Organogenesis
Embryonic germ layer derivatives

- Ectoderm:
  - Epidermis: placodes, glands, scales, feathers, beak, hair, nails
  - Neural tube: central nervous system (brain, spinal cord), eyes, motor nerves
  - Neural crest: peripheral nervous system (sensory ganglia, nerves)
  - Extra-embryonic ectoderm: amnion

- Mesoderm:
  - Chordamesoderm: notochord
  - Head mesenchyme: facial connective tissue and skull
  - Paraxial mesoderm: somites (dermis, skeleton, limb muscles)
  - Intermediate mesoderm: urogenital system (kidneys, gonads)
  - Lateral plate mesoderm:
    - Somatic mesoderm:
      - parietal pleura
      - pericardium
      - parietal peritoneum
      - amnion
    - Splanchnic mesoderm: heart, blood, blood vessels, visceral pleura, visceral peritoneum, mesenteries, visceral connective tissue, gonad stroma, yolk sac mesoderm

- Endoderm:
  - Primitive gut
  - Extra-embryonic endoderm: endoderm of yolk sac
  - Allantois
  - Endoderm:
    - Original of all the organs can be traced back to the germ layers.
Differentiation of neural tube
1 = telencephalon
2 = diencephalon
3 = mesencephalon
4 = metencephalon
5 = myelencephalon
6 = spinal cord
7 = cranial intestinal portal
8 = heart
9 = vitelline artery
10 = somite
Divisions of the Brain

• Telencephalon
  • Cerebrum
  • Olfactory lobes (smell)

• Diencephalon
  • Optic cups (eyes)
  • Thalamus and hypothalamus
  • Infundibulum (posterior pituitary)
    • Anterior pituitary forms from ectodermal tissue (Rathke’s pouch)

• Metencephalon
  • Cerebellum and pons

• Myelencephalon
  • Medulla
Peripheral nerves

• Cranial nerves
  • Exit ventral surface of brain

• Spinal nerves
  • Formed from neural tube and neural crest cells
    • Dorsal root – sensory nerves
    • Ventral root – motor nerves
Special senses

• Derived from ectodermal tissue
  • Evolved from skin surface receptors
  • Placodes – thickened areas that develop specialize receptors
    • Olfactory – smell (chemosensory)
    • Otic (auditory) – hearing (mechanosensory)
    • Optic – sight (light sensing)

• Form pits that connect with neuron in neural tube
FIGURE 9.7 Whole mount of a 9.7 mm frog tadpole showing the plane of section in Figs. 9.8 and 9.11.

1=mesencephalon
2=prosencephalon
3=pigmented retina
4=sensory retina
5=lens placode
6=optic stalk
7=notochord
8=foregut
9=mesocele
10=prosococele
11=head mesenchyme
12=lens
13=diencephalon
14=optic nerve
Bilateral organism

• Special senses concentrated at anterior end
• Useless unless you do something with information.
• Brain developed at anterior end to process information and react.
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- Mesoderm:
  - Chordamesoderm: Notochord
  - Head mesenchyme: Facial connective tissue and skull
  - Paraxial mesoderm: Somites → dermis, skeleton, limb muscles
  - Intermediate mesoderm: Urogenital system → kidneys, gonads
  - Lateral plate mesoderm → Somatic mesoderm: parietal pleura, pericardium, parietal peritoneum, amnion
  - Splanchnic mesoderm → Digestive system: heart, blood, blood vessels

- Endoderm:
  - Primitive gut
  - Extra-embryonic endoderm → Endoderm of yolk sac
  - Allantois
  - Oocytes, Sperm
  - Germ cells
Holoblastic eggs

• Pharynx, alimentary canal and lungs develop from archenteron
Amniote endoderm development

• Pharynx, alimentary canal and lungs develop from pinching in of body folds
• Starts as tube that begins anterior and moves posterior
  • Cranial intestinal port open at posterior end
  • Diverticuli (sack-like outgrowth) form the different sections of the digestive system and respiratory system
• Endoderm forms the inner surface of the digestive system
• Splanchnic mesoderm surrounds the endoderm and forms the smooth muscle of the digestive tract
1 = telencephalon
2 = diencephalon
3 = mesencephalon
4 = metencephalon
5 = myelencephalon
6 = spinal cord
7 = cranial intestinal portal
8 = heart
9 = vitelline artery
10 = somite
1 = stomodeum
2 = oral plate
3 = pharynx
4 = thyroid diverticulum
5 = air bladder diverticulum
6 = lung diverticulum
7 = esophagus
8 = stomach
9 = heart
10 = hepatic (liver) diverticulum
11 = dorsal pancreas diverticulum
12 = ventral pancreas diverticulum
13 = small intestine
14 = yolk stalk (yolk duct)
15 = yolk sac diverticulum
16 = large intestine
17 = mesonephros
18 = allantoic/bladder diverticulum
19 = mesonephric duct
20 = cloacal diverticulum
21 = postanal gut
22 = proctodeum
23 = cloacal membrane
24 = pharyngeal arches
1 = stomodeum
2 = pharyngeal arch 1 (mandibular arch)
3 = first pharyngeal groove
4 = second pharyngeal arch (hyoid arch)
5 = second aortic arch
6 = second pharyngeal groove
7 = third aortic arch
8 = third pharyngeal arch
9 = third pharyngeal groove
10 = fourth pharyngeal arch (hyoid arch)
11 = fourth pharyngeal groove
12 = fifth pharyngeal arch
13 = fifth aortic arch
14 = first pharyngeal pouch
15 = second pharyngeal pouch
16 = third pharyngeal pouch
17 = fourth aortic arch
18 = fourth pharyngeal pouch
19 = fifth pharyngeal pouch
20 = pharynx
1 = telencephalon
2 = eye
3 = diencephalon
4 = mesencephalon
5 = metencephalon
6 = myelencephalon
7 = otic vesicle
8 = atrium
9 = ventricle
10 = spinal cord
11 = wing bud
12 = vitelline blood vessels
13 = allantois
14 = hindleg bud
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- Paraxial mesoderm: somites, dermis, skeleton, limb muscles
- Intermediate mesoderm: urogenital system
- Lateral plate mesoderm
- Somatic mesoderm: parietal pleura, pericardium, parietal peritoneum, amnion
- Splanchnic mesoderm: heart, blood, blood vessels, visceral pleura, visceral peritoneum, mesenteries, visceral connective tissue, gonad stroma, yolk sac mesoderm
- Primitive gut: digestive system
- Extra-embryonic endoderm: respiratory system
- Allantois
- Endoderm: yolk sac endoderm
- Germ cells: oocytes, sperm

Diagram showing the development of the embryo, highlighting the contributions of each germ layer (ectoderm, mesoderm, and endoderm) to various organ systems. The origins of all the organs can be traced back to the germ layers.
Somite formation

• Derived from paraxial mesoderm

• Three regions
  • Dermatome – integument of back
  • Myotome – muscles
  • Sclerotome – cartilage
FIGURE 9.14 Transverse section through a 48-hour chick embryo showing several types of mesoderm. The plane of section is shown in Fig. 9.3.
Heart development

• Derived from splanchnic mesoderm
  • Two thickened areas split to form tubes that then fuse to form heart tube

• The heart tube develops into four sections
  • Sinus venosus, atrium, ventricle, bulbus cordis
    • Atria divide in half to form a left and right atria
    • Ventricles divide in half for mammals and birds
FIGURE 9.15 Diagram of the embryonic frog heart and associated blood vessels. View is lateral and anterior is to the right. Regions of the heart, and six paired aortic arches (I–VI) are shown. Arrows indicate the direction of blood flow.
Vascular development

- Derived from lateral plate mesoderm
- Forms six paired aortic arches
- Degeneration and reorganization of aortic arches is species specific
1 = internal carotid artery
2 = external carotid artery
3 = ventral aorta
4 = right dorsal aorta
5 = left dorsal aorta
6 = dorsal aorta
7 = degenerating
8 = right pulmonary artery
9 = right subclavian artery
10 = left subclavian artery
11 = pulmonary trunk
12 = descending aorta
Embryonic circulation

- Cardinal system – head and body wall
- Vitelline system – yolk sack
- Hepatic veins – liver
- Allantoic vessels – gas exchange and waste removal
  - Develop into umbilical vessels in mammals
Kidney development

• Derived from intermediate mesoderm
• Three pairs of embryonic kidneys form
  • Pronephros – primary kidney of frog embryo
  • Mesonephros – permanent kidney in frog, embryonic kidney of some amniotes
  • Metanephros – permanent kidney of amniotes
• Only one pair of kidneys are permanent, the rest degenerate