SYNAPOMORPHIES OF VERTEBRATE GROUPS

MYXINI

- ca 40 speciesw in two genera (*Eptatretus*, *Myxine*)
- marine
- worldwide in distribution, except in polar regions.
- deep sea and cold water
- scavengers of the sea floor
- large mucus glands open through body wall
- lack of vertebrae
- simple kidney
- one semicircular canal
- single terminal nasal opening
- eye degenerate, rudimentary, covered by skin
- mouth surrounded by 6 tentacles
- two horny plates in mouth with toothlike structures
- 1 to 15 external gill openings on each side of body
- accessory hearts in liver and tail
- red blood cells present, with hemoglobin
- true heart with 3 chambers
- female to male ratio usually 100 to 1
- some are hermaphroditic
- large eggs (1 cm in diameter), probably hatched into juveniles

CEPHALASPIDOMORPHA

- ca 40 species in two major genera (*Petromyzon* and *Lampetra*)
- vertebrae (arcualia) present, probably homologous to neural arches in other vertebrates
- most species have parasitic adults; some have non-feeding adults
- round mouth with oral hood, inner surface with horny conical spines
- protrusible "tongue" also with spines. (not true tongue, which is innervated by the 12th cranial nerve (hypoglossal), lamprey "tongue" innervated by trigeminal nerve (V))
- oral gland secreting anticoagulant
- single nostril on tope of head, with a duct to hypophysis
- eyes large, well developed
- pineal body well developed, posterior to nasal opening
- two semicircular canals (same as Ostracoderms)
- heart innervated by vagus nerve

- chloride cells in gills and in kidney
- seven gill pouches
- tidal ventilation
- adults die after breeding once
- 1 mm diameter eggs hatched into ammocoetes larvae

GNATHOSTOMES

- jaws formed of bilateral palatoquadrate and mandibular cartilages of the mandibular visceral arch at some stage of development
- modified hyoid arch, major branchial elements internal to gill membranes
- branchial arches contain four elements on each side plus one unpaired ventral median element
- three semicircular canals
- internal supporting girdles associated with pectoral and pelvic fins
- cranium enlarged anteriorly to end in a precerebral fontanelle
- cranium elongated posteriorly, so that one or more occipital neural arches are incorporated in the rear of the skull
- development of a posterior process on the cranium, separating the functions of supporting the jaws and enclosing the eyes
- intrinsic musculature in the eye to focusing the lens
- atrium lies posterodorsally to ventricle
- renal portal vein present
- spiral valve primitively formed
- pancreas with both endocrine and exocine functions
- distinct spleen
- kidney formed only by more posterior sections (meso- and metanephros)
- male gonads linked by ducts to excretory duct (archinephric duct)
- female gonads with distinct oviduct
- two contractile actin protein (smooth and striated muscles, respectively)
- nerves in myelinated sheath
- large, distinct cerebellum in hindbrain
- thicker spinal cord with gray matter horns
- dorsal and ventral spinal nerves roots linked to form compound spinal nerves
- unique and evolutionary conservative pattern of head lateral line canals
- lateral line on trunk region flanked or enclosed by specialized scales

CHONDRICHTHYES

- uniue perichondral and endochondral mineralization (presmatic plates of apatite)
- placoid scales

- unique teeth and tooth placement mechanisms
- distinctive characters of the fins
- inner ear labyrinth opens externally via the endolymphatic duct
- distinct features of the endocrine system

OSTEICHTHYES

- unique pattern of dermal head bones, including dermal marginal mouth bones with rooted teeth
- a unique pattern of ossification of the dermal bones of the shoulder girdle
- presence of lepidotrichia (fin rays)
- differentiation of the muscles of the branchial region
- presence of lungs or swim bladder-derived from gut
- medial insertion of mandibular muscles on lower jaws

ACTINOPTERYGII

- basal elements of pectoral fin enlarged
- median fin rays attached to skeletal elements that do not extend into fin
- single dorsal fin
- scales with unique arrangement, shape, interlocking mechanism, and histology

TELEOSTEI

- elongate posterior neural arches (uroneurals) contributing to the stiffening of the upper lobe of the internally asymmetrical caudal fin
- unpaired ventral pharyngeal tooth plates on basibranchial elements
- premaxilla mobile
- details of skull foramina, jaw muscles, and axial and pectoral skeleton

SARCOPTERYGII

- fleshy pectoral and pelvic fins have a single basal skeletal element
- muscular lobes at bases of fins
- enamel on surface of teeth (enameloid)
- cosmine in body scales
- unique characters of jaws, articulation of jaw supports, gill arches and shoulder girdles

TETRAPODA

- limbs with carpals, tarsals, and digits
- vertebrae with zygapophyses
- iliac blade of pelvis attached to vertebral column

- loss of contact between dermal skull and pectoral girdle

LISSAMPHIBIA

- structure of skin: mucus and poison glands
- cutaneous gas exchange
- papilla amphibiorum in the wall of the sacculus of the inner ear (for sound < 1000 Hz), in addition to the papilla basilaris (> 1000 Hz)
- operculum-columella complex with fenestra ovalis of the inner ear, fused in anurans and caecilians and some salamanders
- green rods
- pedicellate teeth
- structure of levator bulbi muscles

AMNIOTA

- loss of labyrinthodont teeth
- hemispherical and well-ossified occipital condyles
- frontal bone contact orbit in skull
- transverse pterygoid flange present
- three ossification in scapulocoracoid
- distinct astragulus bone in ankle

REPTILIA

- suborbital foramen in palate
- tabular bone in skull small or absent
- large post-temporal fenestra in skull

DIAPSIDA

- upper and lower temporal fenestra present
- exoccipitals not in contact on occipital condyle
- ridge-and-groove tibia-astragulus joint

LEPIDOSAURIA

- determinant growth with epiphyses on the articular surface of the long bones
- post-parietal and tabular absent
- fused astragulus and calcaneum
- other skull, pelvis, feet characteristics

ARCHOSAURIA

- presence of antorbital fenestra

- orbit shaped like an inverted triangle
- teeth laterally compressed with serration

CROCODYLOMORPHA

- secondary palate present, and includes at least the maxilla

DINOSAURIA

- S-shaped swan-like necks
- forelimb less than half the length of hindlimb
- hand digit IV reduced
- other characteristics of palata, pectoral and pelvic girdles, hand, hindlimbs, foot

AVES

- progressive loss of teeth on maxilla and dentary
- well developed bill
- feathers
- characteristics of skulls, vertebrae, and axial and appendicular skeleton

SYNAPSIDA

- lower temporal fenestra present

MAMMALIA

- dentary-squamosal jaw articulation
- double-rooted postcanine teeth
- specialization of the portion of skull housing the inner ear

THERIA

- mammary glands with nipples
- viviparity with loss of egg shell
- digastric muscles used in jaw opening
- anal and urogenital openings separate in adults
- spiraled cochlea
- scapula with supraspinous fossa
- numerous features of skull and dentition

EUTHERIA

- egg shell membrane lost
- intrauterine gestation prolonged with suppression of estrous cycles
- corpus callosum connects cerebral hemisphere

- ureters pass lateral to Mullerian ducts to enter bladder
- fusion of Mullerian ducts into a median vagina
- penis simple (not bifid at tip)
- details of dentition

ARCHONTA (Scandentia, Primates, Dermoptera, Chiroptera)

- pendulous penis, plus details of ankle structure

EUPRIMATES

- cheek teeth bunodont
- a nail always present in extant forms at least on the pollex
- postorbital bar present

ANTHROPOIDEA

- fused frontal bones
- fused mandibular symphysis
- lower molars increases in size posteriorly, the thrid one slightly larger than the second, all with 5 cusps, the hypoconulid (most posterior cusp) small

CATARRHINI

- narrowly spaced nostrils
- number of premolars reduced to two
- contact between frontal and sphenoid bones in lateral wall of skull
- tympanic bone extendslaterally to form a tubular auditory meatus

HOMINOIDEA

- lower molars with expanded talnid basin surrounded by five main cusps
- broad palate and nasal regions
- enlarged brain
- broad thorax with dorsally positioned scapular
- reduced lumbar region, with expanded sacrum and the absence of a tail.

HOMONIDAE

- relatively small incisors and canines
- short snout
- ventrally positioned foramen magnum
- short, broad ilium
- long legs in comparison with arms
- big toes not opposable