4. Gastrulation rearranges the blastula to form a three-layered embryo with a primitive gut
5. In organogenesis, the organs of the animal body form from the three embryonic germ layers
6. Amniote embryos develop in a fluid-filled sac within a shell or uterus
4. Gastrulation rearranges the blastula to form a three-layered embryo with a primitive gut

- **Gastrulation** rearranges the embryo into a triploblastic **gastrula**.
  - The embryonic germ layers are the **ectoderm, mesoderm**, and **endoderm**.
• Sea urchin gastrulation.
  • Begins at the vegetal pole where individual cells enter the blastocoel as mesenchyme cells.
    • The remaining cells flatten and buckle inwards: invagination.
      • Cells rearrange to form the archenteron.
        • The open end, the blastopore, will become the anus.
        • An opening at the other end of the archenteron will form the mouth of the digestive tube.
Fig. 47.9
• Frog gastrulation produces a triploblastic embryo with an archenteron.

• Where the gray crescent was located, invagination forms the **dorsal lip** of the blastopore.

• Cells on the dorsal surface roll over the edge of the dorsal lip and into the interior of the embryo: **involution**.

• As the process is completed the lip of the blastopore encircles a **yolk plug**.
5. In organogenesis, the organs of the animal body form from the three embryonic germ layers

- The derivatives of the ectoderm germ layer are:
  - Epidermis of skin, and its derivatives
  - Epithelial lining of the mouth and rectum.
  - Cornea and lens of the eyes.
  - The nervous system; adrenal medulla; tooth enamel; epithelium of the pineal and pituitary glands.
• The endoderm germ layer contributes to:
  • The epithelial lining of the digestive tract (except the mouth and rectum).
  • The epithelial lining of the respiratory system.
  • The pancreas; thyroid; parathyroids; thymus; the lining of the urethra, urinary bladder, and reproductive systems.
• Derivatives of the mesoderm germ layer are:
  • The notochord.
  • The skeletal and muscular systems.
  • The circulatory and lymphatic systems.
  • The excretory system.
  • The reproductive system (except germ cells).
  • And the dermis of skin; lining of the body cavity; and adrenal cortex.
Fig. 47.11

(a) A cross section of a frog embryo at the beginning of organogenesis

(b) Formation of the neural tube from the neural plate.

(c) Somites

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6. Amniote embryos develop in a fluid-filled sac within a shell or uterus

- The **amniote** embryo is the solution to reproduction in a dry environment.
  - Shelled eggs of reptiles and birds.
  - Uterus of placental mammals.
• Avian Development.

• Cleavage is meroblastic, or incomplete.

• Cell division is restricted to a small cap of cytoplasm at the animal pole.

• Produces a blastodisc, which becomes arranged into the epiblast and hypoblast that bound the blastocoel, the avian version of a blastula.
• During gastrulation some cells of the epiblast migrate (arrows) towards the interior of the embryo through the primitive streak.

• Some of these cells move laterally to form the mesoderm, while others move downward to form the endoderm.
• In early organogenesis the archenteron is formed as lateral folds pinch the embryo away from the yolk.

• The yolk stalk (formed mostly by hypoblast cells) will keep the embryo attached to the yolk.

• The notochord, neural tube, and somites form as they do in frogs.

• The three germ layers and hypoblast cells contribute to the extraembyonic membrane system.
• The four extraembryonic membranes are the yolk sac, amnion, chorion, and allantois.

• Cells of the yolk sac digest yolk providing nutrients to the embryo.

• The amnion encloses the embryo in a fluid-filled amniotic sac which protects the embryo from drying out.

• The chorion cushions the embryo against mechanical shocks.

• The allantois functions as a disposal sac for uric acid.
Fig. 47.14

- Amniotic folds
- Chorion
- Amnion
- Archenteron
- Allantois
- Yolk sac
- Yolk
- Vitelline membrane
- Extraembryonic coelom
- Anterior end of embryo
• Mammalian Development.

• Recall:
  
  • The egg and zygote do not exhibit any obvious polarity.
  
  • Holoblastic cleavage occurs in the zygote.

  • Gastrulation and organogenesis follows a pattern similar to that seen in birds and reptiles.
• Relatively slow cleavage produces equal sized blastomeres.
  
  • **Compaction** occurs at the eight-cell stage.
    
    • The result is cells that tightly adhere to one another.
• Step 1: about 7 days after fertilization.
  • The blastocyst reaches the uterus.
  • The **inner cell mass** is surrounded by the **trophoblast**.

Fig. 47.15 (1)
• Step 2: The trophoblast secretes enzymes that facilitate implantation of the blastocyst.

  • The trophoblast thickens, projecting into the surrounding endometrium; the inner cell mass forms the **epiblast** and **hypoblast**.

  • The embryo will develop almost entirely from the epiblast.

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Fig. 47.15 (2) and (3)
• Step 3: Extraembryonic membranes develop.
  • The trophoblast gives rise to the chorion, which continues to expand into the endometrium and the epiblast begins to form the amnion.
  • Mesodermal cells are derived from the epiblast.

Fig. 47.15 (2) and (3)
• Step 4:

• Gastrulation: inward movement of epiblast cells through a primitive streak form mesoderm and endoderm.
• Once again, the embryonic membranes – homologous with those of shelled eggs.

• **Chorion**: completely surrounds the embryo and other embryonic membranes.

• **Amnion**: encloses the embryo in a fluid-filled amniotic cavity.

• **Yolk sac**: found below the developing embryo.
  • Develops from the hypoblast.
  • Site of early formation of blood cells which later migrate to the embryo.

• **Allantois**: develops as an outpocketing of the embryo’s rudimentary gut.

• Incorporated into the umbilical cord, where it forms blood vessels.
• Organogenesis begins with the formation of the neural tube, notochord, and somites.