

# BMS2011- Developmental Biology and Anatomy

## Animal Diversity I

1. What makes an animal?
2. Body plans
3. Animal phylogeny: protostomes, deuterostomes, vertebrates
4. Simple animal body plans: porifera (sponges)
5. Cnidarians (jellyfish, corals, anemones)
6. Worms
7. Ecdysozoa

## ONE

Definition:

- Nutritional mode
  - o Heterotrophs: Animals
    - Ingest
    - \*Fungi absorb
    - Enzyme breakdowns food
  - o Autotrophs: Plants
    - Cannot generate organic molecules for energy
    - Energy obtained from environment
- Cell structure and specialisations
  - o Animals:
    - Eukaryotes
    - Multi-cellular
    - Lack a cell wall: have matrix proteins (collagen) instead

## TWO

Body Plans:

\*A body plan is not a plan but a map to describe how an animal functions as an integral whole

\*\* Function: defined by where the characteristic sit on the evolutionary spectrum

- Organisation
- Tissues
  - o Specialised
  - o Membranous compartments
- Gastrulation
  - o Germ layers:
    - Diploblastic
    - Triploblastic

Body Cavity:

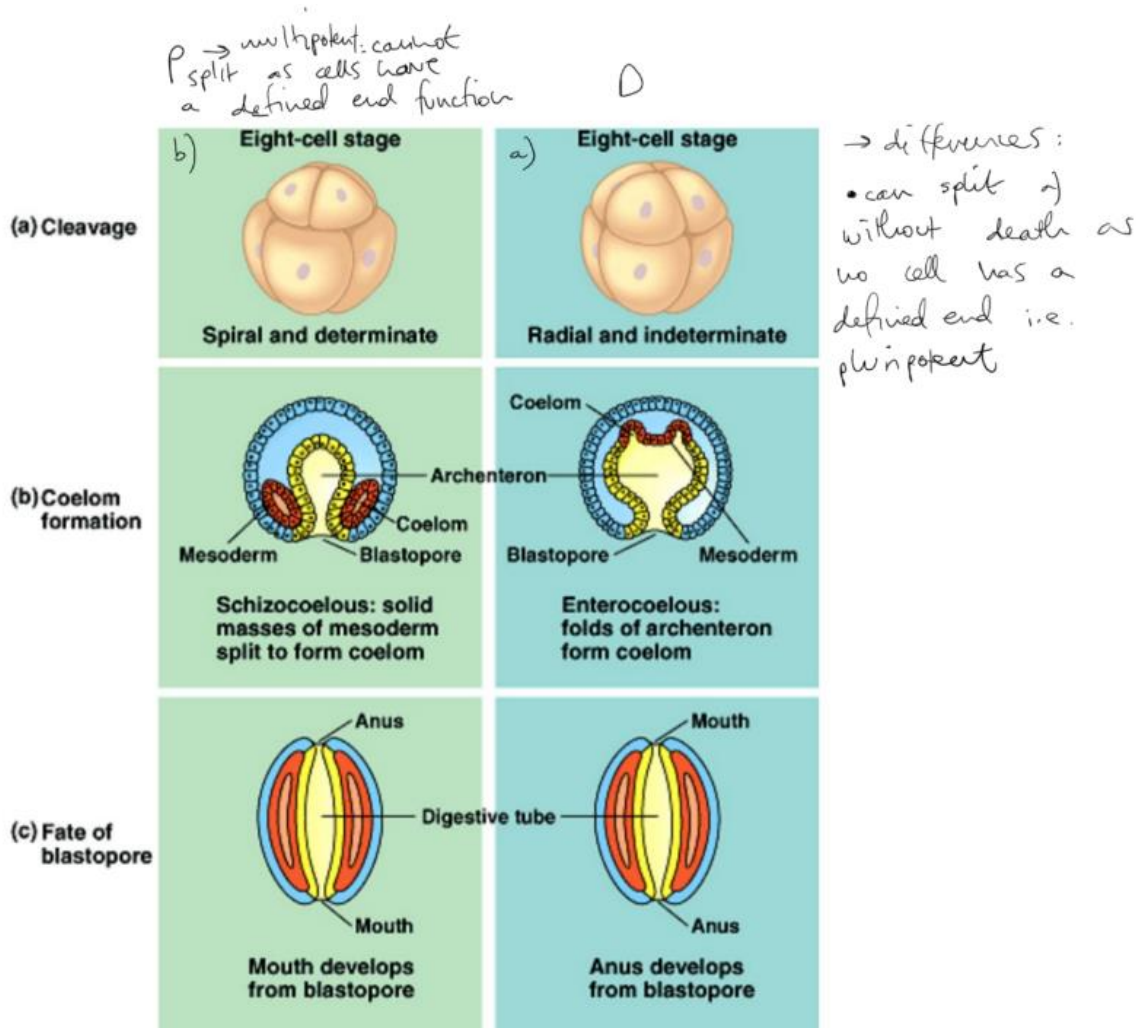
- Coelom:
  - o Fluid filled compartment
  - o Has gastroventricular cavity
  - o Cushions/space for other organs
  - o Store/circulate metabolites
  - o Larger animal without extra cells
  - o Hydroskeleton
- Acoelomates (flatworms: Platyhelminthes)
  - o No space between the digestive tract and ectoderm

- Pseudocoelomates (round worms: Nematoda)
  - o Line by tissue from both mesoderm and endoderm
- Coelomates (segmented worms: Annelids)
  - o Completely lined by tissue from the mesoderm

### THREE

#### Animal Phylogeny:

- Protostomes and deuterostomes comprise the Bilateria phylogeny. Deuterostomes are comprised of the Chordata and Echinodermata. Protostomes are all other phylogenies.
  - Protostomes: have cells that are pre-programmed.
    - o Lophotrochozoa
    - o Ecdysozoa
    - o Development:
      1. Cleavage: spiral and determinate
      2. Schizocoel: mesoderm mass splits to form coelom.
      3. Secondary anus formation
  - Deuterostomes: have cells that can specialise to have any function.
    - o Deuterostomia
- Based on:
  - o Shared characteristics
  - o Ancestry and relationships
  - o Developmental and molecular characteristics



## FOUR

### Porifera:

- Basal animals without specialised tissue
- Simple which restricts size
- Fast diffusion due to small size and one layer of cells
- Molecular exchange: gases/waste/nutrients
- Self-aggregating
- No germ layers/organs
- No circulatory/pulmonary/digestion/excretion system.

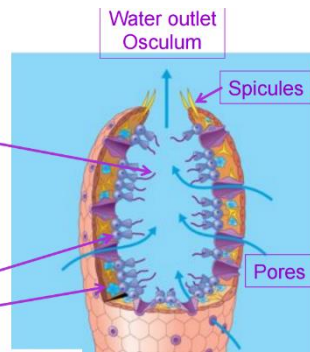
#### ❖ Water transport

- ❖ Pores
- ❖ Flagella create currents
- ❖ Osculum (outlet)

#### ❖ Connective material

#### ❖ Specialised cell types

- ❖ Collar cells (Choanocytes)
- ❖ Amoebocytes



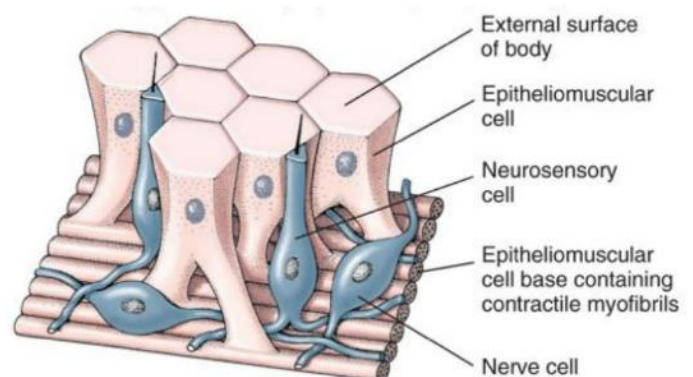
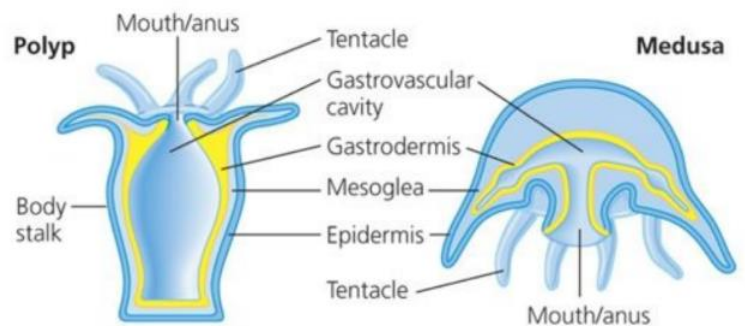
## FIVE

### Eumetazoa

- Have specialised tissues

### Cnidaria:

- Radially symmetrical
  - o Oral/aboral
- Hydrostatic skeleton
- Gastro ventricular cavity with digestion via movement of muscles against skeleton
- Epidermis (ectoderm)
- Gastrodermis (endoderm)
- Nerve network
- Epithelialmuscles layers:
  - o Epidermis- longitudinal
  - o Gastrodermis- circular
- Blastopore (opening at the bottom of the cell aggregate)
- Medusa: free floating and mobile therefore can catch larger prey
- Polyp: sessile (fixed location)
- Carnivorous: tentacles around the mouth
- Cnidocytes have defence and prey capture:
  - o Hair trigger
  - o Sting threads
  - o Toxins



## SIX

### Bilateria

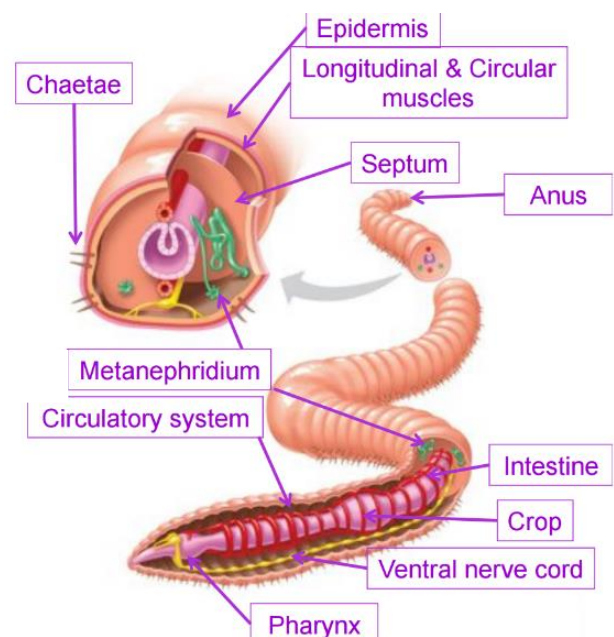
- Largest group
- Bilateral symmetrical
  - o Dorsal/ventral
  - o Lateral/medial
- Triploblasts

### Platyhelminthes:

- Parasitic
  - o Monogeneans
  - o Trematodes (flatworms)
  - o Cestodes (tapeworms)
- Marine/damp terrestrial/freshwater/planarians (ponds/streams)
- Ectoderm
  - o Epidermis
- Endoderm
  - o Blind gut
    - Has a mouth but no anus
- No respiratory/circulatory system or skeleton
- Flatness
  - o Diffusion
  - o Restricts size and capability
  - o Limited weight as movement would be restricted
- Can regenerate due to their simplicity
- Anatomy:
  - o Cilia on ventral side and muscles for locomotion
  - o Limited cephalisation for eyes
  - o Front ganglia (nerve cell cluster)
  - o Nerve cord
- Tapeworms: absorption i.e. have no gut at all

### Annelids:

- Repeated segmented which allows for self
- Soil/marine/moist forest/freshwater
- Cephalisation: nerve ring (ring of nerves and ganglia circling pharynx) and cerebral ganglia
- Closed circulatory system
- Locomotion: peristalsis
  - o Muscles act on hydroskeleton
  - o Circular muscles lengthen
  - o Longitudinal muscles shorten
  - o Anchored by setae
- Complex digestive system:
  - o Pharynx
  - o Oesophagus
  - o Crop
  - o Intestine





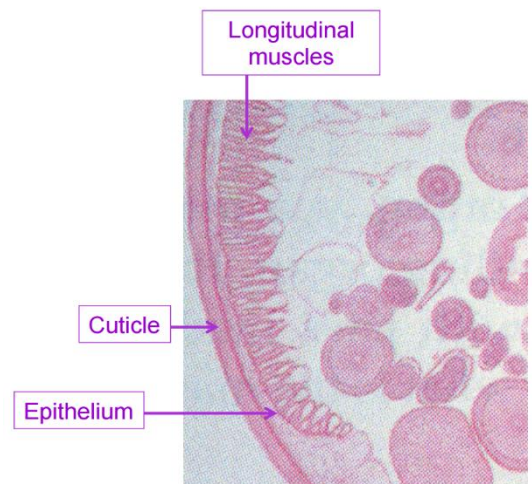
- mucus
- ectoderm
- artery
- typhlosole
- gut
- longitudinal muscle
- circular muscle

## SEVEN

### Ecdysozoa

#### Nematoda:

- Soil/fresh water/inside plants and animals
- Cuticle:
  - o Tough/flexible/non-living
  - o Limits size (most are small) and therefore required moulting
  - o Excretes coelomic fluid when under pressure
  - o Only have longitudinal muscles therefore move by undulations
    1. Muscle blocks contract on one side.
    2. Counterbalanced by hydrostatic pressure & cuticle.
    3. Push against the substrate to be effective.
- No circulatory/respiratory/excretory system
- Digestive system: one way (muscular pharynx)
- Nervous system: has been mapped with 302 nerves
- In every form of life: some may cause disease
  - o Lymphatic filariasis
- Examples:
  - o Potato cyst nematode
  - o Pratylenchus in roots
  - o Caenorhabditis in soil
  - o Ascaris in gut
  - o Trichinella in muscle



#### Anthropoda:

- Coelomates: limited
- Most species/diverse/limited
- Segmented with appendiges
- Cuticle made from chitin
  - o Exoskeleton advantages:
    - Protection
    - Reduce evaporation



- Support for muscles
- Exoskeleton disadvantage:
  - Costly to make
  - Vulnerable during moulting
  - Limits size
- Examples:
  - Chelicerates (spiders/lice/scorpions)
  - Myriapods (centipedes/millipedes)
  - Crustaceans (crabs)
  - Insects (largest group)

## Animal Diversity II

1. Deuterostomes
2. Chordates
3. Vertebrates

### ONE

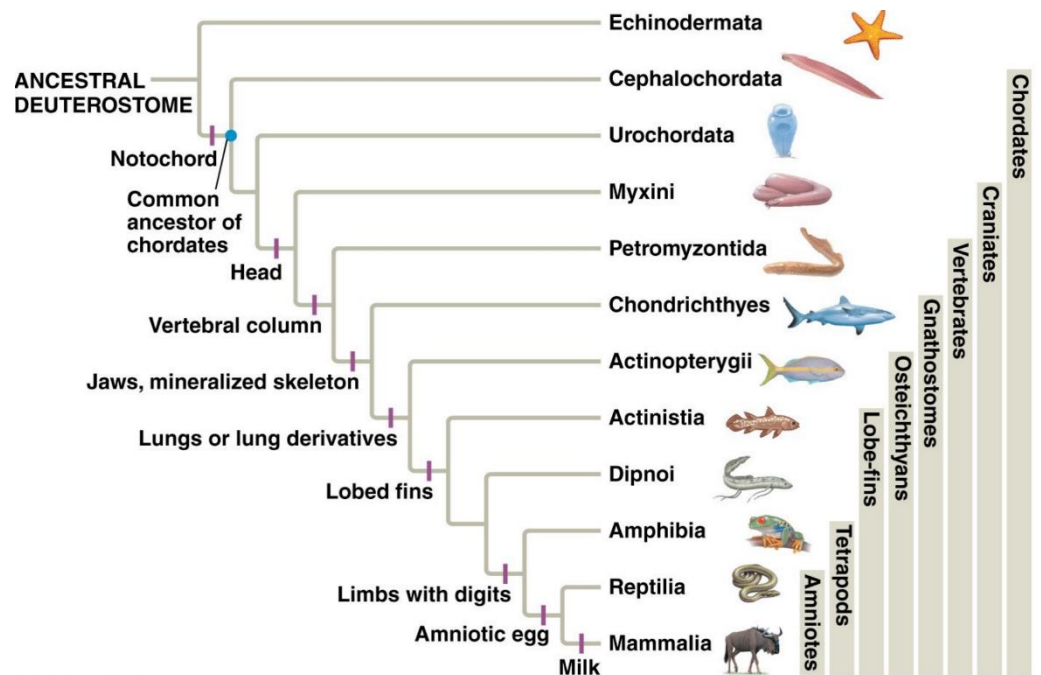
#### Deuterostomes

Defined by:

- Development
- Molecular characteristics

Include:

- Echinodermata
- Chordata
- Hemichordata



Echinoderms:

- Marine (diverse)
- Secondary radially symmetrical
- Sessile (slow moving)
- Hydraulics (moving tube feet)
  - Food capture
  - Waste transport
  - Locomotion
    - Alternate muscle contraction, forcing water into the tube feet, causing them to extend (stretch) and push against the ground, then relaxing to allow the feet to retract.
  - Respiration

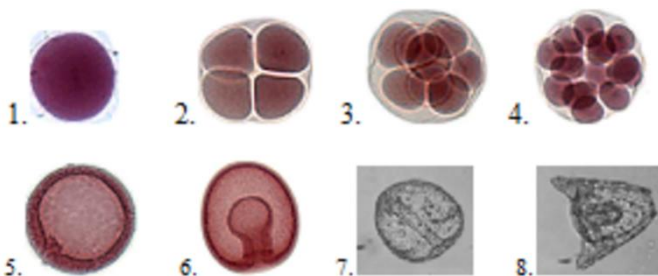
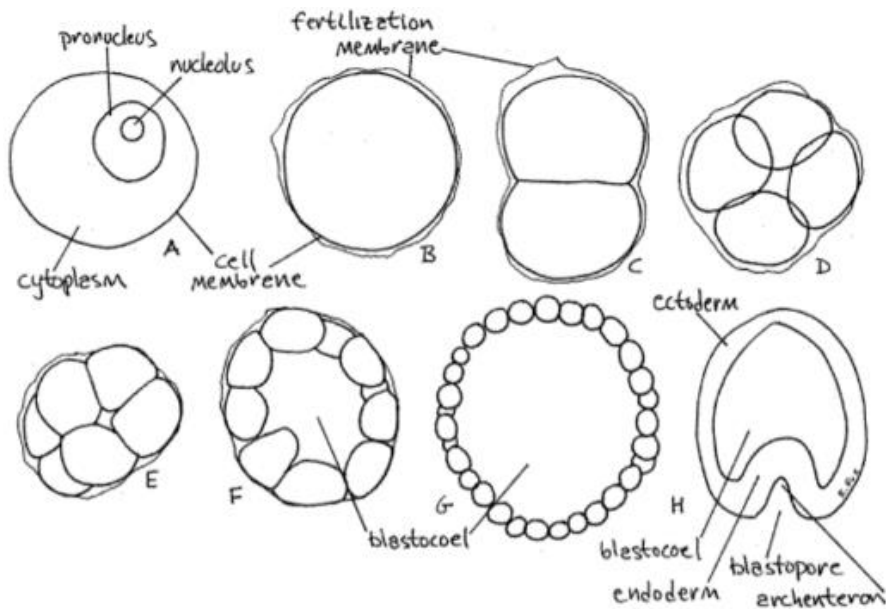


Figure 8. The developmental stages of Starfish (Echinoderm)

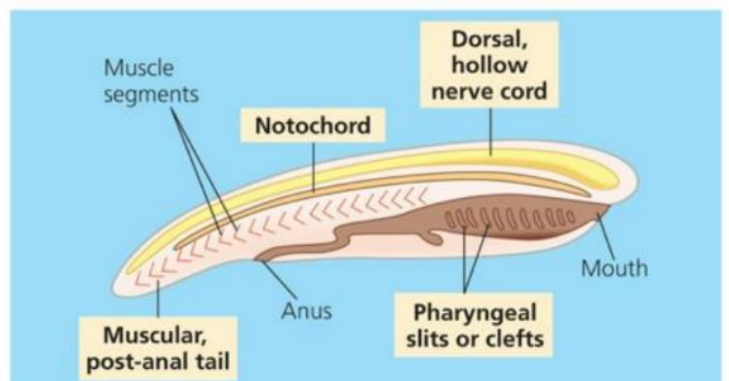
1. Zygote
2. 4-cells
3. 8-cells
4. Morula
5. Blastula
6. Gastrula
7. Ciliated Gastrula
8. Larva



## TWO

### Chordata

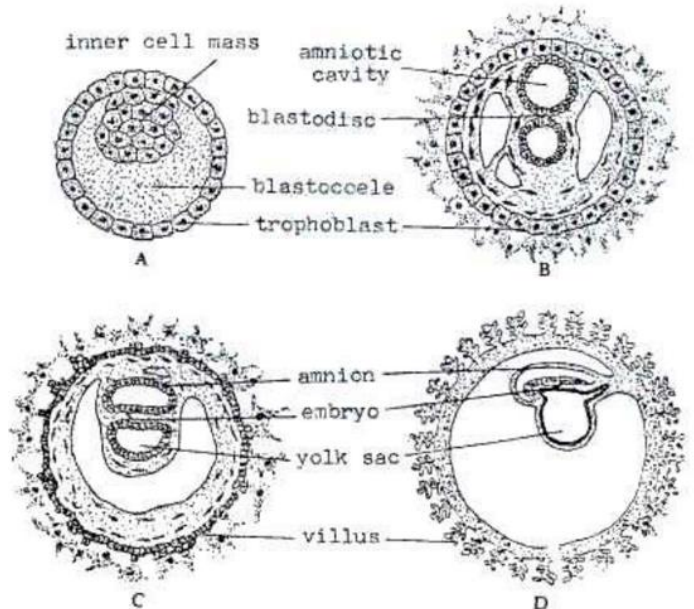
- Includes:
  - o Cephalochordates
    - Small suspension feeders
    - Retain basic chordate characteristics
  - o Urochordates (sea-squirts)
    - The body is enclosed in a translucent **tunic** consisting of living connective tissue - a gelatinous hydrated fibre mesh which is infiltrated by blood cells and amoebocytes (mobile cell via pseudopodia which are temporary projections from the eukaryotic membrane).
    - Mesh often contains a type of cellulose (tunicin) fibres (rare in animals).
    - Highly modified
    - Sessile
  - o Craniates
- Characteristics:
  - o Notochord (vertebrae)
  - o Post-anal tail
  - o Dorsal hollow nerve chord (spinal cord)
  - o Pharyngeal slits (feeding and breathing)
  - o Shared:
    - Cranium and brain
    - Eyes and other sensory organs
    - Neural crest



## THREE

### Vertebrae

- Craniate with a backbone
- Paired appendages
- Endoskeleton
  - o Light
  - o Supports bodyweight
  - o Can grow
- Petromyzontida (Lampreys):
  - o Oldest vertebrate
  - o No paired appendages/jaw/bone skeleton
  - o Larvae
    - Notochord
    - Filter feeders similar to lancelets
  - o Cartilage in adults
- Gnathostomes:
  - o Jawed vertebrae
  - o Pharyngeal slits → jaw bone
  - o Chondrichthyes:
    - Cartilaginous fish
    - Ca may be present
- Osteichthyan:
  - o Actinopterygii (ray finned fish)
    - Fins supported by dermal rays
    - No muscles in fins
    - Dominant: 27,000 species
    - Habitats:
      - Marine
      - Freshwater
- Sarcopterygii (lobe fins):
  - o Rod-shaped bones/muscles
  - o Coelacanth/lungfish
- Tetrapods:
  - o Evolution of podia:
    1. Humorous and digits
    2. Radius and ulna
    3. Decrease of digit size
  - o Evolution:
    1. Neck
    2. Stronger vertebral column
    3. Ribs
    4. Supporting girdles
  - o Amphibia:
    - External fertilization (eggs in water)
    - Aquatic larvae: gills and finned tail
    - Adults (metamorphosis):
      - Legs
      - Lungs
      - Terrestrial, moist habitats
- Amniotes:





- Amniotic egg
  - Differs from the jelly egg as it has a shell
  - Bigger
  - Can produce more developed offspring due to large food reserves
  - Amnion protection
  - Allows more successful phylogeny
- Keratinised skin:
  - Fibrous
  - Thick
  - Water proof
- Reptilia:
  - Birds:
    - Highly modified reptiles
    - Derived from theropod dinosaurs
    - Toothless beak
    - Wings/feathers
    - Modified sternum
    - Most abundant tetrapod
    - High metabolism
- Mammalia:
  - Mammary glands
  - Hair
  - High metabolism
  - Larger brains (relative to size)
  - Three groups:
    1. Monotremes (egg-laying mammals)
      - a. Milk from skin (no nipples)
      - b. Only in Australia/New Guinea
    2. Marsupials (pouched mammals)
      - a. In Australia and Americas
      - b. Simple placenta
      - c. Short gestation lactation in pouch
    3. Eutheria (placental mammals)
      - a. Worldwide
      - b. Complex placenta
      - c. Long gestation period

