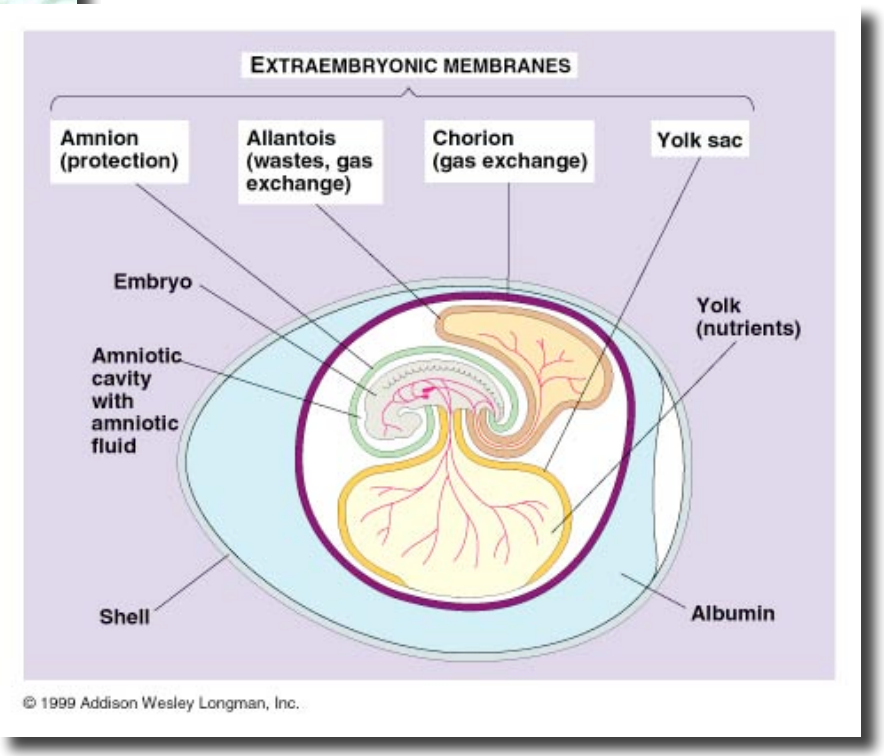
Development of Amniotic Egg



Accessory Envelopes

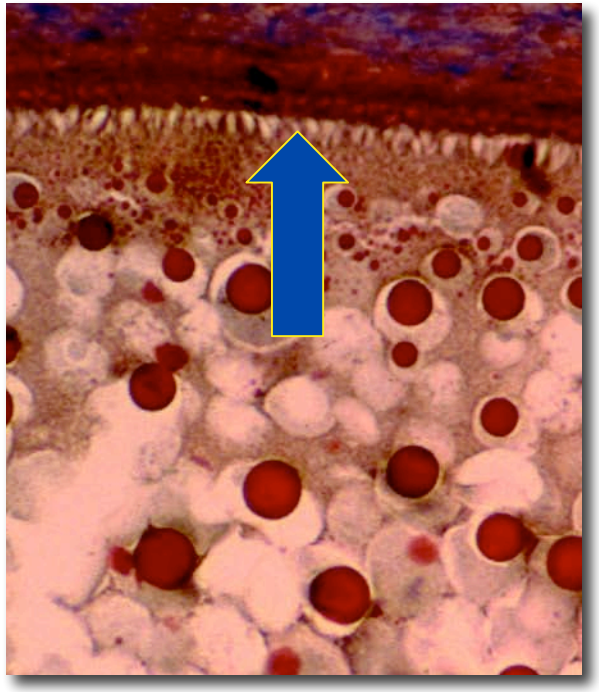
- three types
  - Primary - produced by developing oocyte
  - Secondary - from follicular epithelium
    - derived from follicle cells or other source
    - chorion proteins of fish synthesized by liver
  - Tertiary - secretion of Mullerian duct

Primary membrane

- oocyte and follicle cells separated by space - perivitelline space
- as follicle differentiates, follicle and oocyte extend microvilli forming zona radiata
- next, space filled with secretory material from follicular and oocyte sources
  - depending on species, materials are from either or both,
  - some "follicular materials" are synthesized in the liver
    - Choriogenins found in fish chorion

1°/2° accessory envelopes

- fish = chorion
- amphibians, reptiles, birds = vitelline membrane or ZP
- mammals = zona pellucida (ZP)
  - ZP proteins - mRNA in oocyte only



Tertiary Membranes

- tertiary membranes cover developing embryos
  - exception urodele and anuran amphibians
- secretion occurs post-fertilization

Chondrichthyans I

- egg envelopes or egg cases
- consist of a layer of albumen and orthogonally [at right angles] stacked layers of protein fibrils
- secreted by shell gland / nidamental gland -

Figure from http://www.baltimoresun.com/entertainment/visitor/bal-artslife-sq-sharkgallery,0,2979585.photogallery?coll=bal-visitor-utility&index=3

Chondrichthyans II

- short egg retention - zygoparous -
  - eggs laid and tertiary membrane important for embryo protection
- long retention - viviparous -
  - shell can break down or remain intact thru out gravidity -
  - in some viviparous species they are never secreted

Amphibians I

- distinct from other species
- Anurans/Urodeles
  - one or more semi-transparent gelatinous layers
  - concentric layers of
    - neutral glucosaminoglycans and mucoproteins
  - all layers secreted by oviduct sequentially

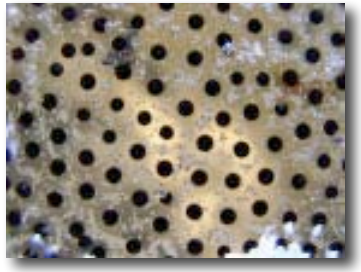


Figure from images.fotoamz.com/ journal/

Amphibians II

Figure from http://groove.gmxhome.de/favourites-costarica.htm

- outermost layer can be adhesive so eggs stick to one another or substrate
- can contain toxins to reduce predation
- in some species - innermost layer liquefies to produce inner capsule of fluid
  - allowing movement and development

Amphibians III

Photo Credit: JLM Visuals

www.bio.davidson.edu/.../ Myths/Herp_Facts.html

- Gymnophione (apodans, caecilians)
  - structurally different
  - elastic and bilayered
    - inner fiberless layer
    - outer fibrous layer

ANAMNIOTES -AMNIOTES

- In vertebrates distinction between those with 3 extra embryonic membranes and those without
  - ANAMNIOTES – without (e.g. fish, amphibians)
  - AMNIOTES – with (e.g. reptiles, birds, mammals)

AMNIOTES

- Many amniotes produce cleidoic eggs
  - Shell encloses and isolates embryo from external environment
  - Adaptation allows true independence from aquatic environment
  - Amnion permits embryo to develop in protected aqueous environment

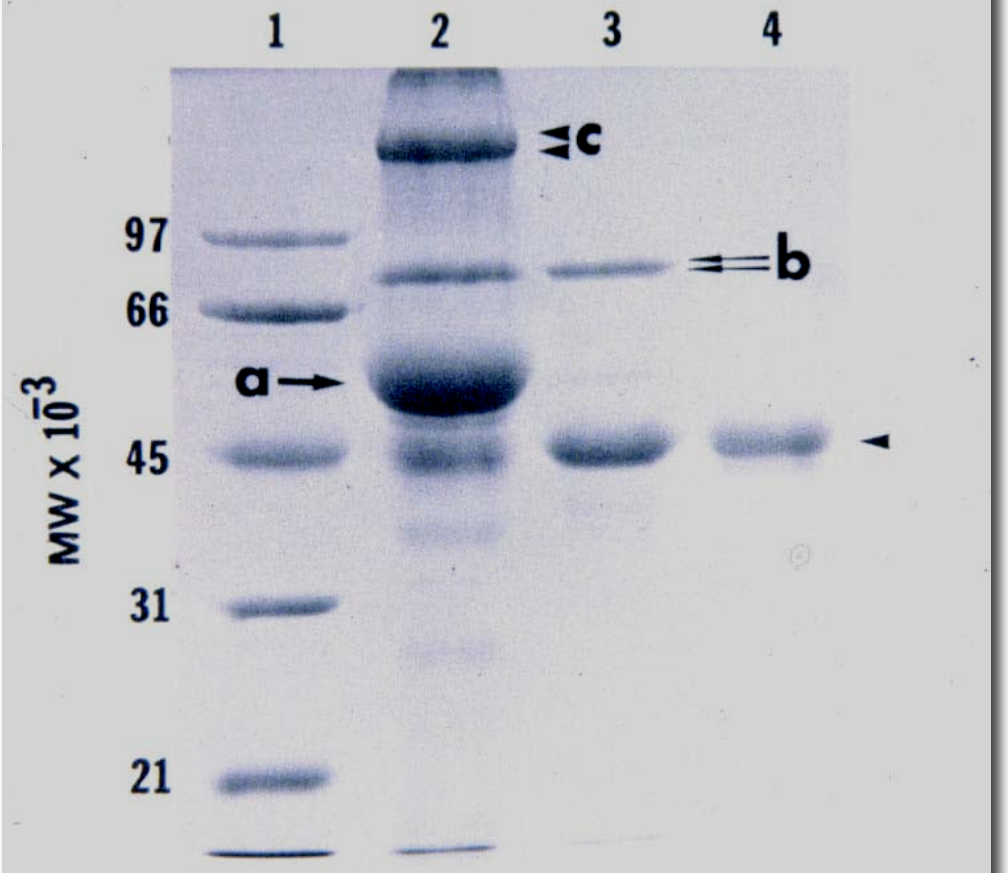
Reptiles & Birds

- surround developing embryo with tertiary shell membrane
  - except a few viviparous reptiles
- secreted by the oviduct

Albumen

- Duct system derived from mullerial duct secretes albumen
- a mixture of numerous proteins
  - serve as:
    - carriers of vitamins, iron, calcium, etc.
    - antibacterial or antiviral agents
    - shock absorbers

1D-SDS-PAGE/COOMASSIE STAINED



LANE 1 = MW STANDARDS; LANE 2 = ALLIGATOR ALBUMEN
LANE 3 = CHICKEN ALBUMEN; LANE 4 = OVALBUMEN STANDARD

A, 55KD AOP-1; B, OVOTRANSFERRIN; C, ???

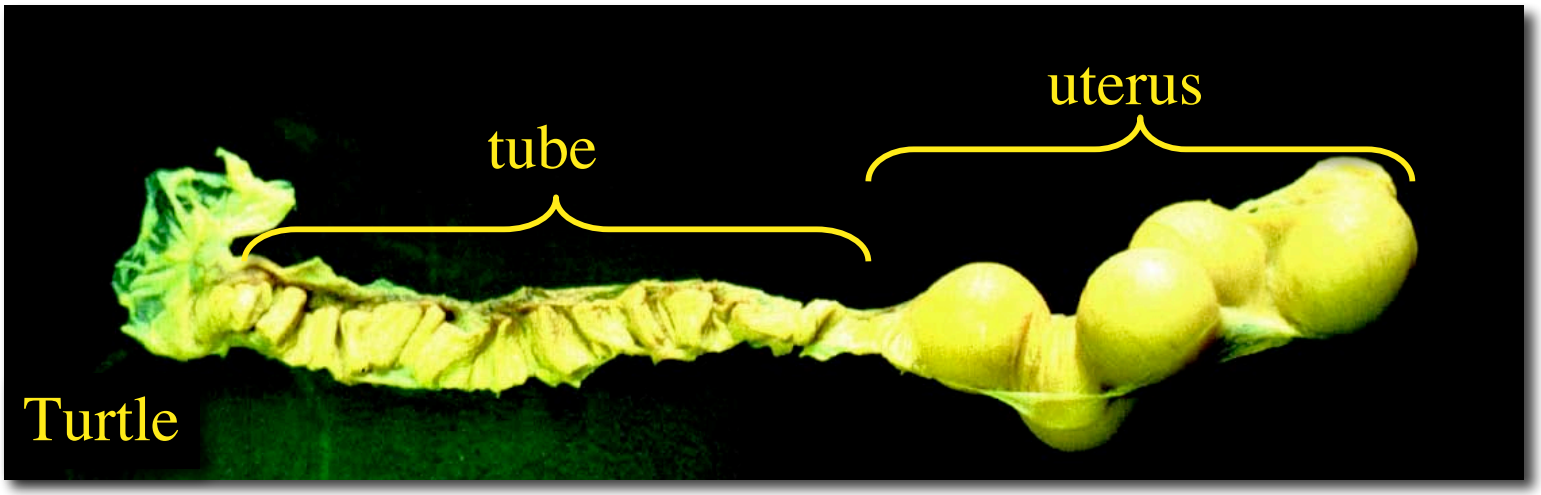
Shell

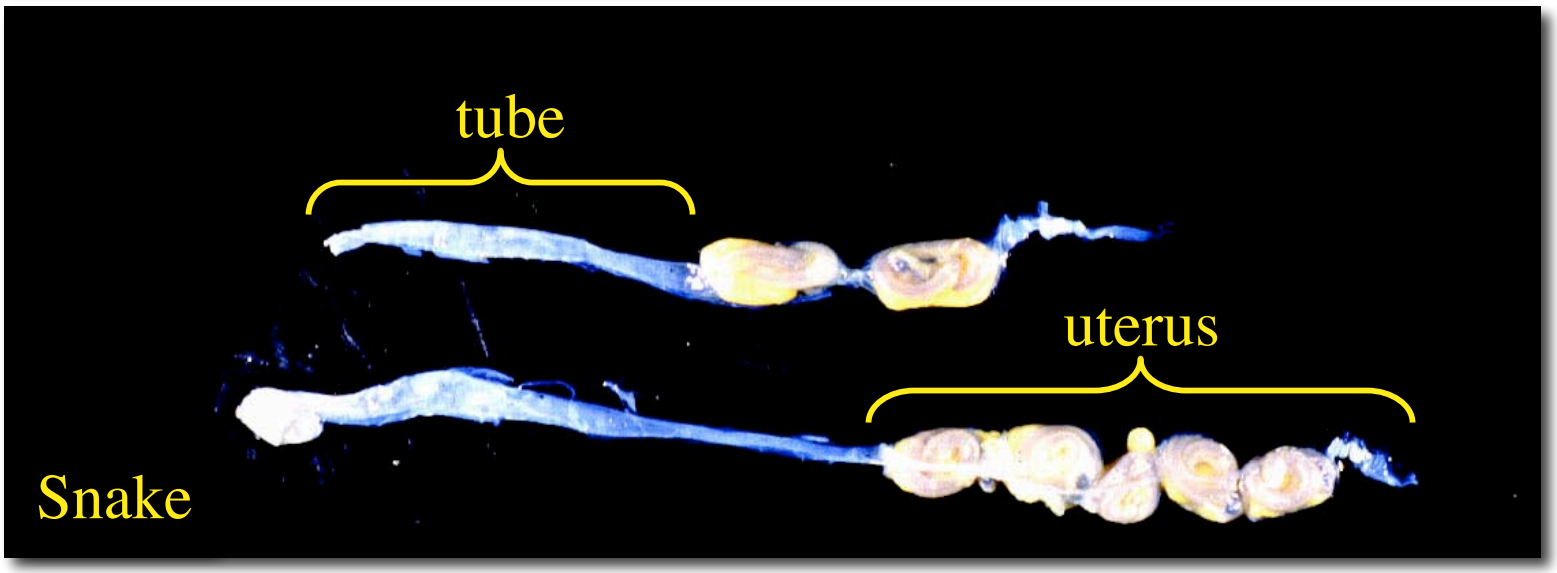
- derived from uterus
- two major components
  - outer calcium layer and inner protein layer
- layers can be secreted from
  - the same region of the uterus*
    - turtles, squamates, tuatara
  - from distinct regions*
    - crocodilians, birds

Shell

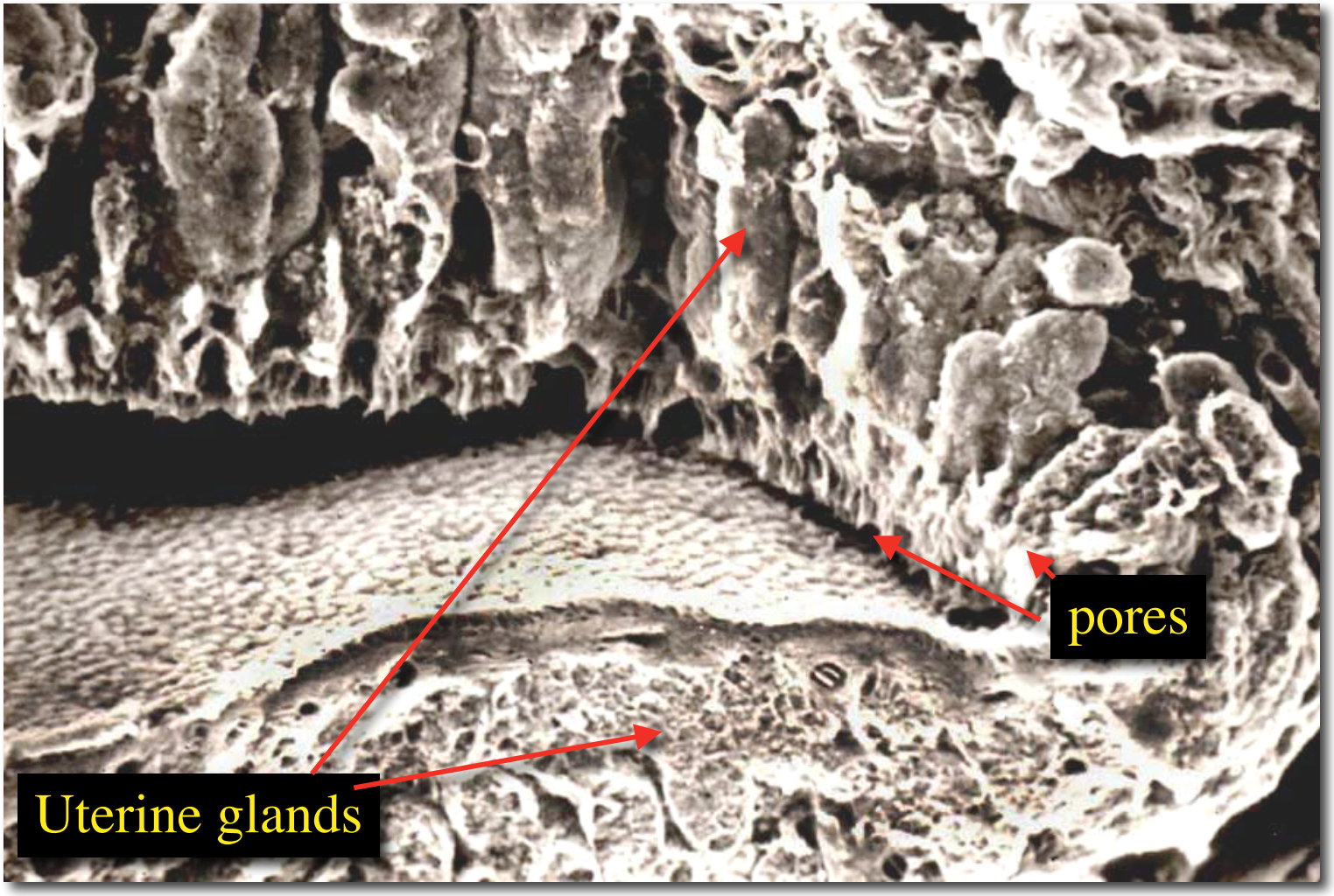
- In squamates, turtles & tuatara
  - calcium from epithelial cells
  - protein fibers from glands in the uterine endometrium
- In crocs and birds -
  - fibers from glands of anterior uterus
  - calcium from glands in posterior uterus

Turtles and Squamates



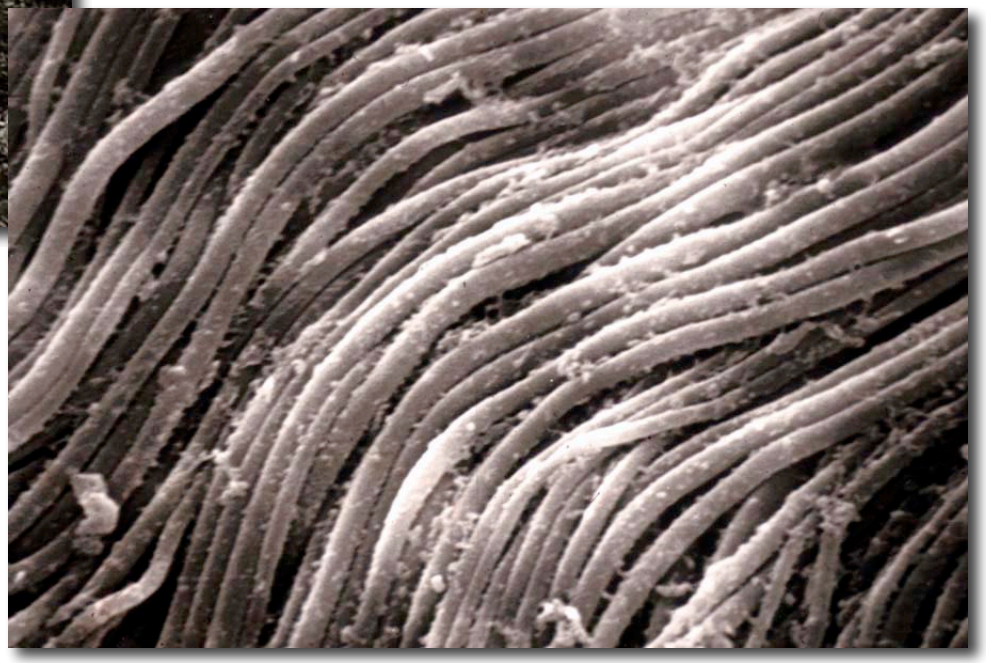


Turtle Uterus - SEM

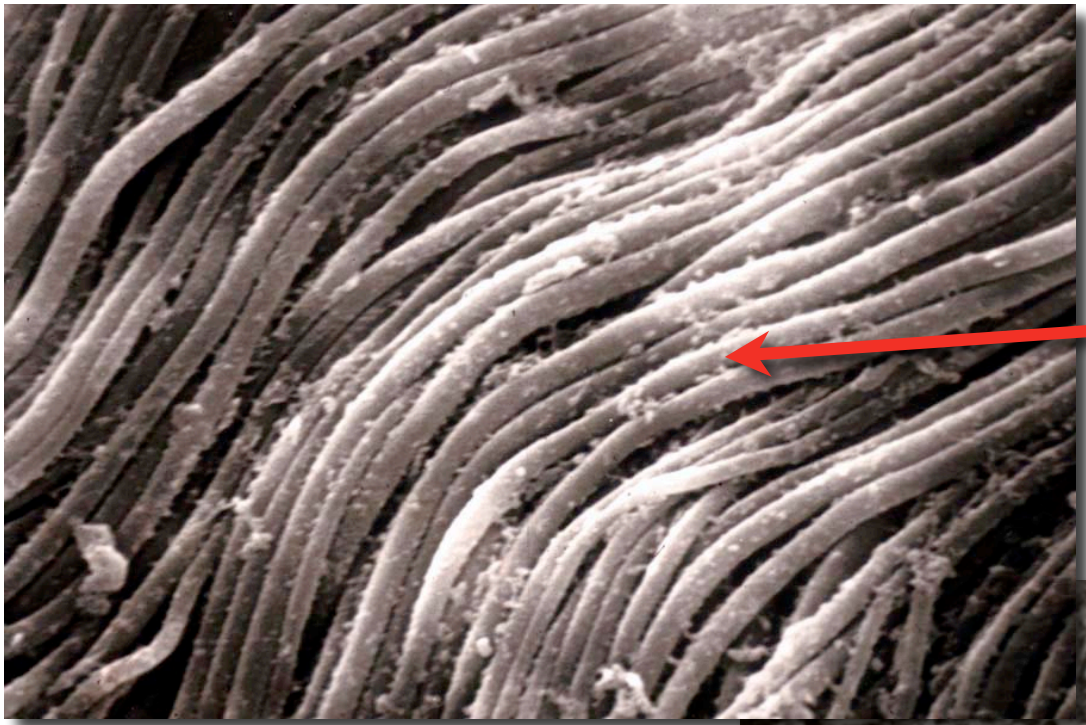


Egg Shell Fibers Secretion

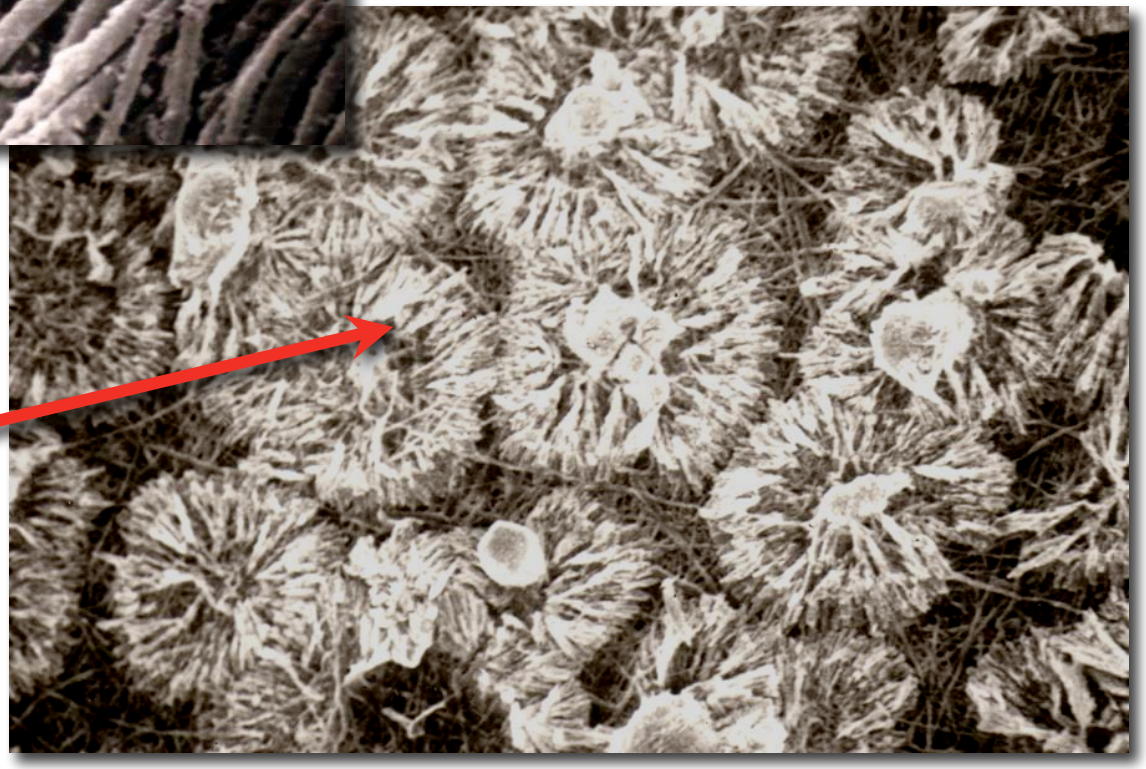
Fiber secretion - turtle



Palmer et al.

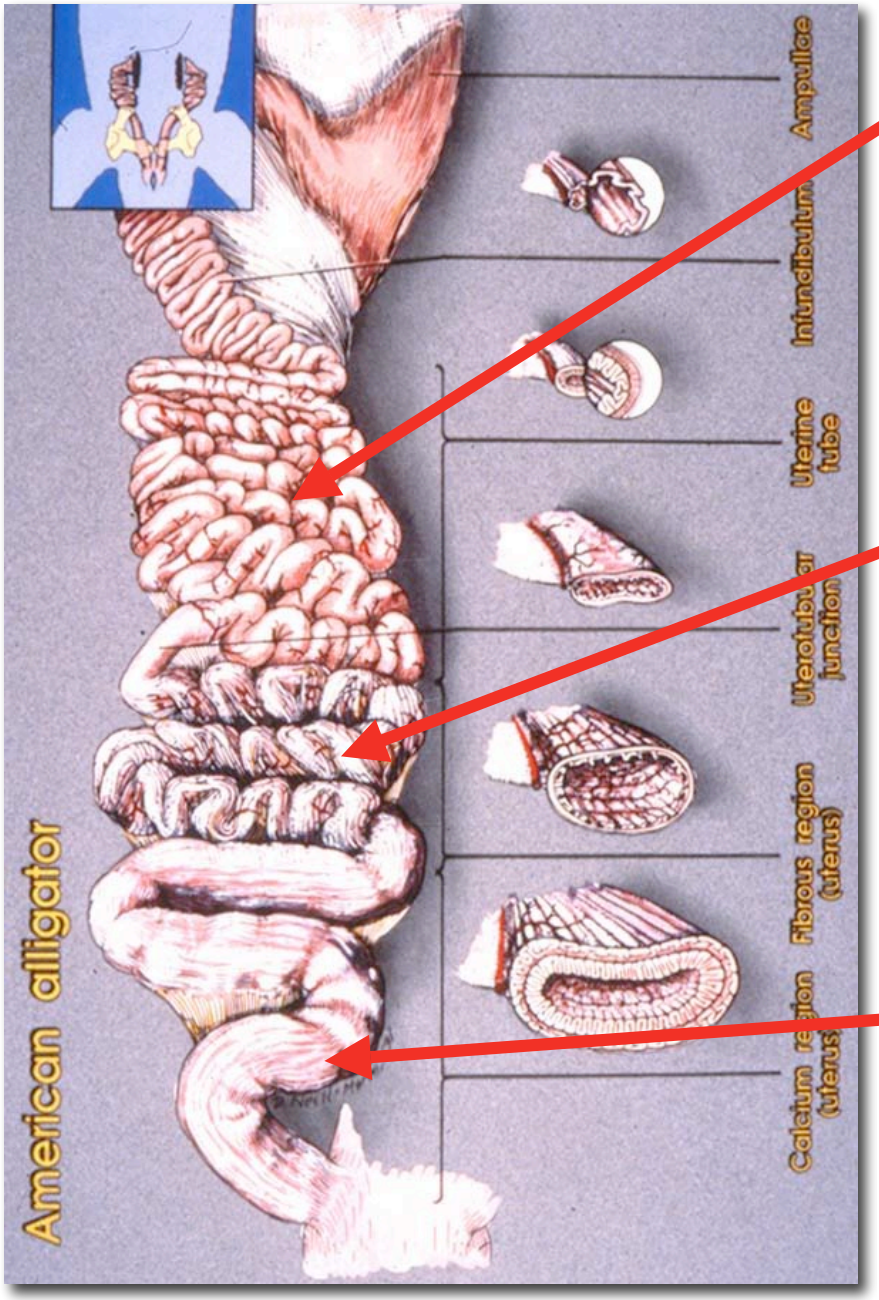


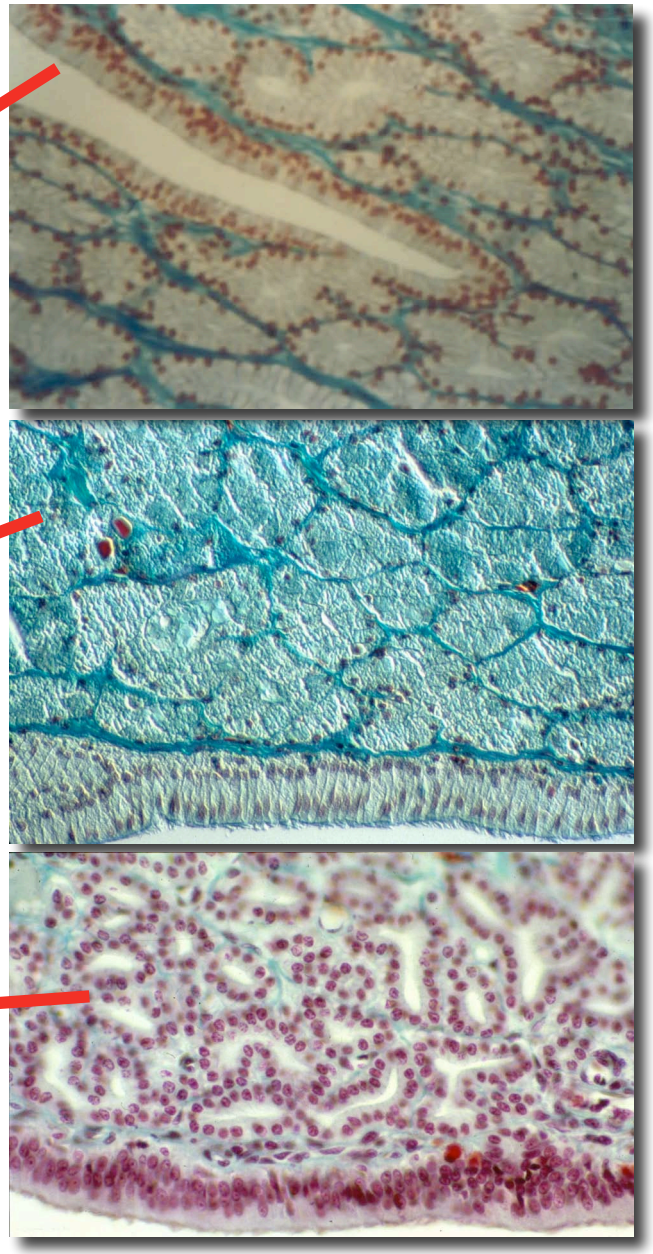
Egg shell fibers (lizard)



Egg shell calcium (lizard)

Evolution of Archosaurian Egg





Albumen

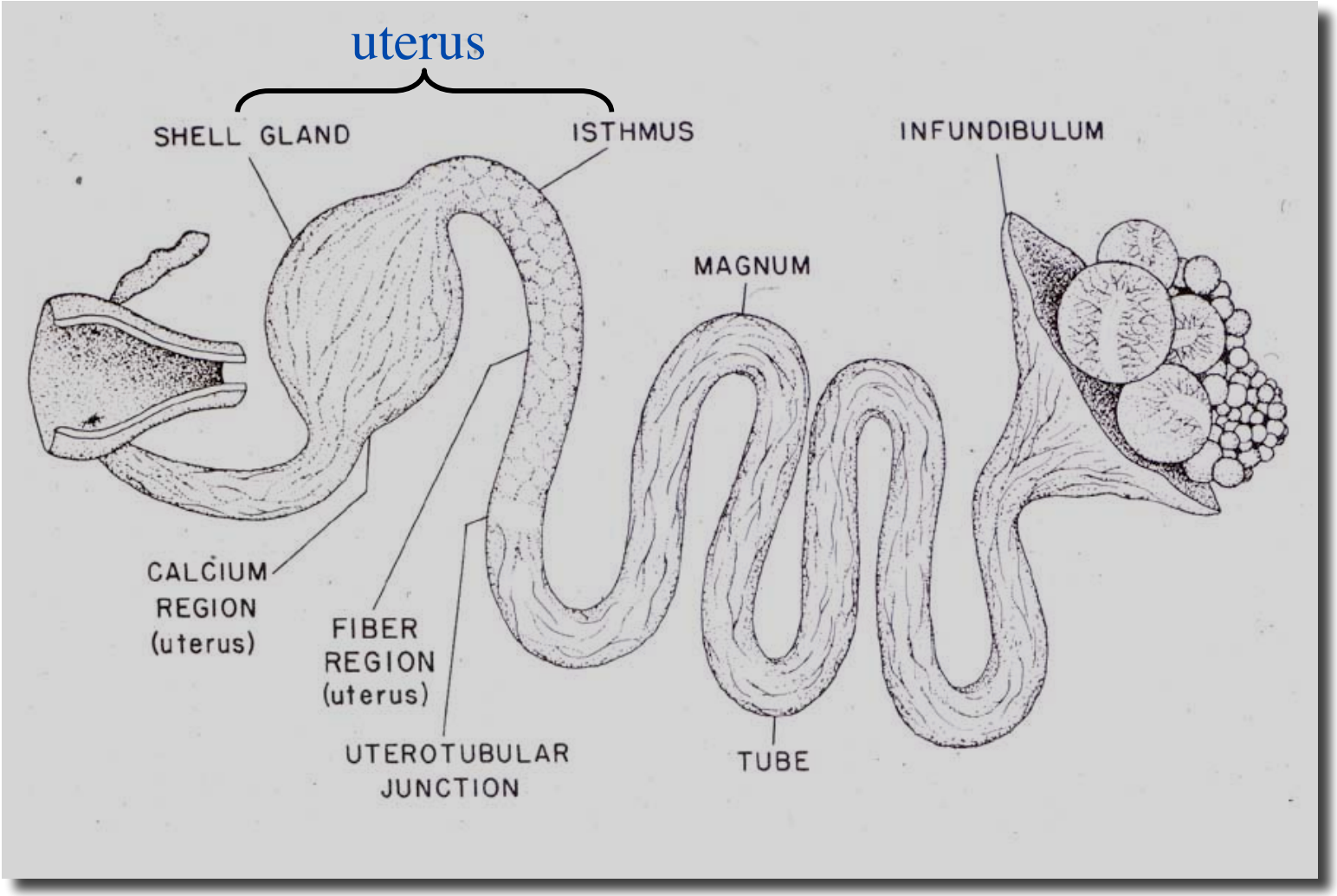
Fibers

Calcium

Birds

- Most birds have a single (left) oviduct
- Ovulate a single egg at a time
- Most shell egg and lay it within 24 hrs
- These characteristics have been argued as adaptations to flight

Reproductive Tract - Bird



Non Eutherian Mammals

- Albumen reduced in most
- Have shell consisting of protein fibers
- Both derived from oviduct
- Monotremes = born covered by shell
- Marsupials = usually break free at birth

Non Eutherian Mammals

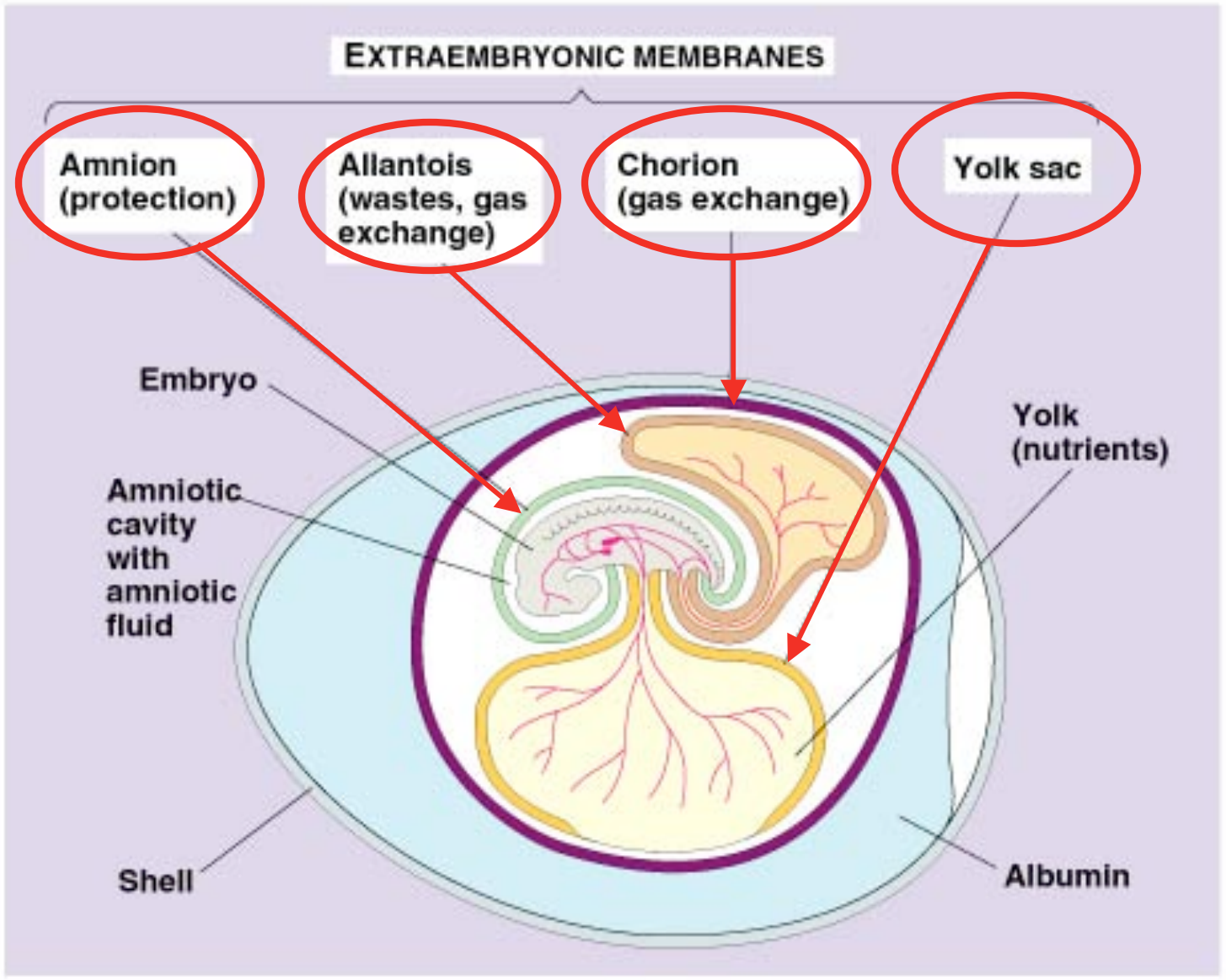
- Monotremes
  - 2º accessory envelope, luteotropic layer, as supplemental nutrient source
  - Released from oviduct within shelled eggs
- Marsupials
  - Inner mucopolysaccharide layer
  - Middle albumen layer
  - Outer keratinous layer
    - Typically ruptured during gestation or at birth

Extraembryonic Membranes

- Found in amniotes

- Evolve with reptilian 'land' egg
  - the amniote egg

- 4 distinct membranes
  - yolk sac
  - amnion
  - allantois
  - chorion



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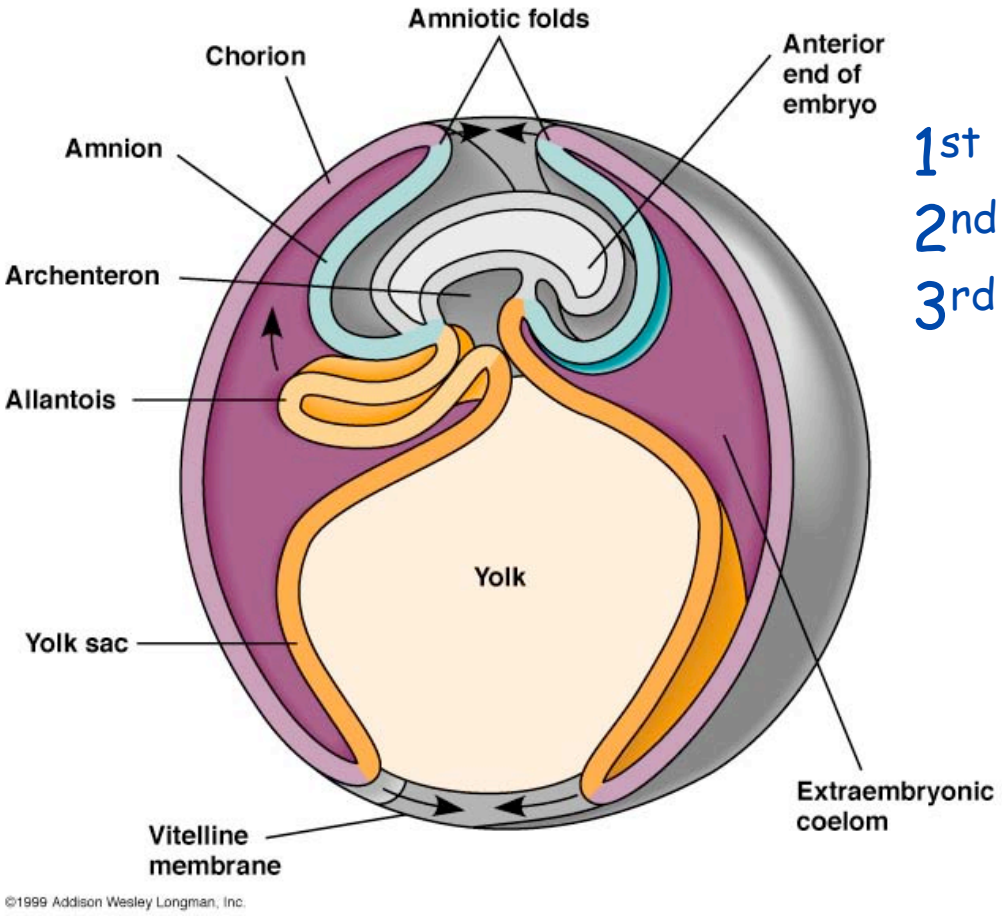
Development of membranes

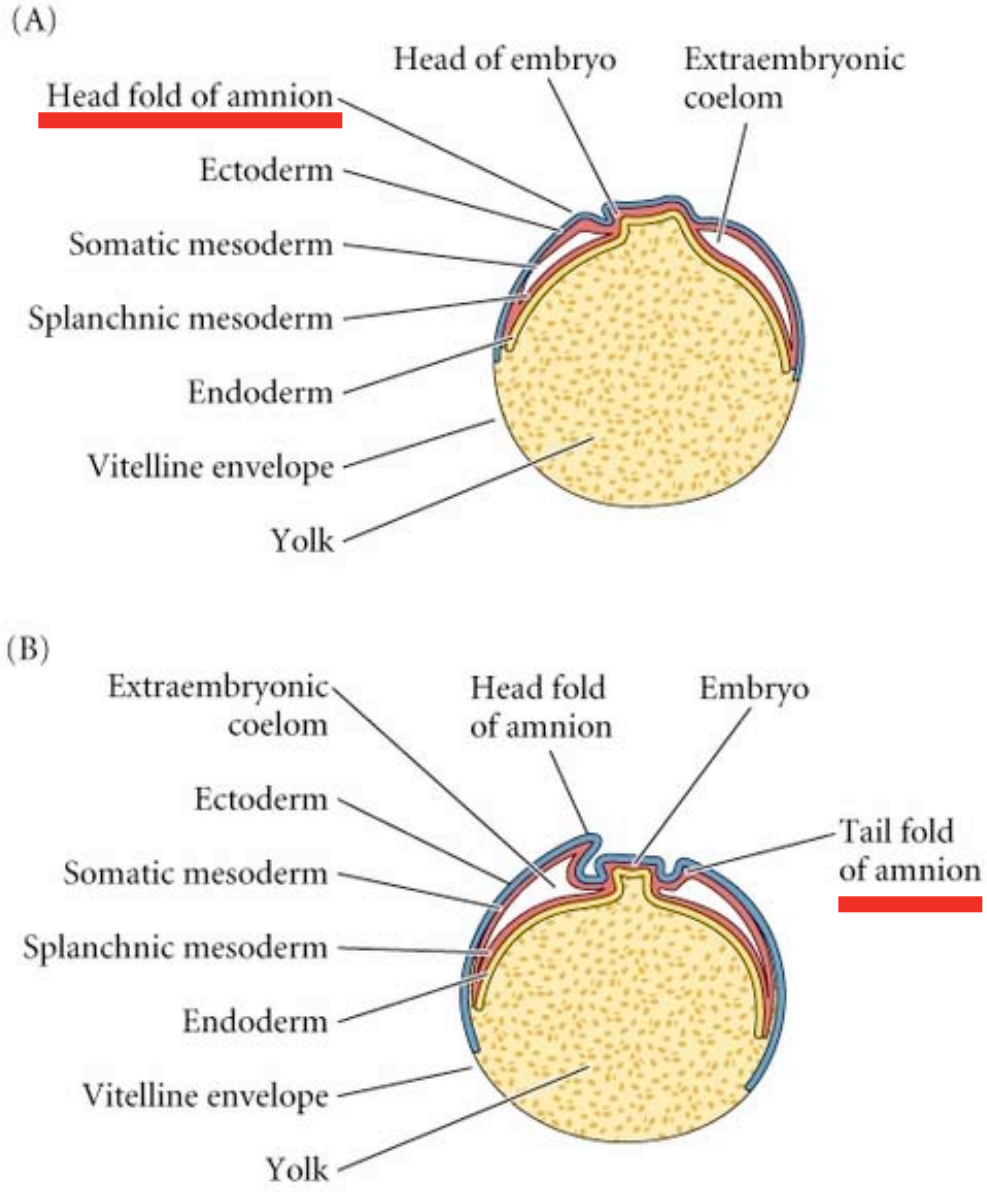
- Initially - no distinction between embryonic and extraembryonic

- As body forms, border epithelia form folds - BODY FOLDS
  - surround embryo and isolate it from yolk



1st - head fold
2nd - lateral folds both sides
3rd - tail fold undercuts tail

folds create composite membranes



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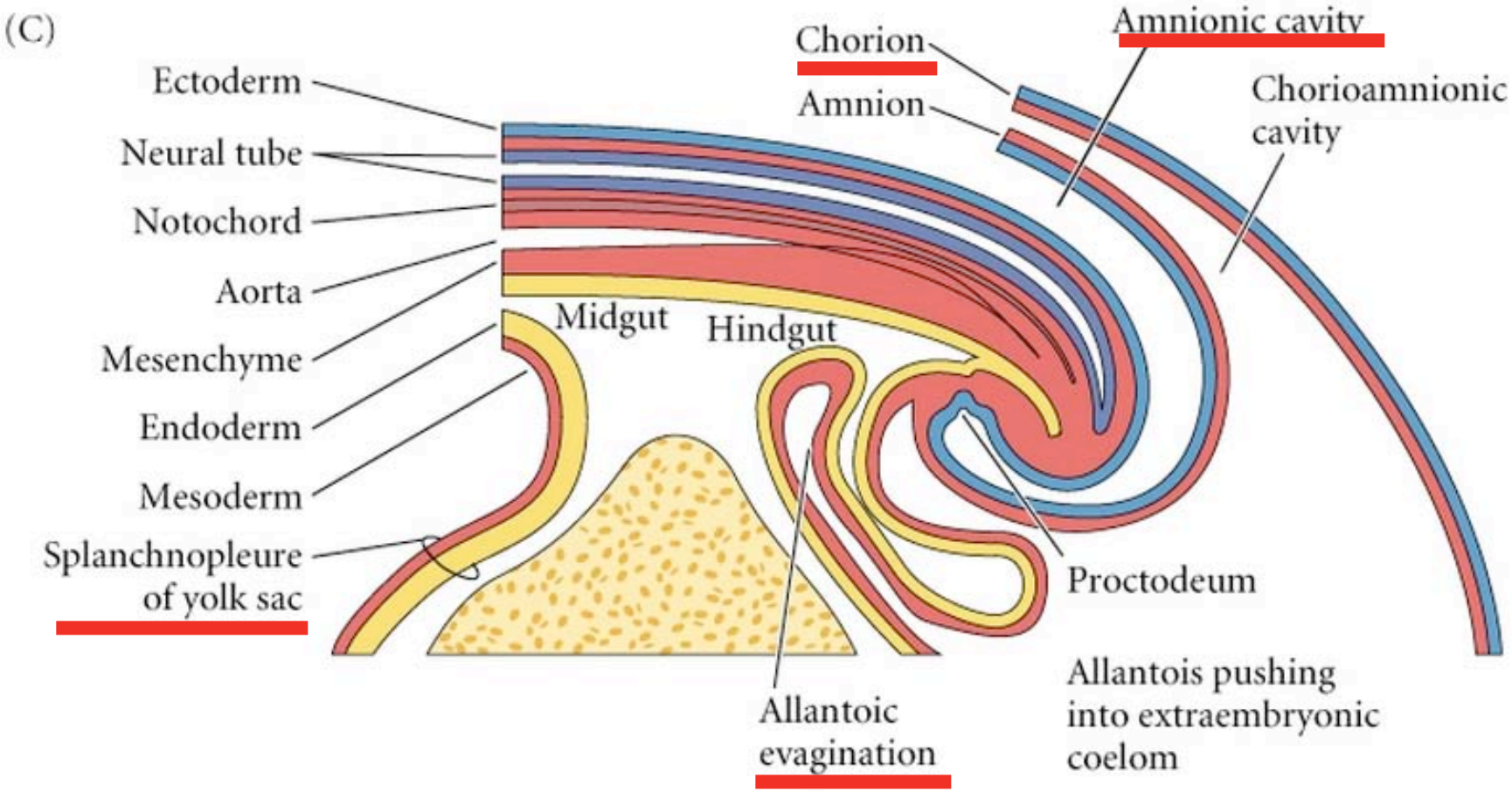

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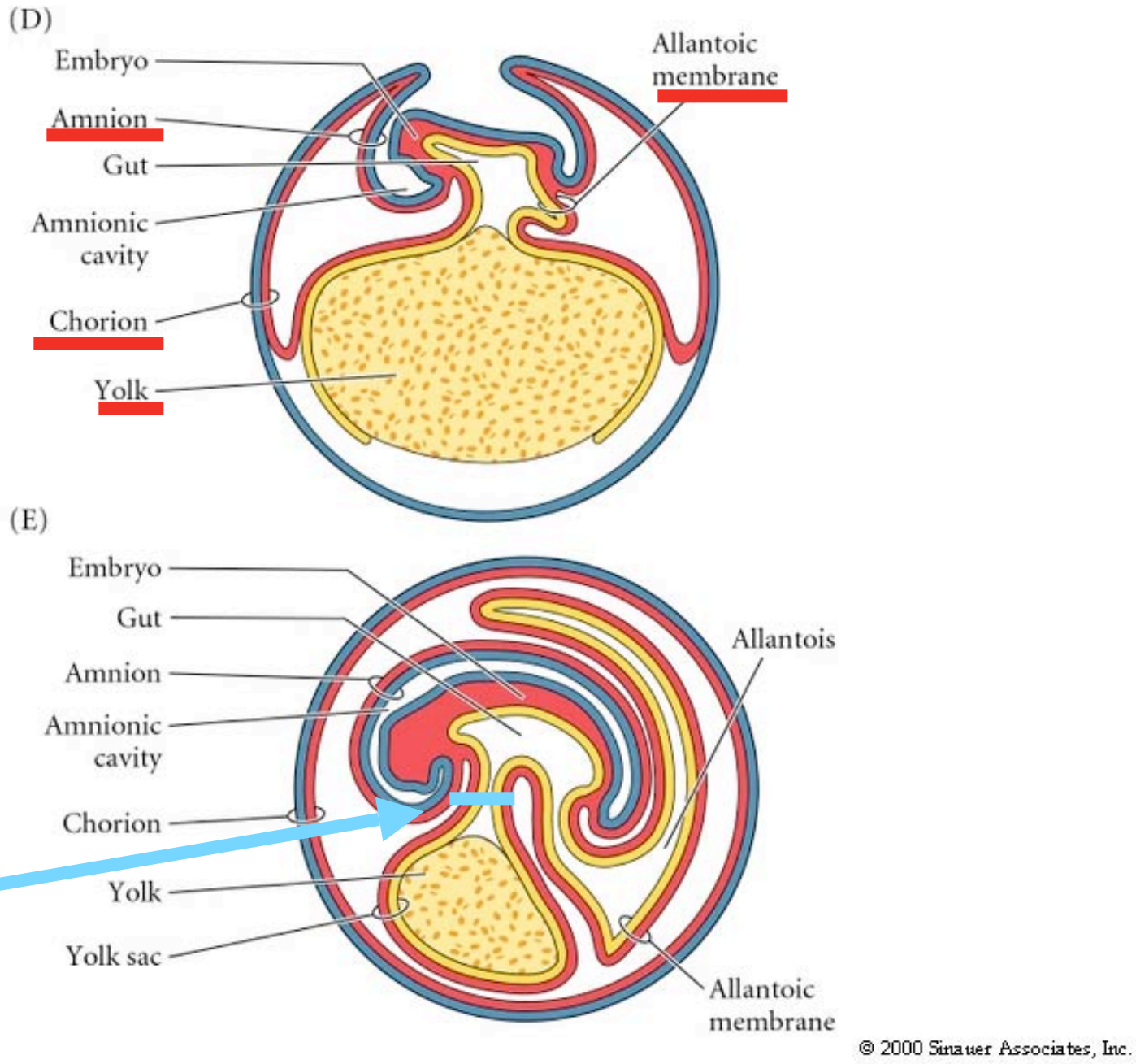
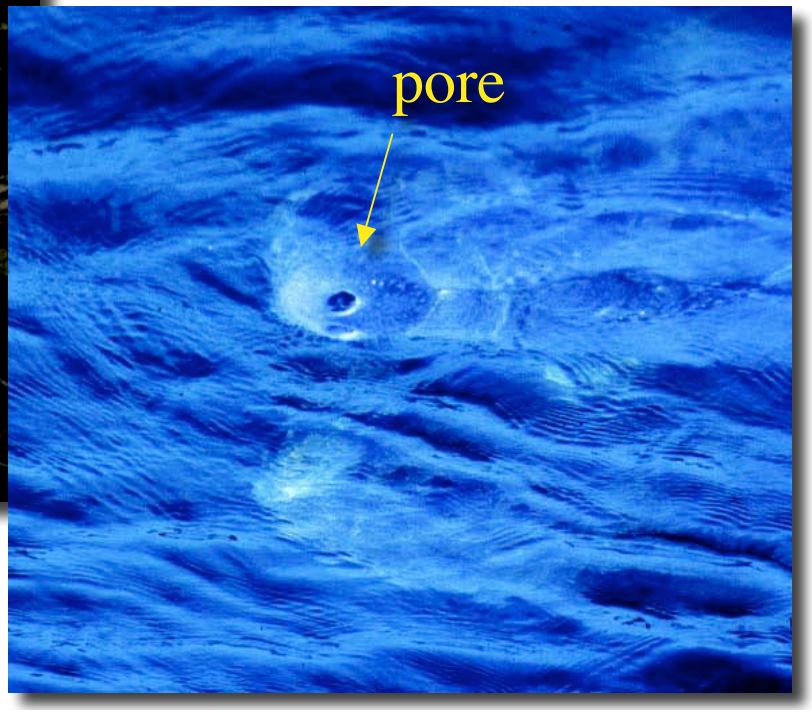


Becomes umbilical cord

'Land' Egg

Problem = desiccation

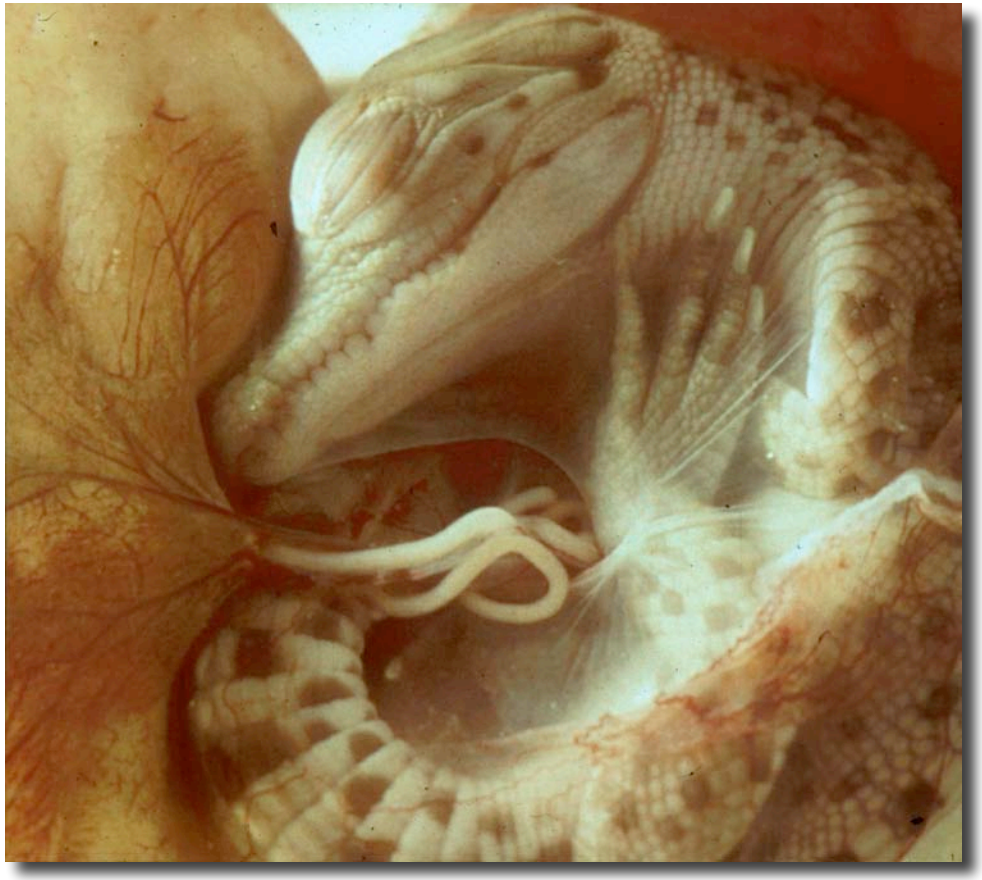


Amnion = water

- Formation of amnion provides aqueous environment
- Cells of amnion secrete and absorb water
- Formation occurs with formation of chorion

Chorioallantois = Gas Exchange

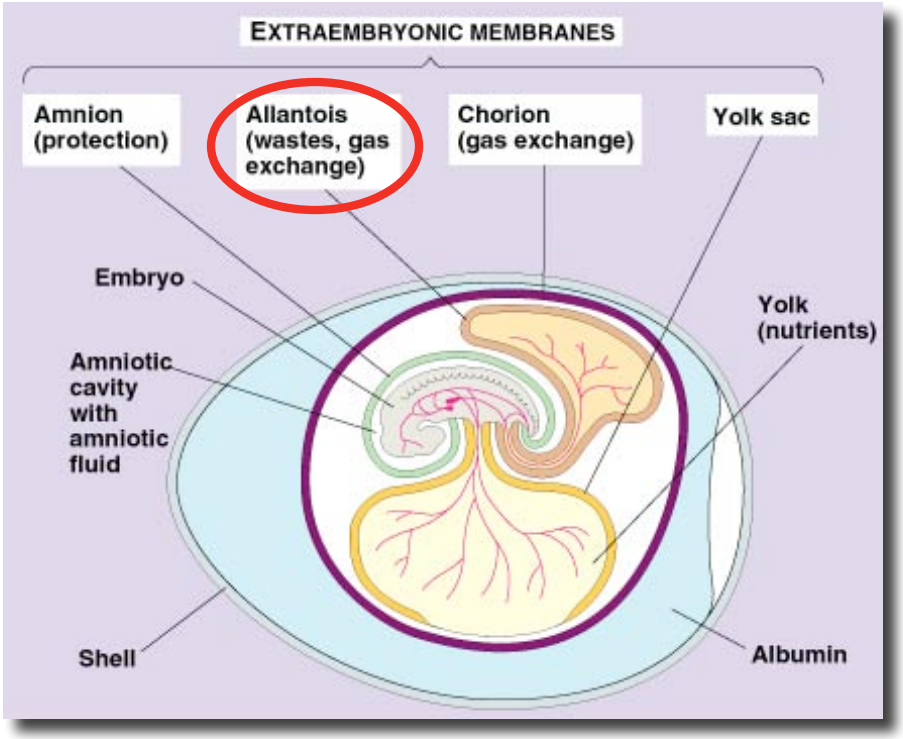
- Second problem - gas exchange
- Chorioallantoic membrane with shell to maximize gas exchange



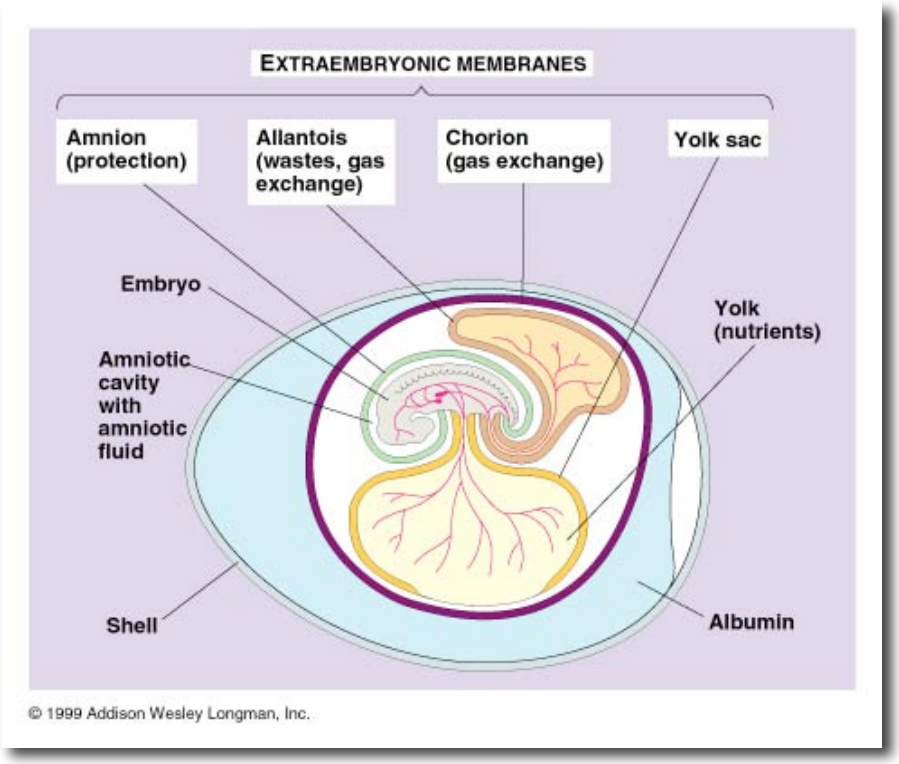
Allantois = waste removal

- 3rd problem
  - store or remove waste

- Reptiles and birds store
  - allantois stores waste
  - Forms as evagination of hindgut
  - attached to hindgut via allantoic stalk
    - highly vascularized and lies next to yolk stalk



Yolk Sac



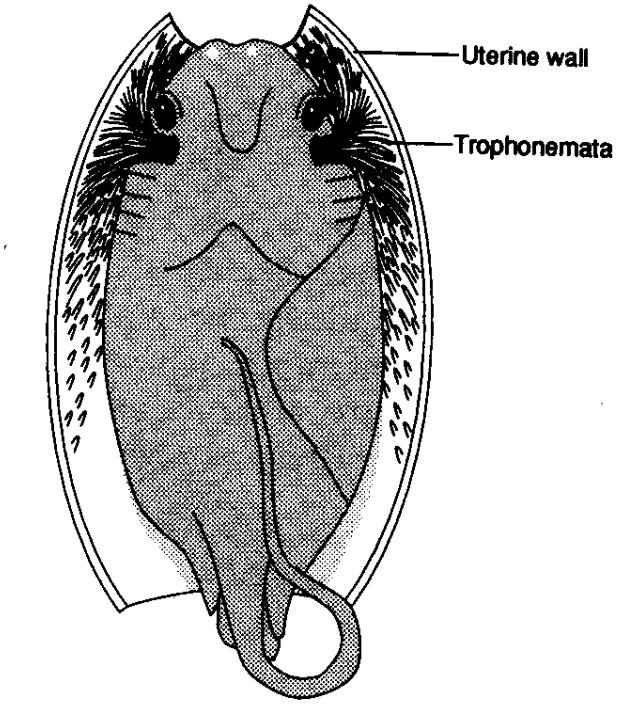
- 1st extra embryonic membrane to form
- mediates nutrition
- derived from endodermal cells that grow over yolk to enclose it

Other Extraembryonic Membranes

- Anamniotes also have 'extraembryonic' membranes

External Gills

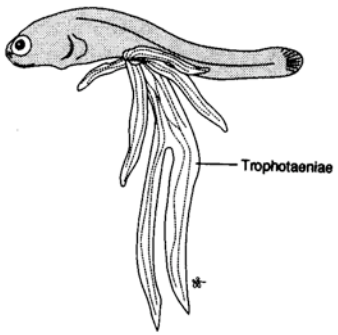
- Hypertrophy of gills for gas exchange during development
  - chondrichthyan fishes
  - gymnophione amphibians
  - salamanders



Integumental Modifications

- **Pericardial trophoderm**
  - highly vascular belly wall for nutrient and gas exchange

- Pericardial sac in teleost fish can form
  - pericardial amnion (pseudoamnion)
  - pericardial chorion (pseudochorion)



- Trophotaeniae - teleost fish
  - modifications of hindgut
  - functions in gas exchange and nutrient transfer