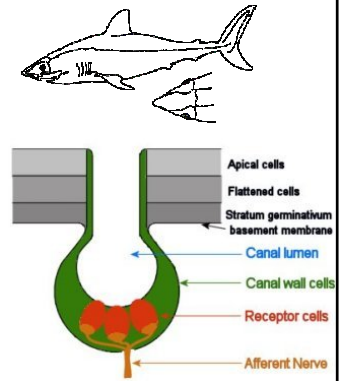
- Taste - internal and external taste buds; some catfish have all over body

Taste Receptors in a Catfish



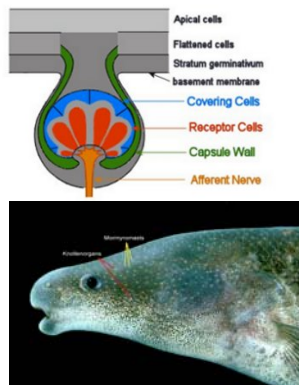
4) Electroreception many fish detect electricity

- Sharks, catfish detect prey by homing in on weak electric fields or slight muscle activity;
- Mormyrids and gymnotids detect electric fields generated by electric organs;
- Two types of electroreceptors
 - 1) Ampullary receptors - lie at base of canal filled w/ conductive gell; ampullae of Lorenzini in Sharks;
 - Sensitive to low frequency AC/DC - do not produce; Can use magnetic fields for navigation



4) Electroreception

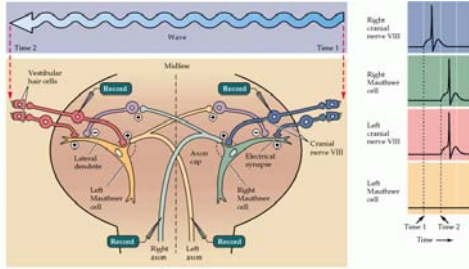
- Two types of electroreceptors
- 2) Tuberos receptors - respond to high frequency AC; most sensitive to electric organ discharges; Fish that generate have both.



Electric communication

- Electrical Communication = Main use of electricity;
- Amplitude, frequency, pulse length vary;
- Species and sex recognition - social attacks, submission, courtship, dominance hierarchies;
- Can also interfere with other outputs – Jamming
- Can also have Jamming Avoidance Response (e.g. prevent jamming by changing discharge)

Mauthner cells and startle response - extremely quick movement; rapid conduction of nerve pulses along specialized nerve cells (Mauthner cells) = large diameter and myelin sheath = fastest conduction in vertebrates; along brain stem; crosses over brain and bypasses and descends along spinal curve (receives input from right goes to left muscles); If one receives input it will inhibit the other; tail flick response.



5) Magnetic Reception

- Few highly migratory ray-finned fishes can detect earth-strength magnetic fields
- Specific mechanisms of **magnetic reception** are unknown
- Magnetite in heads of some tunas (e.g. yellowfin tuna) and in nares of some anadromous salmon (subfamily Salmoninae).
- Magnetic perception thought to help fish locate long distance migration routes for feeding and reproduction.