Polychaeta – reproduce, regeneration + clonal reproduction – some species planktonic development stages (trochopore larva→adult), regeneration possible, most species sexual, some asexual
e.g. dodecaceria – regenerate individual from 1 segment – each segment produces new head + tail, macroseptum formed pre fragementation to preserve fragment integrity, fragmentation occurs at specific points – post separation/nervous system severance – blastema formed – mass of undifferentiated cells, primitive basis of unformed organ, neoblast cells →reforms missing regions
Oligiochaeta – sexual – hermaphrodites – have mechanism to prevent self fertilisation, band on earthworm = sex region, M gonopore opposes other M seminal receptacle
Hirudine – leeches – several pairs of testes, ovary pair, single genital opening – forms cocoon containing few eggs
Arthropoda – Insects – bees – ova haploid, produce drones or workers, Queen fertilised once by drone, sperm stored in seminal receptacles. Produce eggs – fertilised or unfertilised, fertilised → diploid – Female – Queen/workers, unfertilised → Male – drone
Hexapoda – Aphid – cyclical parthogenesis – parthogenesis (F born vivipartity + ready to reproduce)
Parthogenesis – F + M, mating – female lays eggs – no vivi, increases explotation of food in summer
Parthogenesis – ova diploid – essentially have same genome as parent
Chelicerata – arachnae – elaborate courtship, with high visual, sperm transfer by pedipalps, sperm induction into female reproduction tract via pedipalps, courtship – bright colours, attitudes semapohore
Crustacea – daphnia – winter – dancing – conditions less favourable, produce haploid ova needing fertilisation, eggs have thick resistant shells improving winter survival, increased genetic variation – improve suruvival success in harsh conditions – temp, food scarcity, overcrowding
Summer – parthogenetically reproduces – summer eggs – diploid, produced mitotically, large number of eggs rapidly, rapid rising pop to exploit favourable conditions – optimum water temp, abundant food
Echinodermata – sexual + asexual, Asexual – fissiparity – asteroidea – sea star, ophiorodae – brittle star Sexual – have gonads, separate sexes, discharge gametes into sea water in response to chemostimulus of other gametes, gonopore – 2 per arm (asteroidea) large gonads – almost fill arm
Mollusca – cephalopod – nautilus, squid, octopus, cuttlefish – sexual – separate sexes, internal fertilisation – no penis, 1 arm differentiated – Mpus – chitinous sperm packet out of self – passes to F
Tracking – mate tracking important for inverts in dispersed pops, pheromones released by F to attact M (M can also release)
Courtship – varies in complexity, posturing to assure F, M is not a predator→elaborate signalling using body size/feature size/colour/motion
Inverts – care for young – brooding – egg sacs (daphnia), brood chambers – myriapod
Development – zygote →cleavage – early zygote divisions, mitosis →Embryo→mitosis→Blastula (cell ball)→Gastrulation→Gastrula → Juvenile/larvae → Adult
Progressive differentiation of parts, fertilised eggs to adult, development and growth often occur simultaneously
Ovum – specialised sex cell – egg- once fertilised with male gamete →zygote
Egg – nutrient material/yolk, protein + lipoprotein, yolk spheres (vitellin), lipid droplets, mitochondria, RNA
Zygote – polarised cell along animal-vegetal axis, polarity recognisable as development proceeds. Animal pole – relatively yolk free, vegetal pole – yolky
Early development – rapid cell divisions – cleavage – 4 egg types – all cleave, different quantity of yolk → length of feeding embryo Vs energetic cost (less yolk = more eggs)
Microlecithal (isolecithal) egg – small amount of uniformly distributed yolk throughout cytoplasm, blastomeres formed from cleavage are equal size e.g. starfish
Mesolecithal egg – medium size, moderate yolk amount, yolk in vegetal hemisphere only, complete but unequal cleavage e.g. amphibians
Teleolecithal (macrolecithal) egg – large, yolky e.g. squids + octopus

produces gelatinous house for feeding. House – has filters + screens + emergency exit – filters out tiny organisms
Vertebrata - 2 characteristics – vertebral column – numerous vertebrae = no + size vary, supports, allows movemebt, in early fish vertebral elements on or around notochord, taken on major role of support and movement
Cranium – in all vertebrates, structure and size varies, we have relatively large + complex brains – need protection, structure of bone/cartilage, supports sensory organs in head + partially incases brain.
Where is the Notocord? – Agnathans – persists and grows as animal does
Most fishes, some salamanders – persists along length of trunk + tail, constricted within each centrum (vertebrae)
Some amphibs + reptiles + birds = almost all gone
Mammals – vestige remains as numerous pulposus within intervertebral discs

Fish – Sub-Phylum – Vertebrata, Super class – Piseces – 4 Classes – Agnatha, placodermi, chondricthyes, osteichthyes
Evolution of Jaws and Teeth – major transition in vert evolution
Preverts (suspension feeders e.g. amphioxus – can only eat what is in water – small niche) →evolution of muscular pump→Jawless fish e.g. Hagfish →evolution of Jaws→Jawed fish – can eat much more – large niche
Earliest Verts – Jawless marine fish – Early/mid Cambian 530mya, 2 species – both had gills and myotomes (zigzag muscle arrangement only found in fish), 25-28mm long, cartilaginous skeleton – no bone
Ostracoderms – armoured fish, late camb → Devonian (400-525mya), heavy exoskeleton of solid bone – well armoured, in brackish, marine + freshwater
Major Fish Characteristics – Cranium (protects brain), Gills (respiration and waste ion disposal throughout life), fins (locomotion)
Agnathans – Jawless fish – only verts with no jaw, cyclostomes – round mouths – adapted for holding/rasping, primitive – have notochord, no jaws/vertebrae or paired appendages
Hagfish and Lamprey
Hagfish – scavengers + things in burrows, cyclostome mouth used for rasping + cutting, poor vision (live in abyss) good touch (ring of sensitive mouth tentacles) and smell, partial cranium, skeleton of cartilage, no jaw – 2 pairs of rasps on top of tounge like projection, primitive tail fin, secrete very sticky slime if preyed upon (not easy to eat), no metamorphosis – direct development from egg, ALL MARINE, tie in knots to clean, defend and eat
Lamprey – fresh water or anadromous (marine→fresh→marine), metamorphosis – Egg →Larvae → adult, complete cartilaginous brain case and rudimentary true vertebrae (no bones/scales), round jawless mouth – rows of horny teeth and rasp like tounge, medial unpaired fins, parasitic – latch on, bore hole with tounge, drink body fluids, leave gaping wound →death of fish due to water full of pathogenic bacteria + viruses, marine – feed on whales!

Gnathostomes – Jawed fish – upper + lower bony element of 3rd gill arch → maxillary + mandibular elements of gnathostomous jaw, upper + lower bony element of 4th Gill arch →hypoid apparatus
Placoderms – earliest jawed fish – 420-335mya, heavy bony armour on head + neck, rest of body – naked/small scales, jaws – no teeth (biting/grinding structures in dermal bones lining mouth), huge radiation → dramatic extinction, small mostly but dunkleosteus 6m! (bigger bite force than great white shark), first evidence of live birth in verts
Chondrichthyes – cartilaginous fish – sharks, rays, ratfish, skeleton of cartilage, no bone (ancestor had bone), male pelvic fins are claspers to aid internal fertilisation, pointed/conical placoid scales
Subclass elasmobranchi – sharks + rays, characteristic slitlike external gill openings, ancestral 1st gill slit reduced to spiracle – little role in respiration – now a sensory structure, mouth is ventral (head-mouth-tail)

mucous gland – keep skin moist BUT moist = bacteria thrives, poison gland – distasteful/toxic – anti predation –accumulated from food, chromatophores – structures allowing skin colour change, insect repellent in frog skin secretions
Poison – comes from ants/mites, accumulation gives frogs poision
Skeletal System – skull – simplified unlike fossil ancestors, many dermal bones lost/fused, caecilians – compact ossified – push through sediment – need ossified
Vertebrae – 3 types – amphicoelous – concave both ends (caecil + few salamanders), Procoelous – concave front, convex back (anurans), Opisthocoelous – convex front, concave back (most salama)
Appendicular skeleton – varies according to lifestyle/habitat – need to be strong to withstand huge forces from jumping.
Respiration – use air + water as respiratory media – 2 sites of gas exchange – pulmonary e.g. lungs, non pulmonary e.g. skin, gills, pharynx, cloaca
Pulmonary – 2 simple sacs – out-pocketings of guts, internal lining – smooth OR simple sacculation (folding/pockets), simple due to cutaneous exchange, uses positive pressure ventilation – buccal pumping, 1 – mouth lowered, air drawn in through nostrils 2 – close nostrils, open glottis, mouth floor elevates, air forced into lungs 3 – rhythmic ventilation in mouth cavity, 4 – body wall muscle contracts – elastic recoil of lungs – air expelled. Other use - mate choice in cane toads – too small, no mating
Non pulmonary – skin major respiratory organ, some species only respiration, moist skin, thin keratin, rich capillary supply in skin, folded skin increases surface area, moving water – maintains pressure, still water – organism must move, Hairy frog – temporal specialisation develop skin filaments during breeding season – large SA, extensive blood supply, needed for more activity, guarding eggs
No lungs – barbourula Kalimantanensis – in fast flowing streams – lots of O2, aids submersion (lungs would cause buoyancy
Internal/External gills – aquatic amphibs – pharangyeal slits, internal gills, external gills common
Pedomorphosis – in larva (and adult) – need water flow, movement or pumping