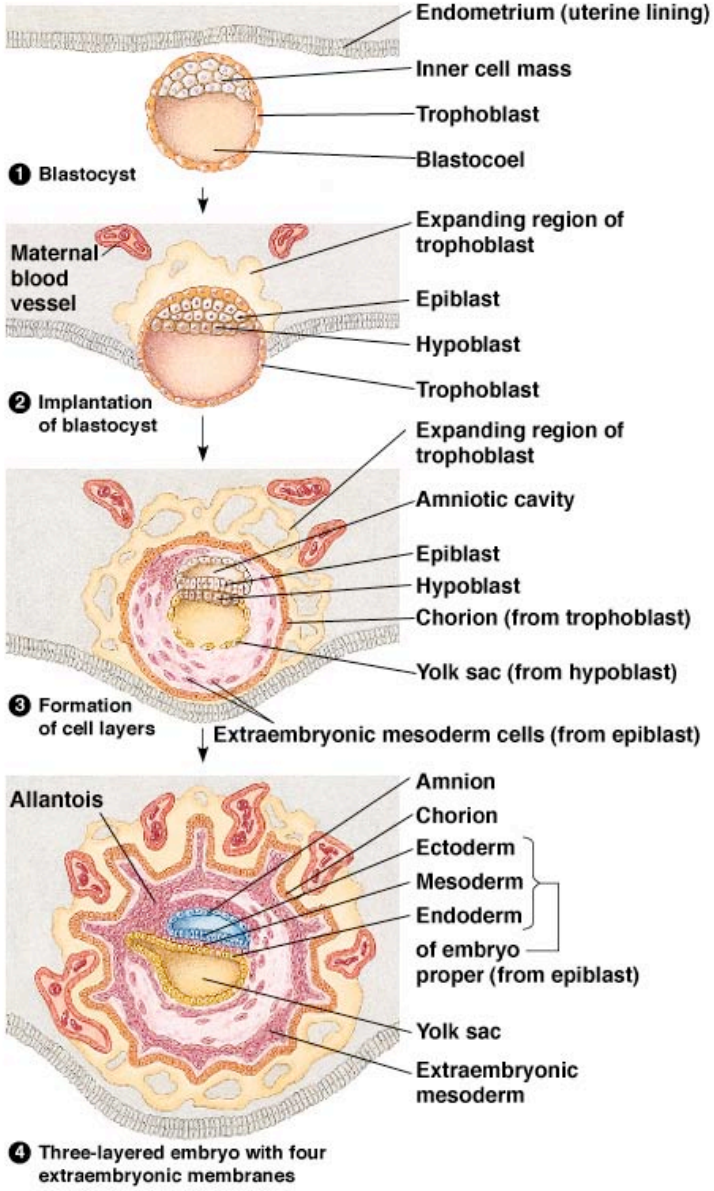
Placentation



The Evolution of Viviparity

still in the general biology textbooks……but wrong for amniotes

Oviparity

Egg retention

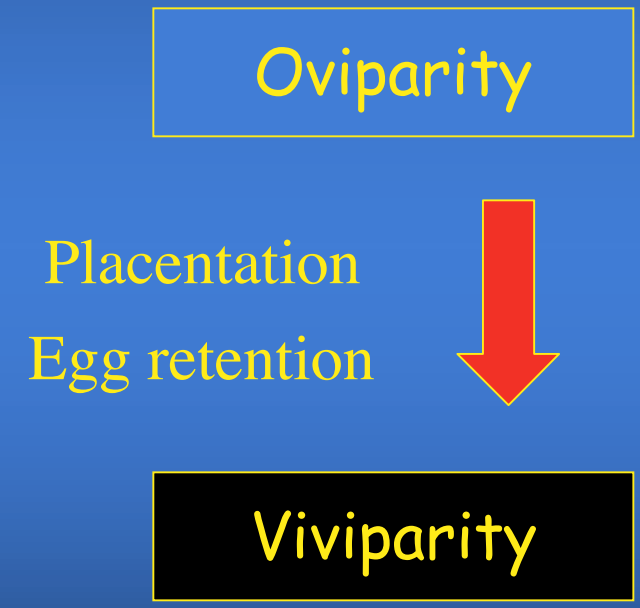
Ovoviviparity

Placentation

Viviparity

The Evolution of Amniote Viviparity

- Not a two step process
- No stage called ovoviviparity
- Placenta formed early

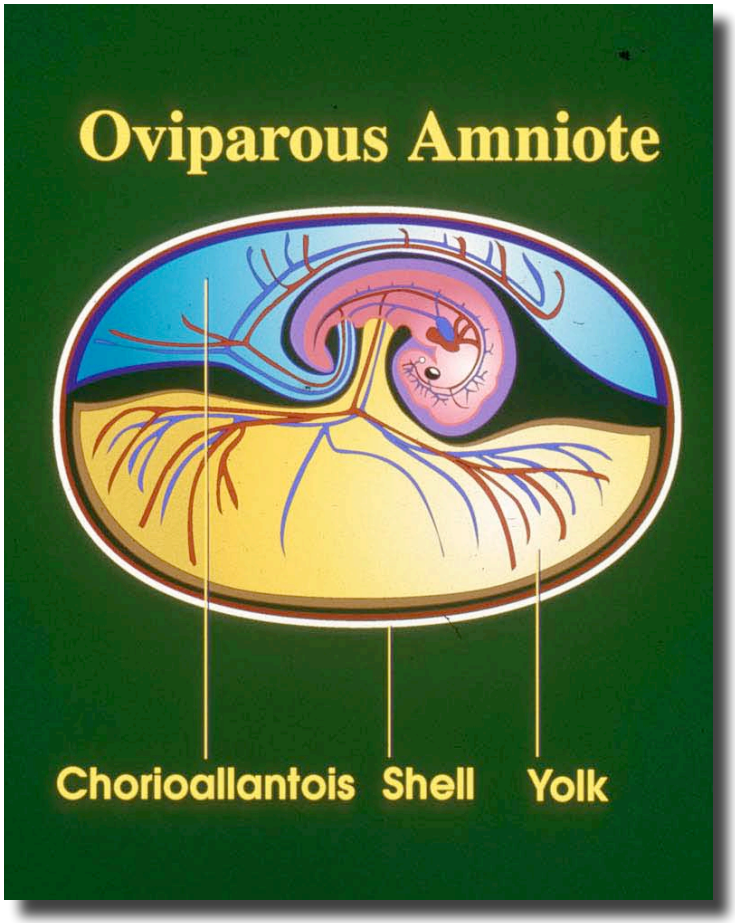


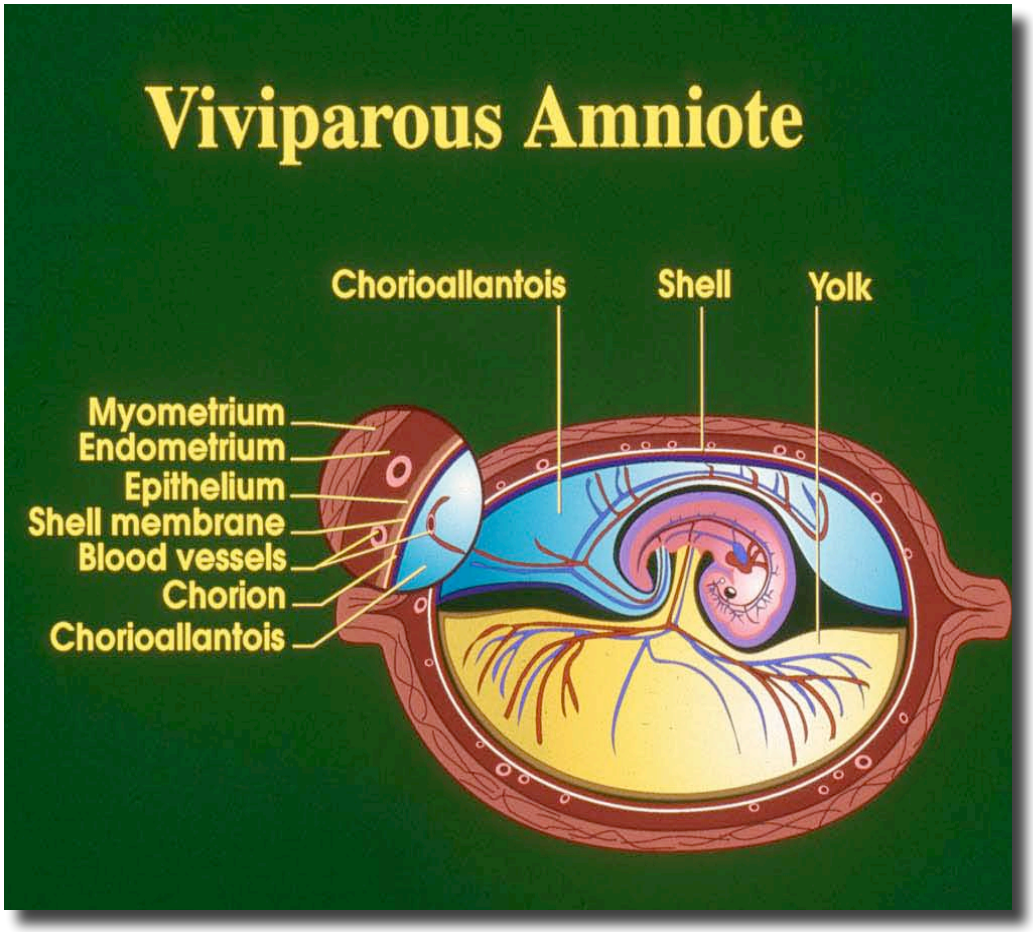
What is a placenta?

- "Structural modification of the maternal organism and/or embryo that facilitates exchange between them"
- Addresses needs of developing embryo:
  - Gas exchange
  - Waste exchange
  - Nutrients

Why a placenta?

- Oviparous species
  - conduct gas / waste exchange
  - Obtain nutrients from yolk
- Viviparous species
  - Must 'communicate' with external environment via maternal tissues
  - Degree of maternal / embryo separation varies across taxa
  - Evolved independently numerous times


Oviparous Amniote
Chorioallantois
Shell
Yolk


Viviparous Amniote
Chorioallantois
Shell
Yolk
Myometrium
Endometrium
Epithelium
Shell membrane
Blood vessels
Chorion
Chorioallantois

Embryo Retention

Advantages

- Predator avoidance
- Maternal homeostasis
- Precociality
- Distribute cost of reproduction
- Colonization of new habitats

Embryo Retention

Disadvantages

- Maternal susceptibility to predation
- Reduced fecundity (brood size)
- Maternal requirements increased / offspring
- Reduced # of reproductive opportunities

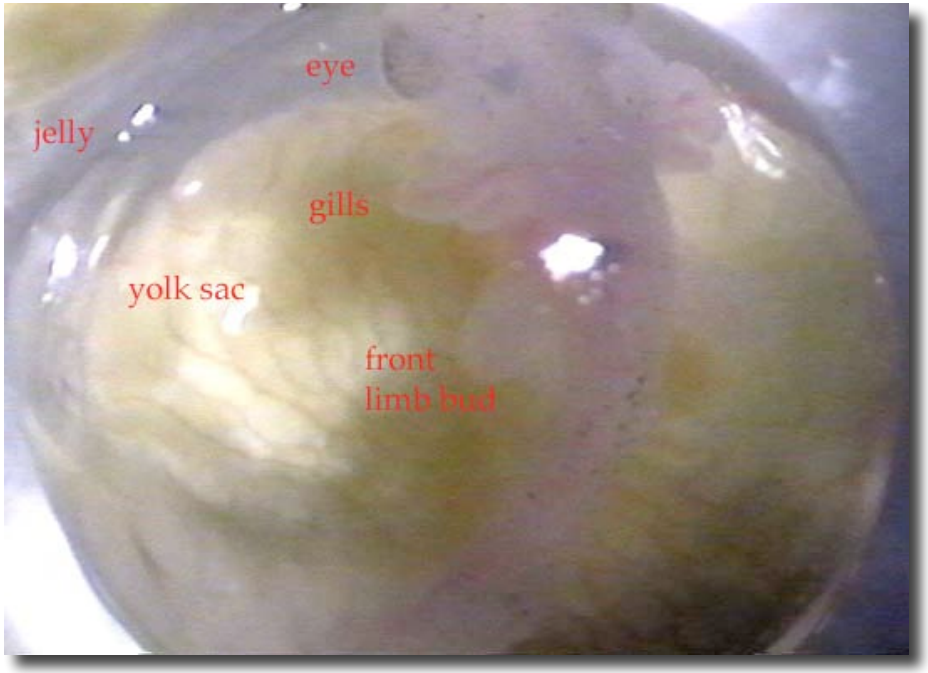
Embryonic Nutrition

- Lecithotrophy – embryo relies on endogenous yolk reserves;
  - Uptake of acellular yolk by inner yolk sac surfaces
    - (e.g., sharks, gymnophiones, reptiles, birds)
  - Uptake of acellular yolk by gut
    - (e.g., sharks)

http://courses.washington.edu/chordate/453photos/urogenital_photos/shark_urogenital_photos.htm

Embryonic Nutrition

- Lecithotrophy – embryo relies on endogenous yolk reserves;
  - Breakdown of cellular yolk and direct uptake by blood vessels
    - (anurans, urodeles)



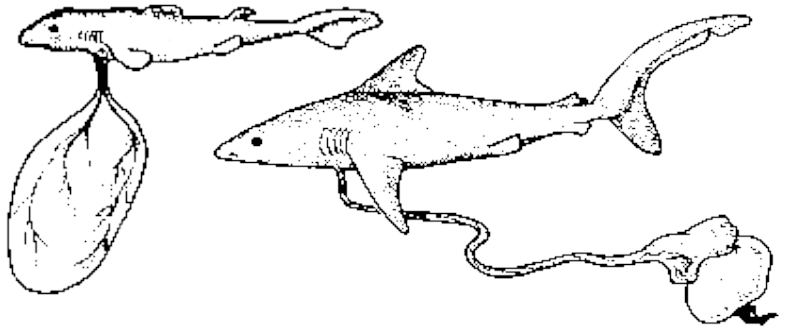
http://academic.reed.edu/biology/professors/sblack/research-salamander.html

Embryonic Nutrition

- Matrotrophy – nutrients provided by maternal organism as needed
  - Enteric
    - Imbibement of maternal secretions
    - Intrauterine cannibalism
    - Hindgut uptake
  - Integumental
    - Uptake by body surfaces
    - Uptake by extra-embryonic membranes

Lecithotrophy vs. Matrotrophy

- Most ovulparous and zygoparous species are lecithotrophic
- Most embryoparous species are matrotrophic
- Exceptions
  - Lecithotropic: external brooding frogs
  - Matrotrophic: embryoparous sharks
- Determined by % change in embryo organic mass
  - 20-40% loss of organic mass in lecithotrophic



Enteric Exchange

- Uterine secretions – histotroph or uterine milk
- Trophonemata – uterine extensions
- Trophotaeniae – hypertrophy of intestinal lining
- Oophagy, Embryophagy & Uterophagy
  - Some sharks, teleosts, and urodeles

Stingray embyro, with yolk stalk (st) and yolk sac (ys) still attached, resides in the uterus (ut) adorned with secretory trophonemata (t). From Hamlett et al. 1993.

www.viviparos.com/Galeria/A%20splendens.htm

From Hamlett 1993. Environ. Biol. Fishes 38: 253-267.

Integumental Exchange

- Dermatrophy involves hypertrophy of epithelial surfaces
  - Fins, gills, pericardial sac
  - Some sharks, teleosts, & amphibians

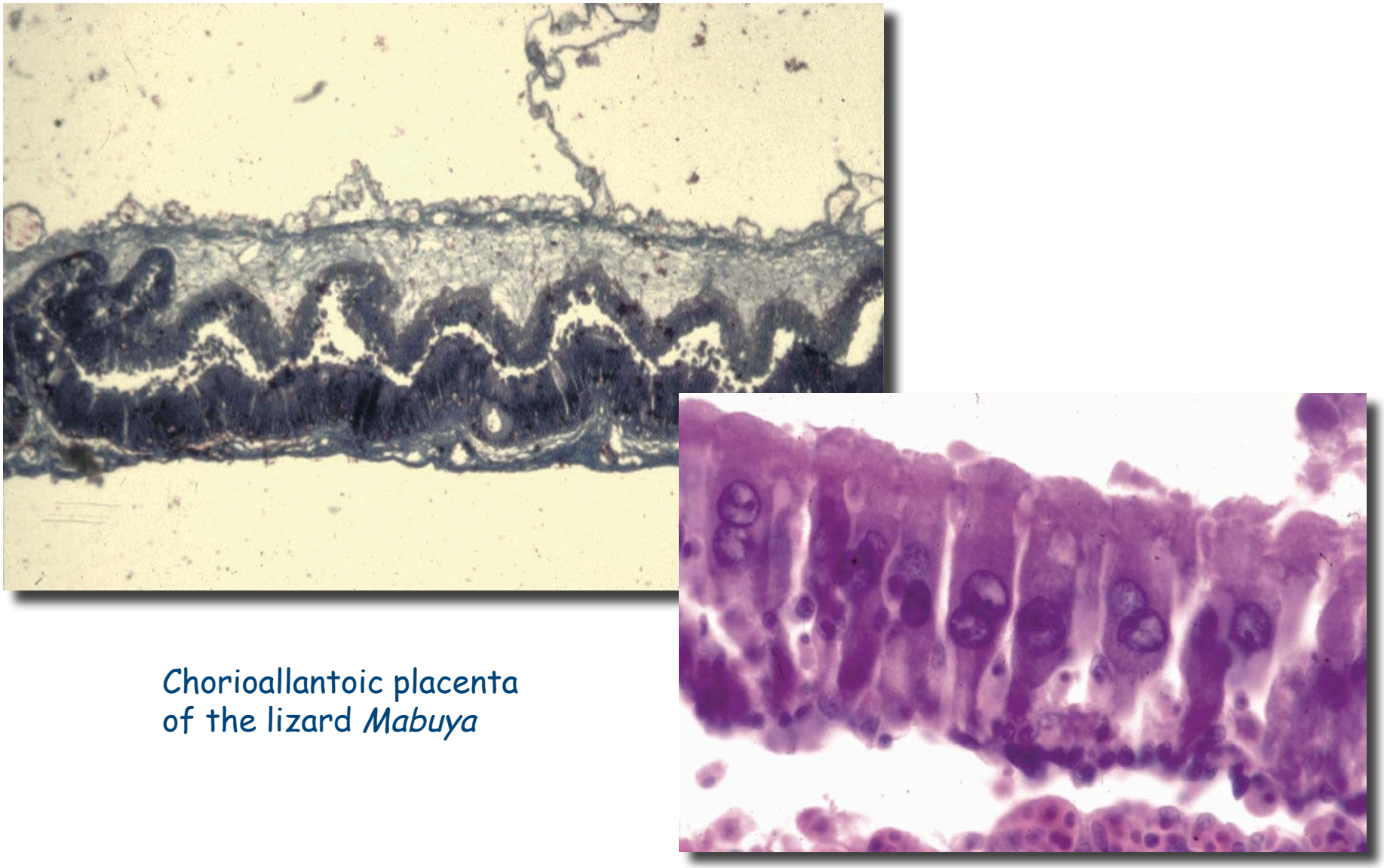
Reptilian Placentation

- Choriovitelline –
  - ectoderm, vascular mesoderm & yolk sac endoderm; transitory
- Omphaloplacenta –
  - bilaminar layer of ectoderm & yolk sac endoderm; some squamates
- Omphalallantoic –
  - omphalopleure associated with expanding allantois; snakes

Reptilian Placentation

- Chorioallantoic –
  - fusion of allantoic mesoderm & extraembryonic somatopleure (ectoderm & mesoderm of the chorion)
  - Highly vascularized
  - Used for
    - Gas exchange
    - Waster exchange
    - Steroid synthesis
    - Nutrient exchange
  - Considered homologous to mammalian placenta

Reptilian Chorioallantoic Placenta



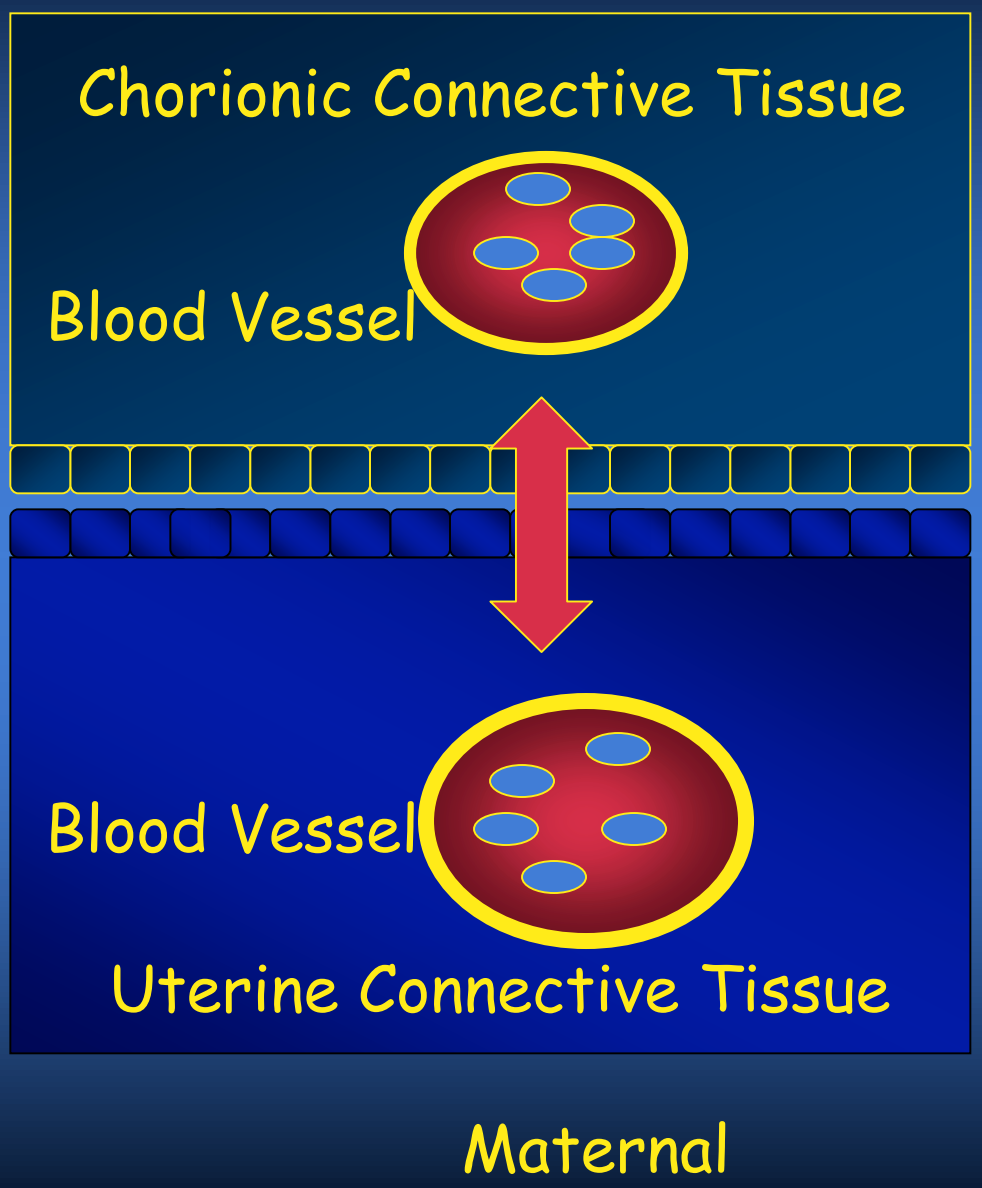
Chorioallantoic placenta
of the lizard *Mabuya*

Mammalian Placentation

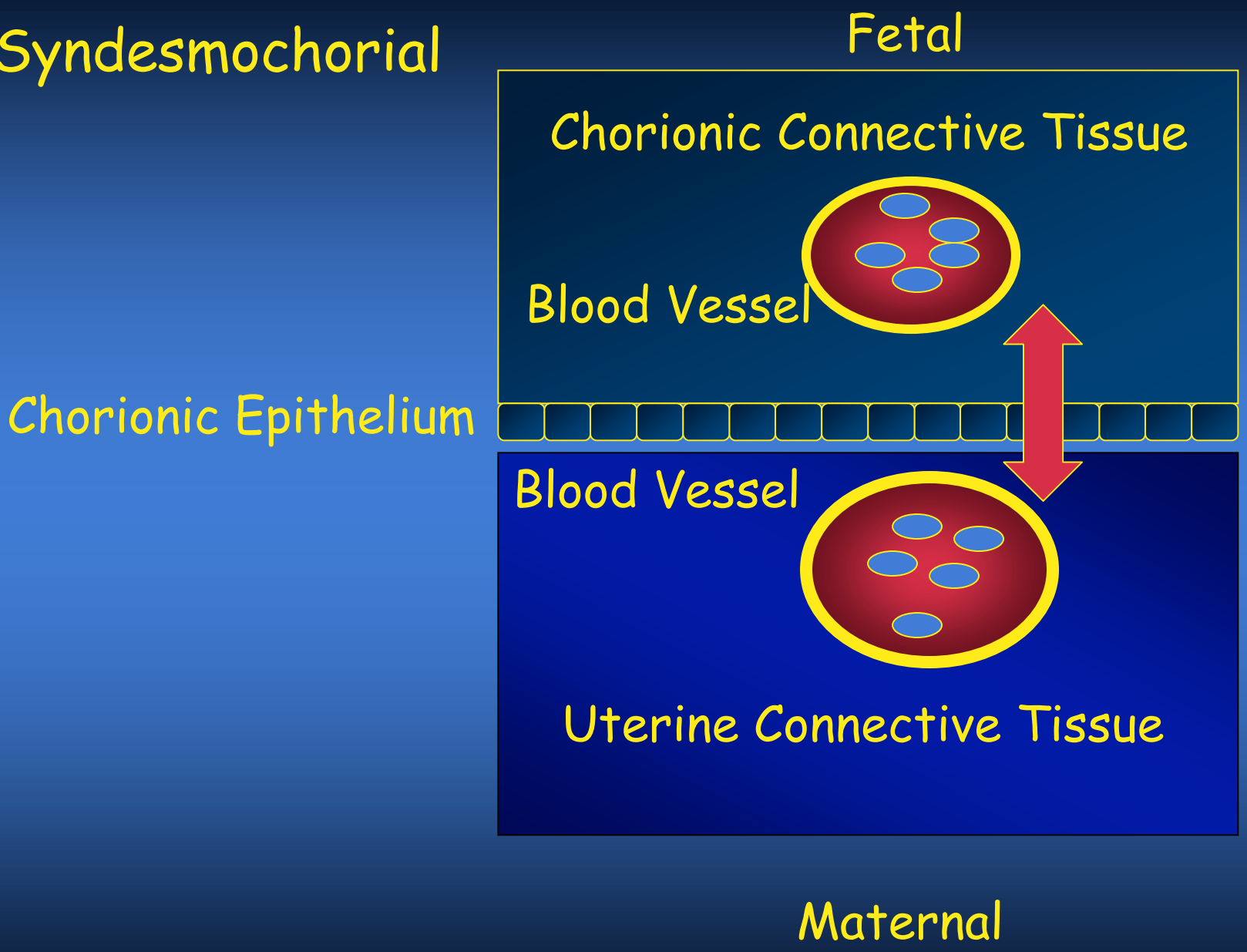
- Transitory placentae exist in most species
  - Yolk sac
  - Chorionic
  - Chorioamniotic
- Chorioallantoic – formed by chorion, allantois; some marsupials and all eutherians
- Chorioallantoamniotic – final placenta of artiodactyls, great apes, & humans

- Epithelialchorial

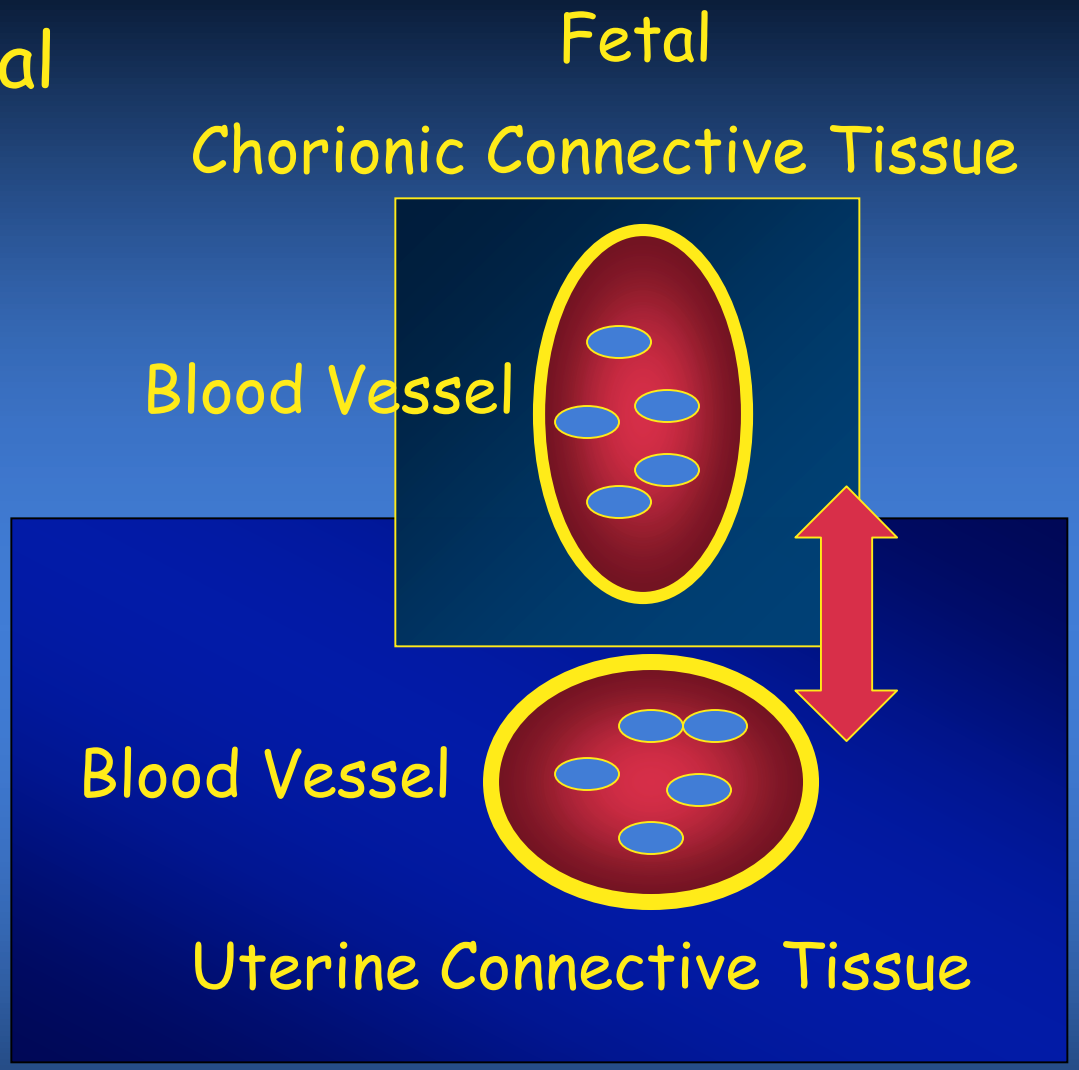
Chorionic Epithelium
Uterine Epithelium



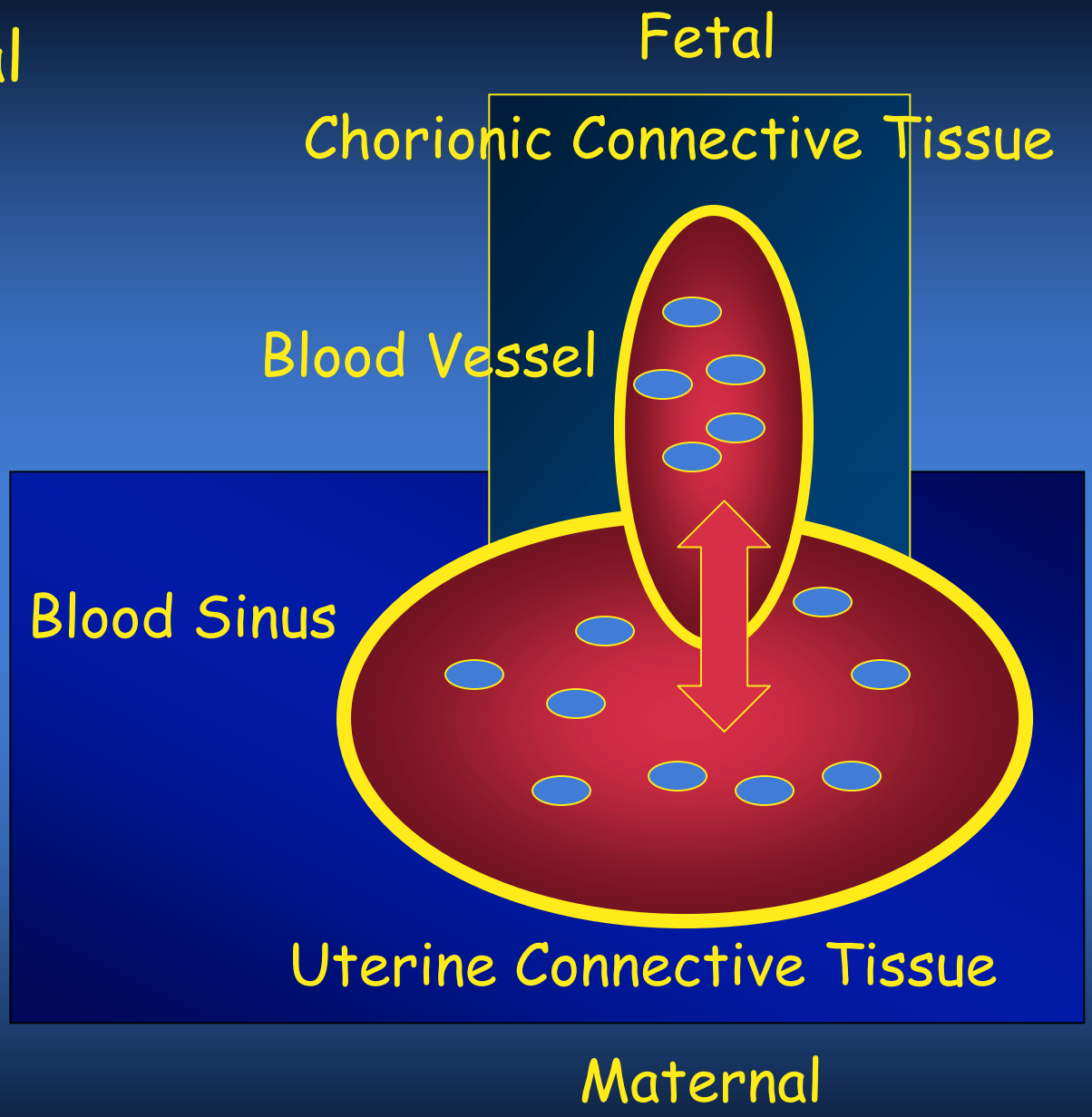
- Syndesmochorial

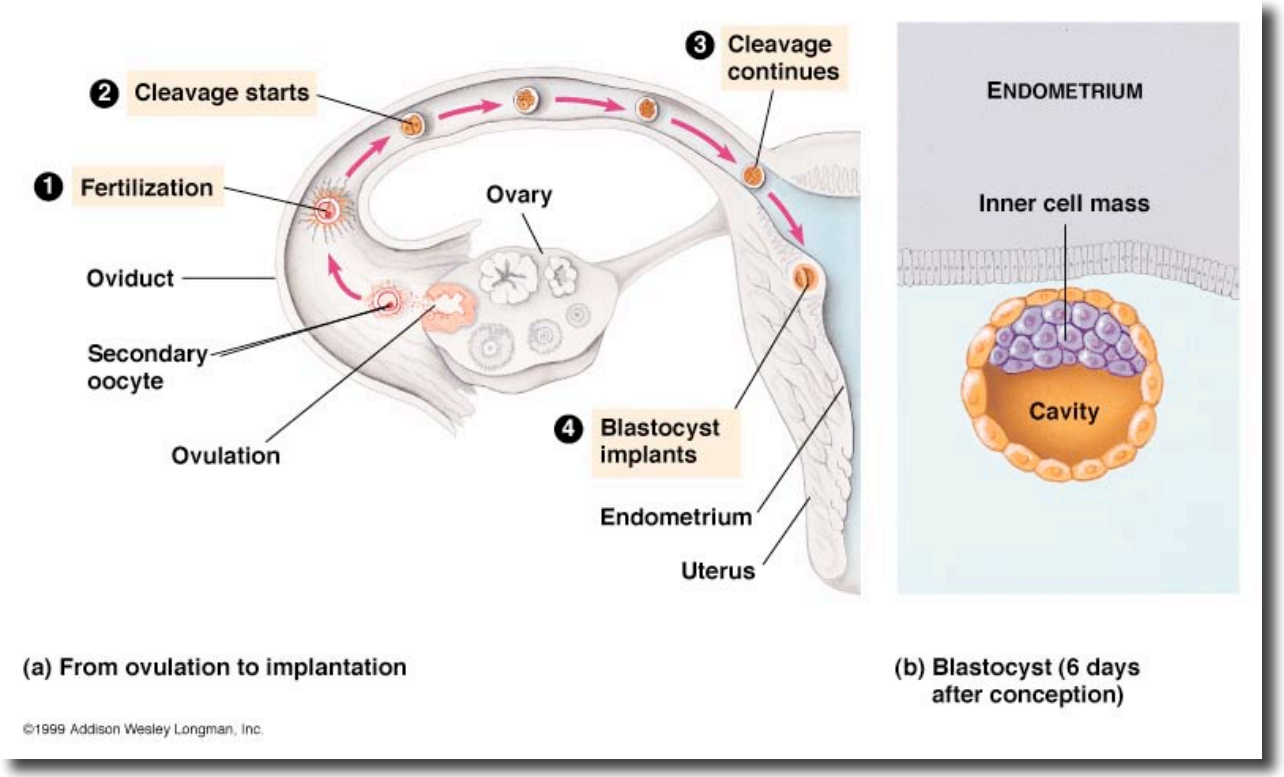


- Endotheliochorial



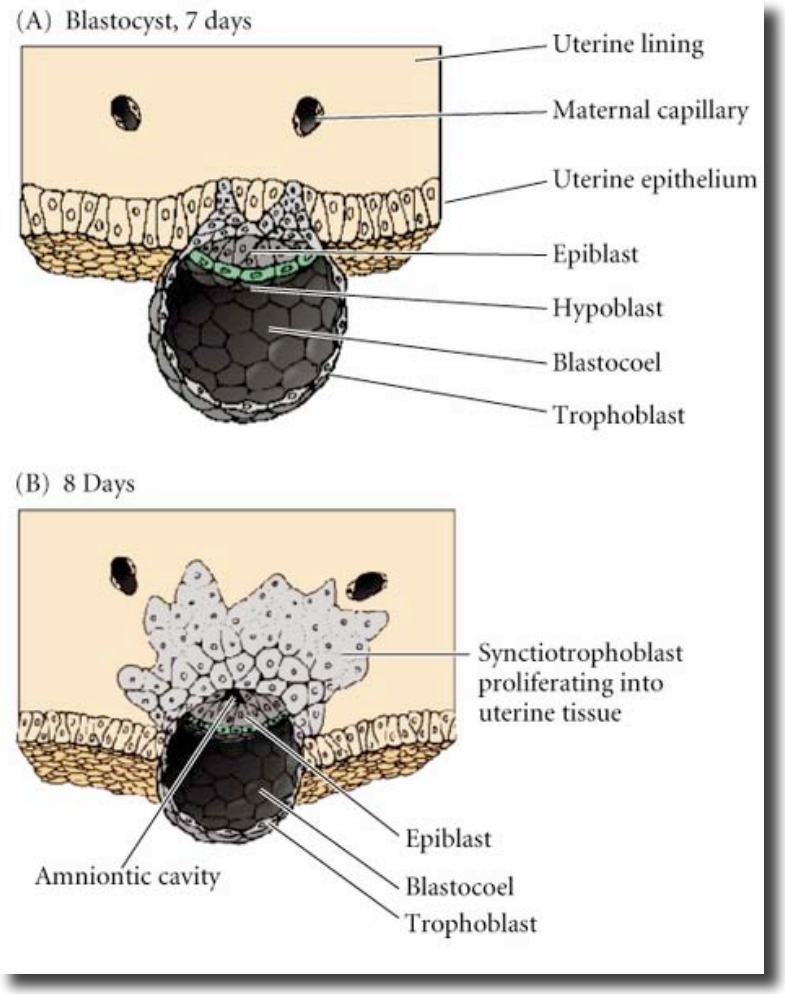
- Hemochorial

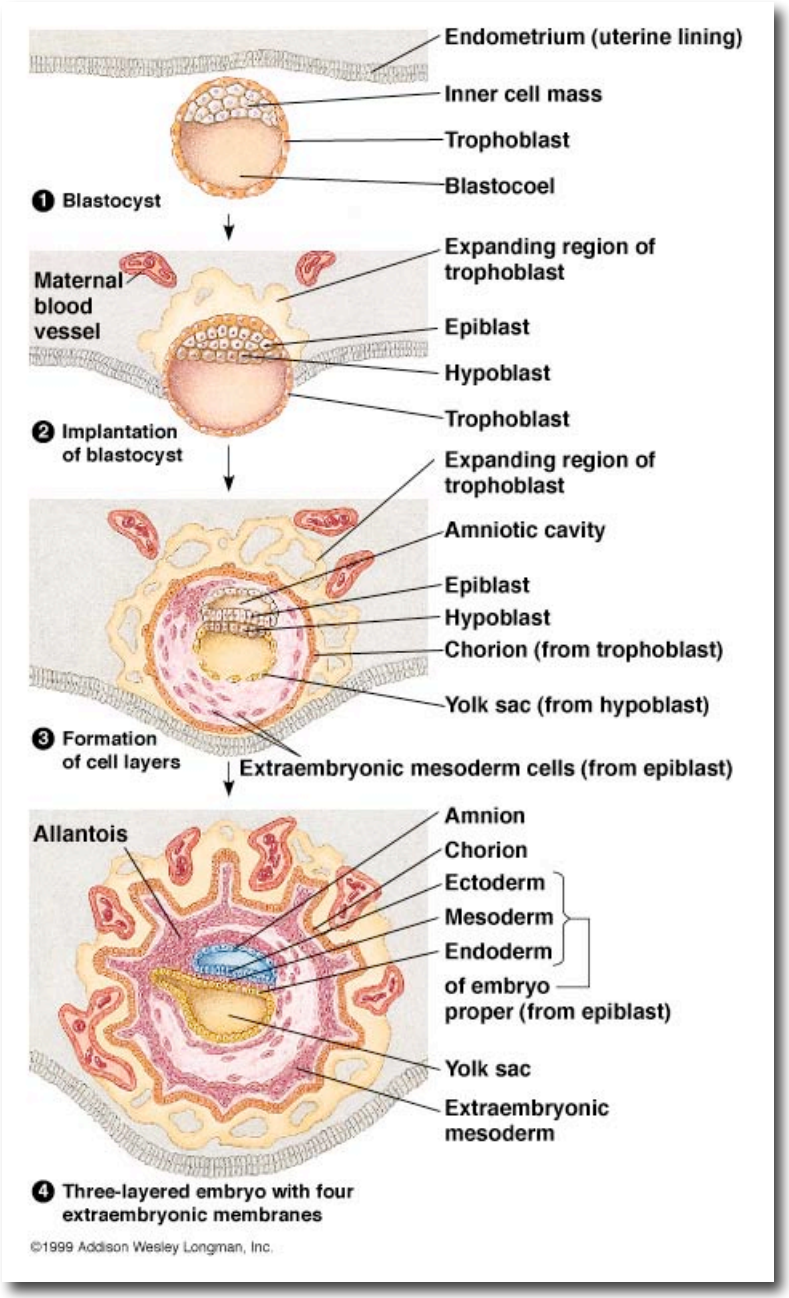




- Embryo travels down tube and enters uterus
- Embryo interacts with wall of uterus
  - -Implantation
  - -Maternal recognition of pregnancy

- Trophoblast
  - expands and forms placental tissues
  - 2 types
    - Cytotrophoblast
    - Syncytiotrophoblast
  - Cyto - main region of the placenta
  - Syncytio- invasive tissue
- Uterine Response
  - Decidualization
  - Inflammation response - endometrium overgrows embryo

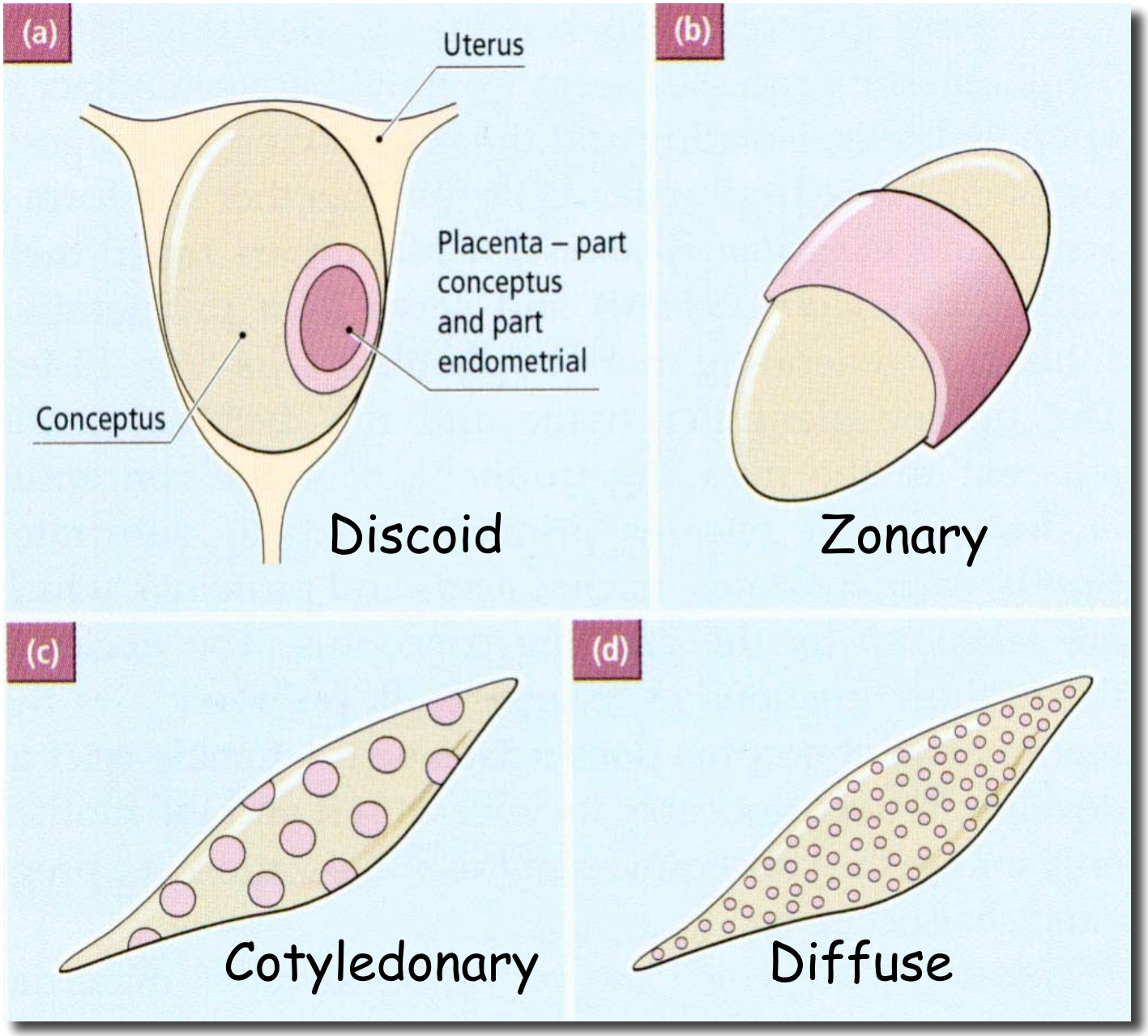




- Inflammation response
  - endometrium overgrows embryo
  - decidualization

Placental Shapes

- Diffuse
  - Horses, camels, pigs, dolphins, whales
- Zonary
  - Carnivores (raccoon, dog, cat)
- Cotyledonary (placentomes)
  - Cows, sheep
- Discoid
  - Primates, rodents, rabbits, insectivores


(a)
Uterus
Placenta – part conceptus and part endometrial
Conceptus
Discoid
(b)
Zonary
(c)
Cotyledonary
(d)
Diffuse

Human Hemochorial