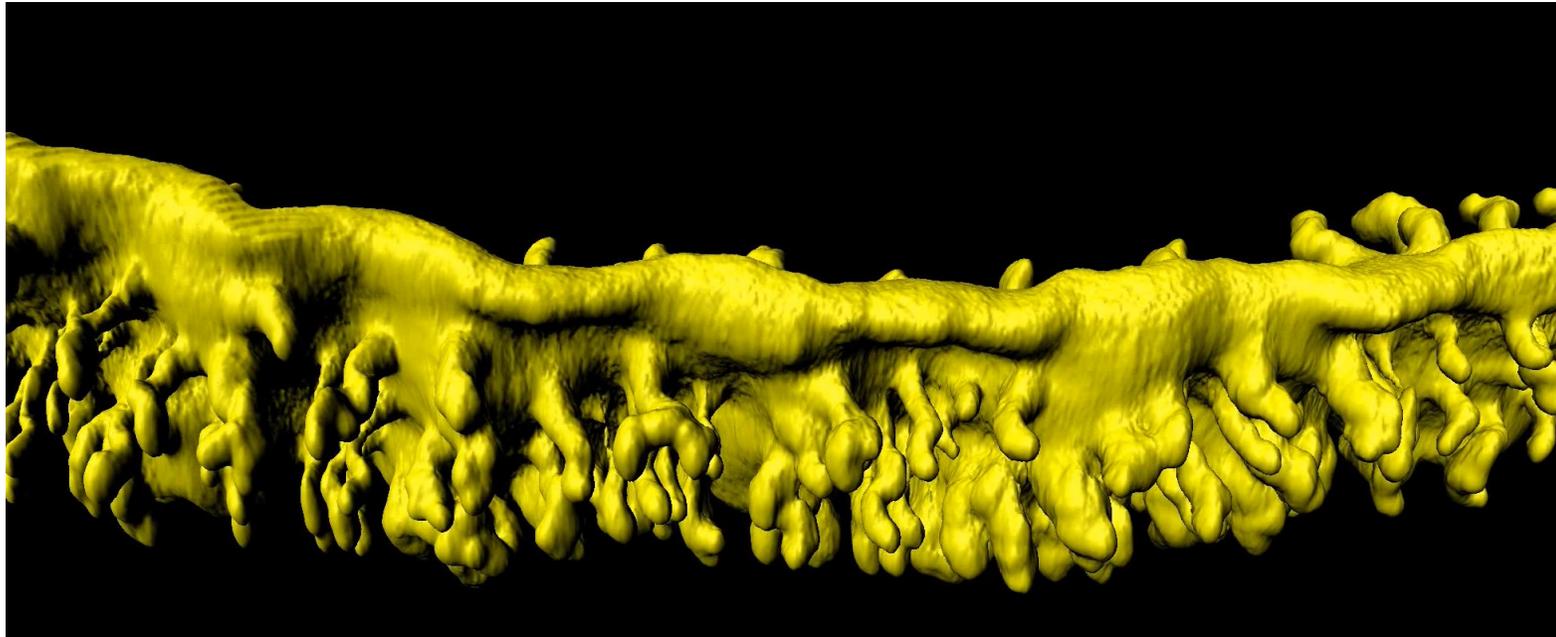




UNC

SCHOOL OF
MEDICINE

Tissue Organization; How do vertebrates make a spine?



Andrew B. Gladden, PhD; Associate Professor
Department of Pathology & Laboratory Medicine
University of North Carolina at Chapel Hill
Introduction to Pathology of Disease
August 18, 2022

Goals for today's class!

- Learn how to describe the orientation of cells and tissue in an organism.
- Understand what the three Germ Layers are and how they are organized.
- Learn how the neural tube is formed.
- Understand what and how different cellular components contribute to heart and vascular development.
- Define the different types of epithelial tissues and how the gut and skin develops.

Try to Think in 3D!

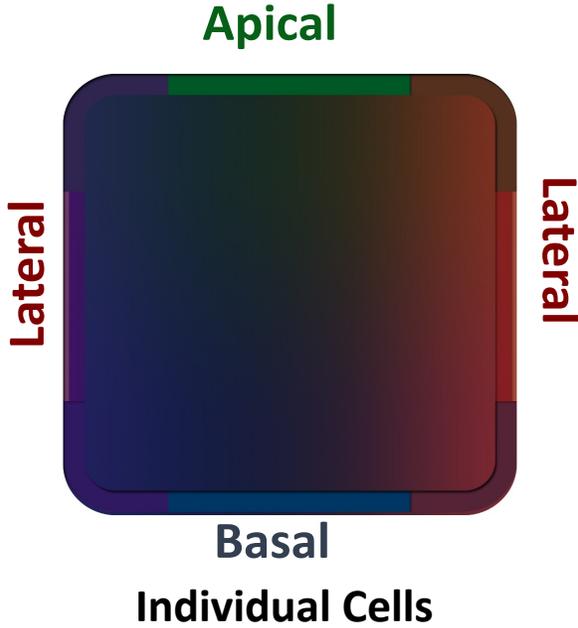
How Can the Cans be Organized?



Try to Think in 3D! Like This?



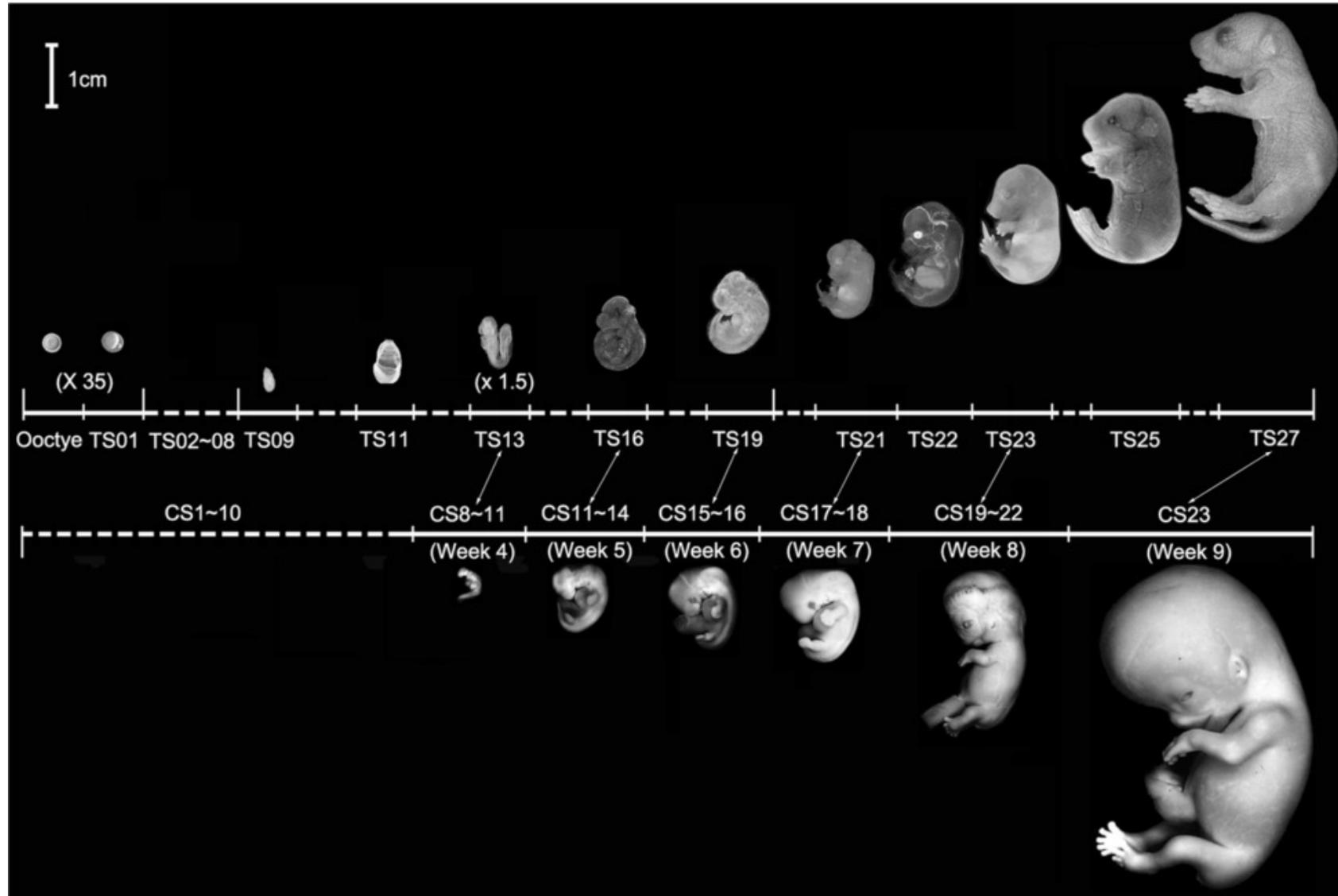
How do you describe orientation in tissue?



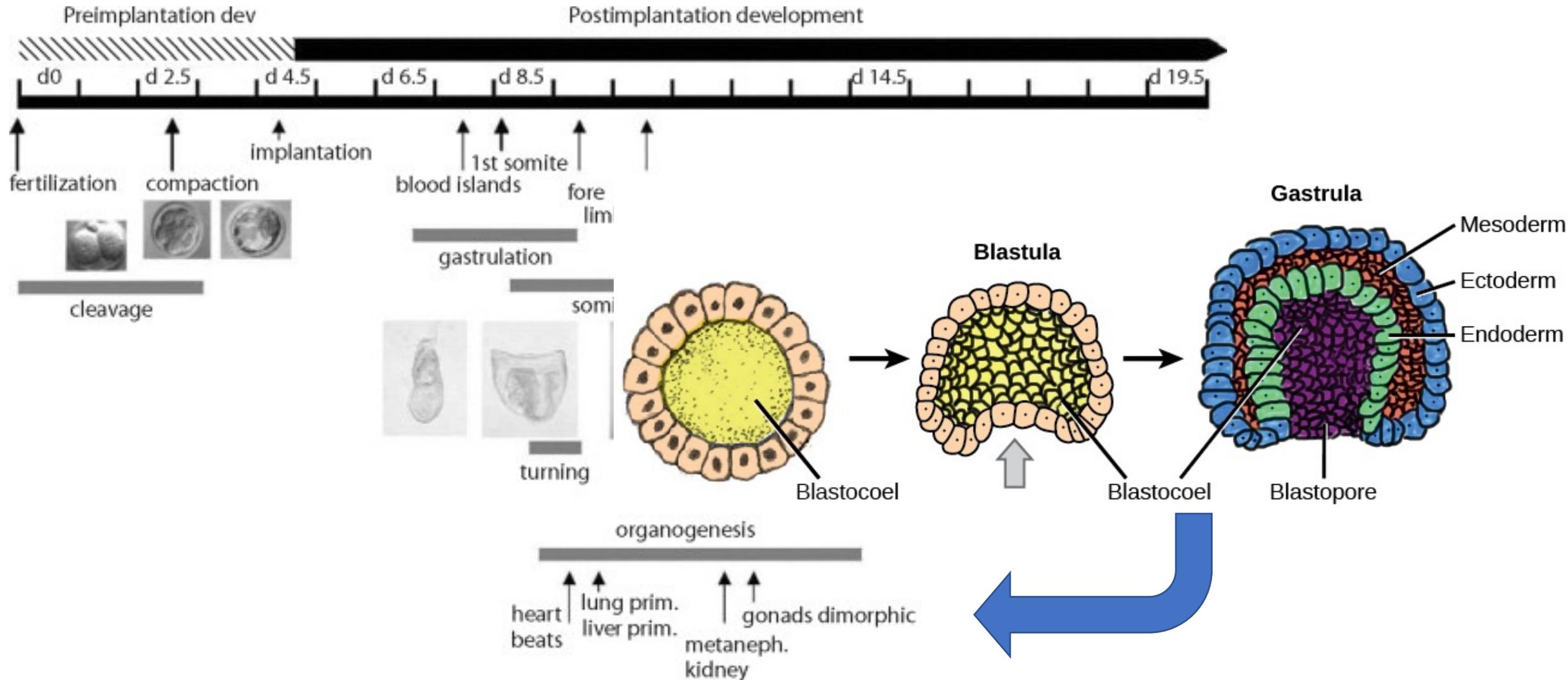
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Mouse versus Human Embryo Development

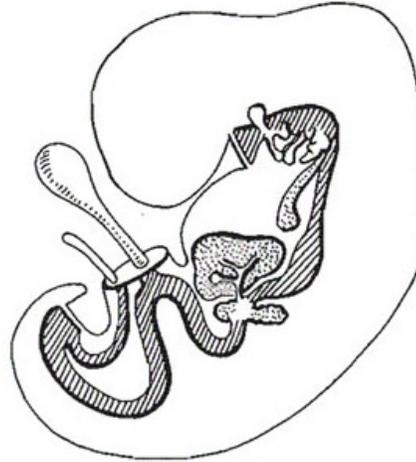
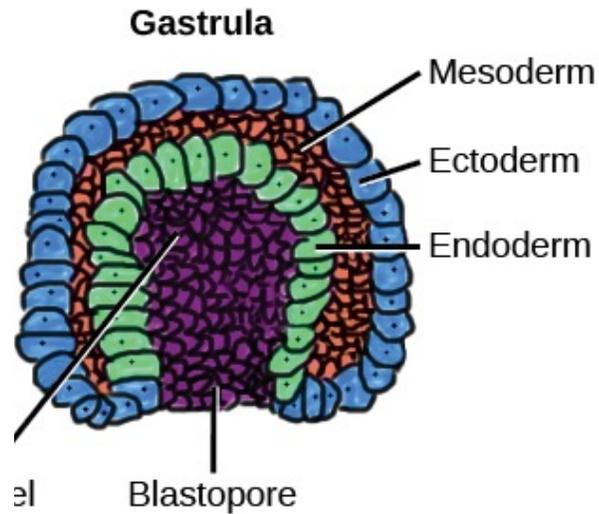


The Three Germ Layers



MacCord, Kate, "Germ Layers". *Embryo Project Encyclopedia*, 2013.

Germ Layer Derivatives

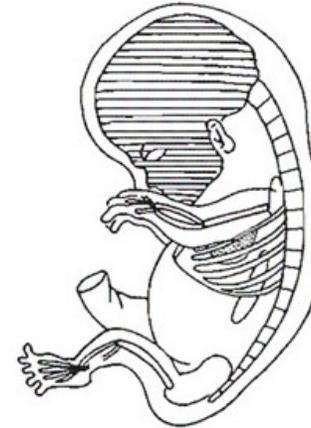


ENTODERM

Epithelium of GI tract
 Liver
 Pancreas
 Urachus
 Urinary bladder

Epithelial portions
 Pharynx
 Thyroid
 Trachea, bronchi, lungs
 Tympanic cavity
 Pharyngotympanic tube
 Tonsils
 Parathyroids

Endoderm = Entoderm



MESODERM

Skeleton (head and body)
 Muscle
 Connective tissue
 Circulatory system
 Cardiovascular
 Lymphatic
 Urinary system
 Spleen
 Adrenal cortex
 Genital system:
 gonads, ducts, accessory glands
 Dermis
 Dentine of teeth



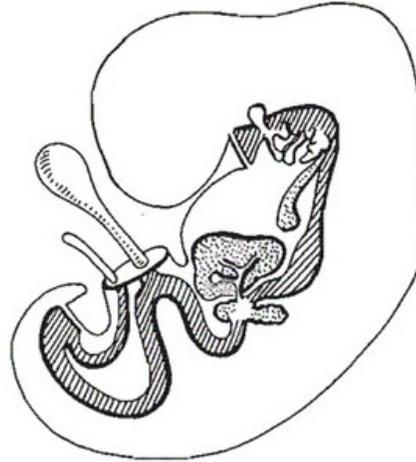
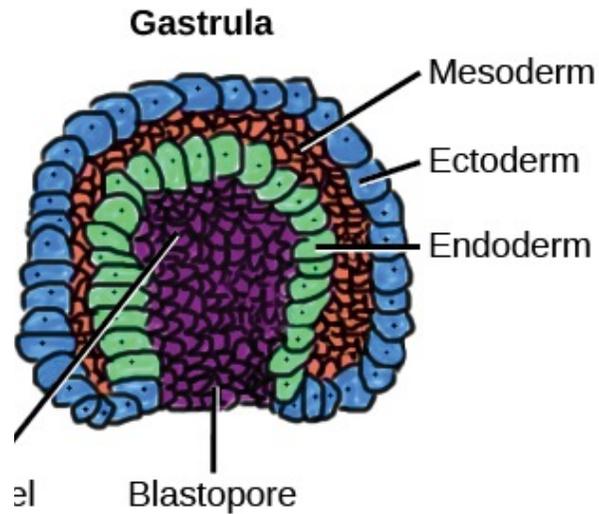
ECTODERM

<u>NERVOUS TISSUE</u>		<u>EPIDERMIS</u>
Neural tube	Neural crest	Hair
CNS	Pigment cells	Nails
Retina	Adrenal medulla	Mammary glands
Post. pituitary	Cranial and sensory nn.	Cutaneous glands
Pineal gland	Cranial and sensory ganglia	Ant. pituitary
		Teeth enamel
		Inner ear
		Eye lens

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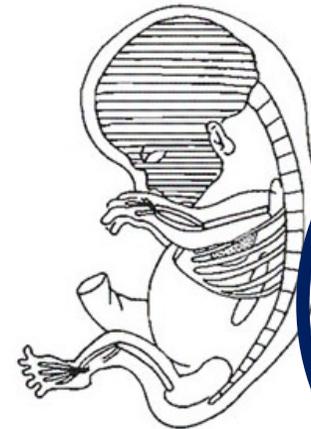
Germ Layer Derivatives



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MESODERM

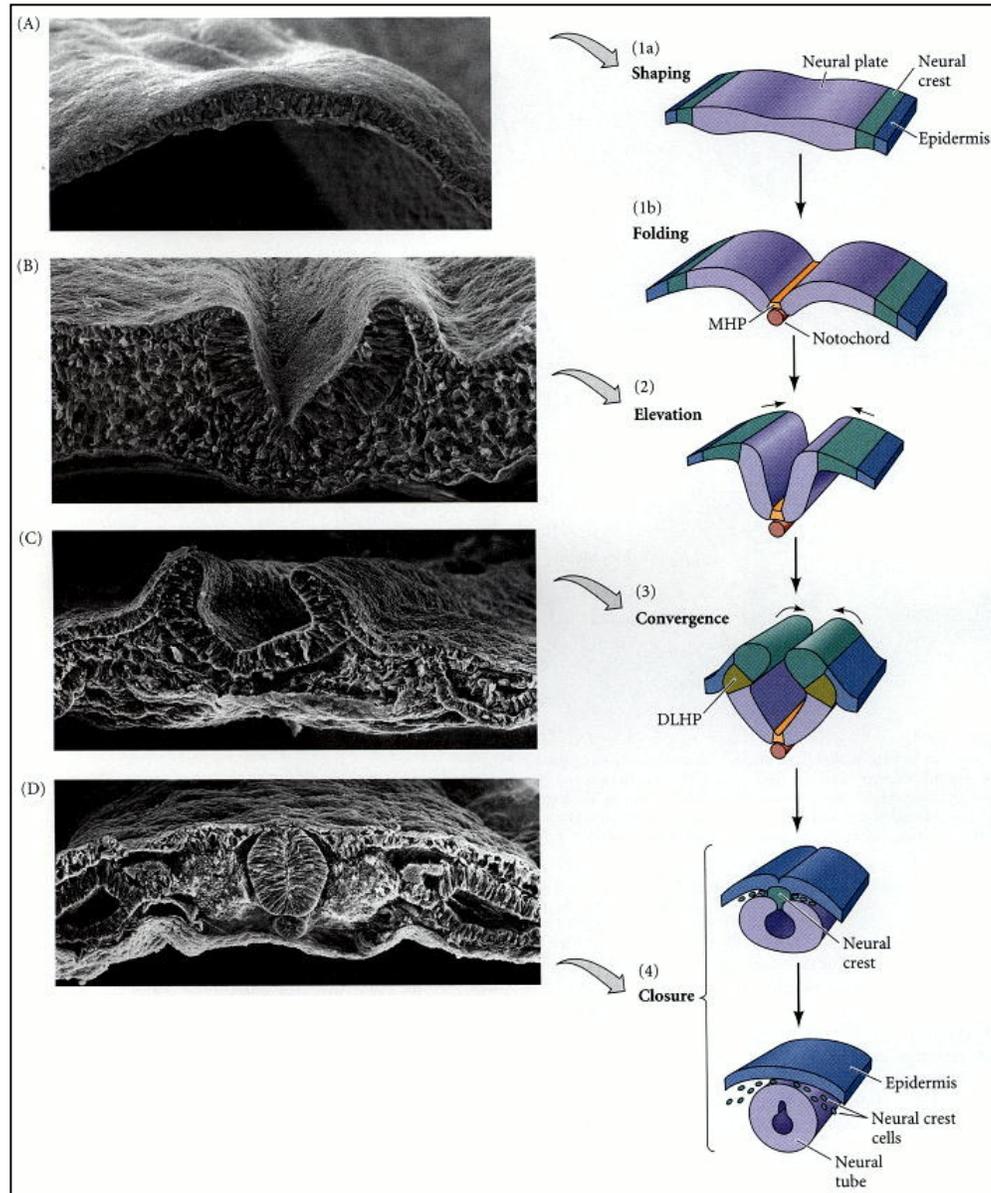
- Skeleton (head and body)
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 - Cardiovascular
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ECTODERM

- | <u>NERVOUS TISSUE</u> | | <u>EPIDERMIS</u> |
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| | | Teeth enamel |
| | | Inner ear |
| | | Eye lens |

The Beginning of a Spine!



Starts at e8.5 in mouse,
completed at e10.5.

Completed the fourth week
of pregnancy in humans.

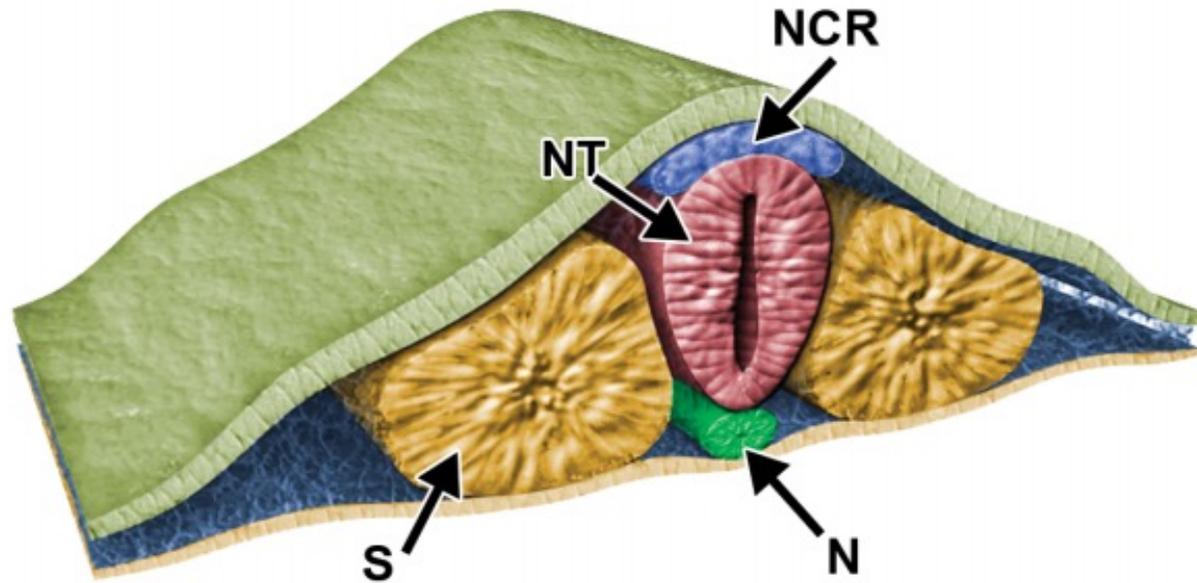
The Beginning of a Spine! In Real Time!



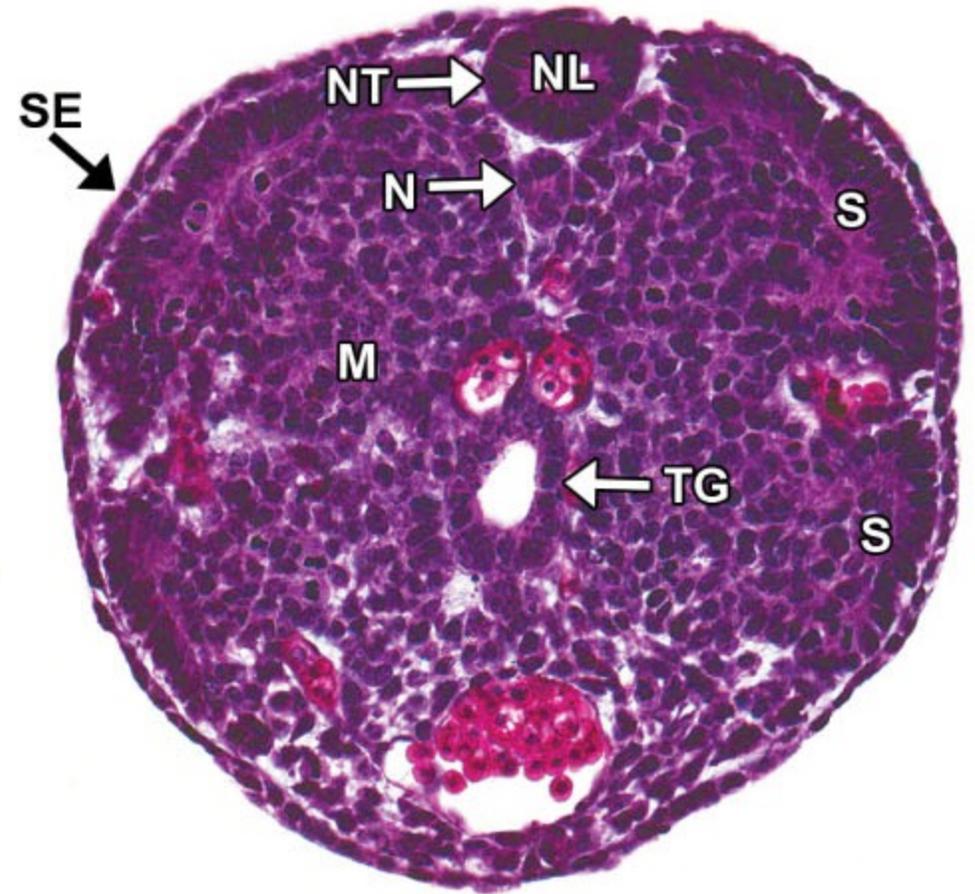
Axoloti embryo:
Tiger Salamander or
Mexican Salamander



The Beginning of a Spine! In Still Time!



NT = Neural Tube
N. = Notochord
TG = Tail gut
S. = Somite
NCR = Neural Crest Cells
M. = Mesenchyme

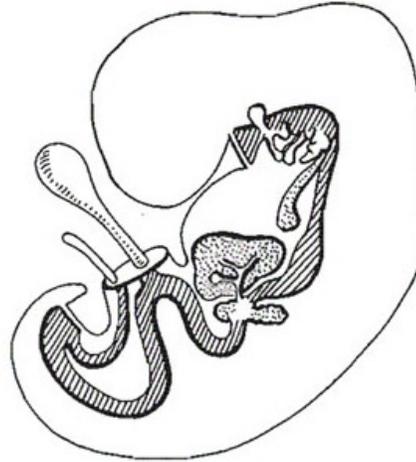
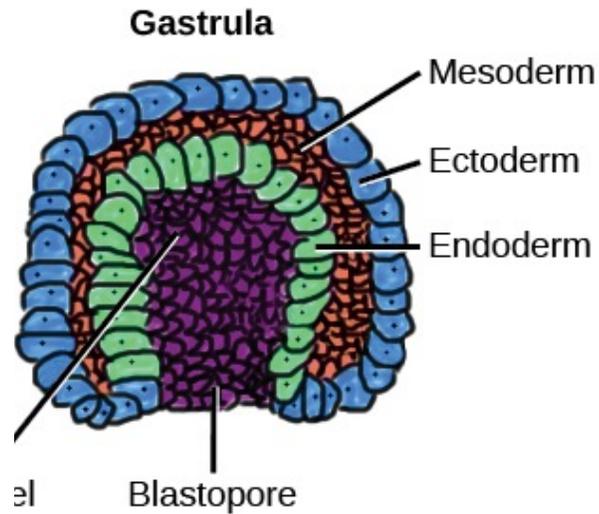


Chen, VS, et al. Toxicologic Pathology, 2017.

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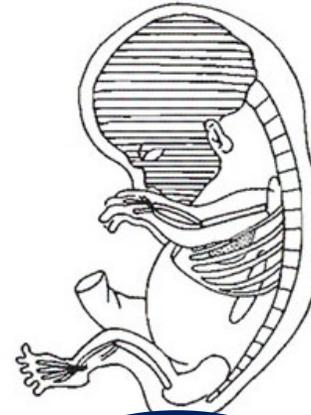
Germ Layer Derivatives



ENTODERM

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- Pancreas
- Urachus
- Urinary bladder
- Epithelial portions
 - Pharynx
 - Thyroid
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 - Tonsils
 - Parathyroids

Endoderm = Entoderm



MESODERM

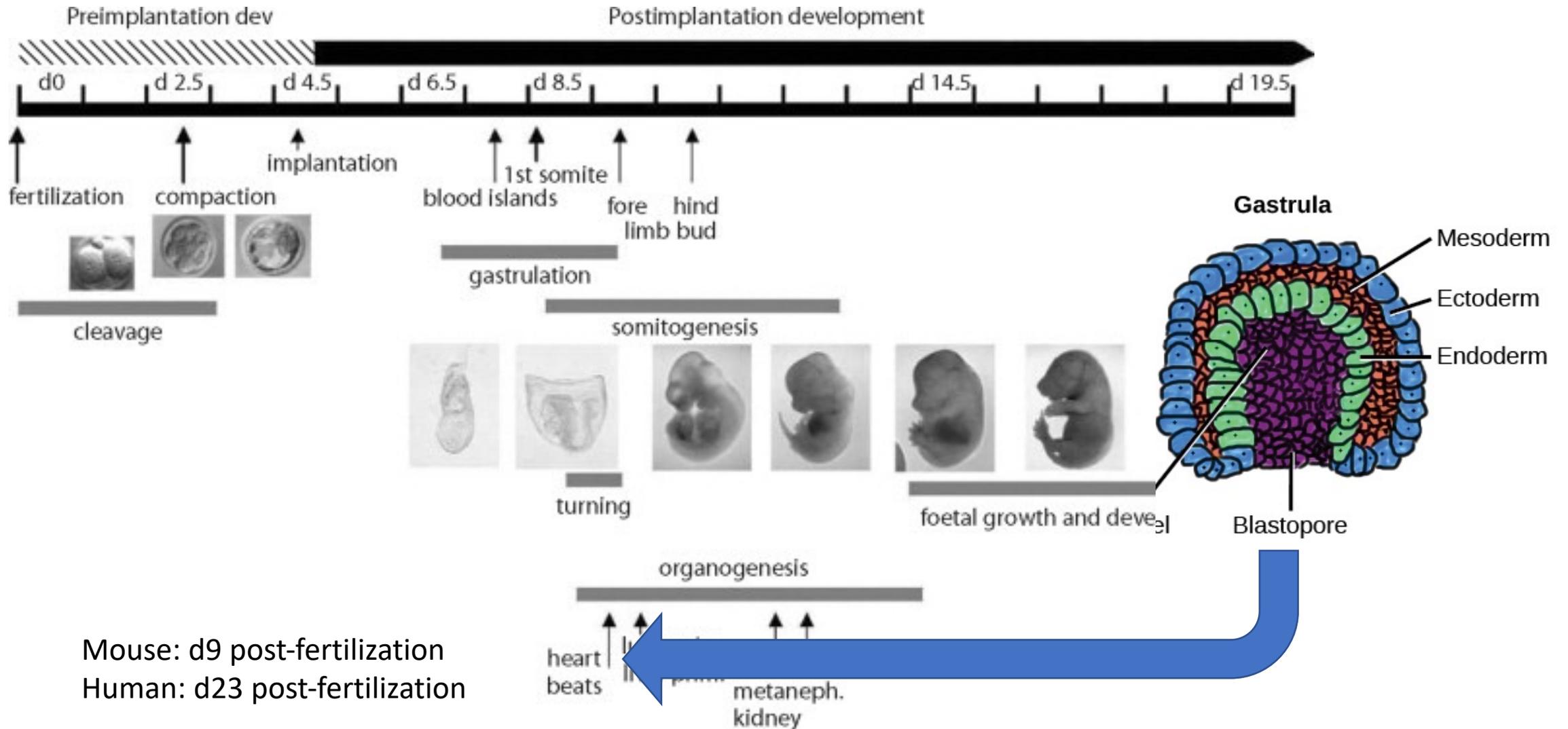
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- Genital system
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- Dermis
- Dentine of teeth



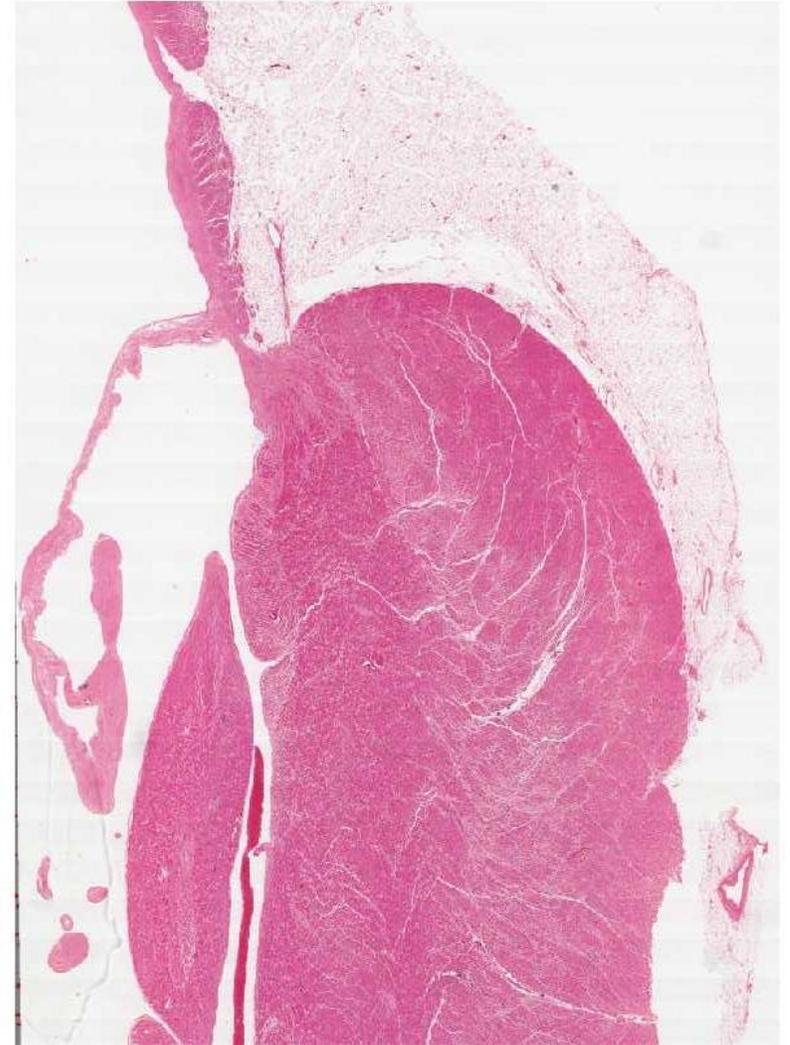
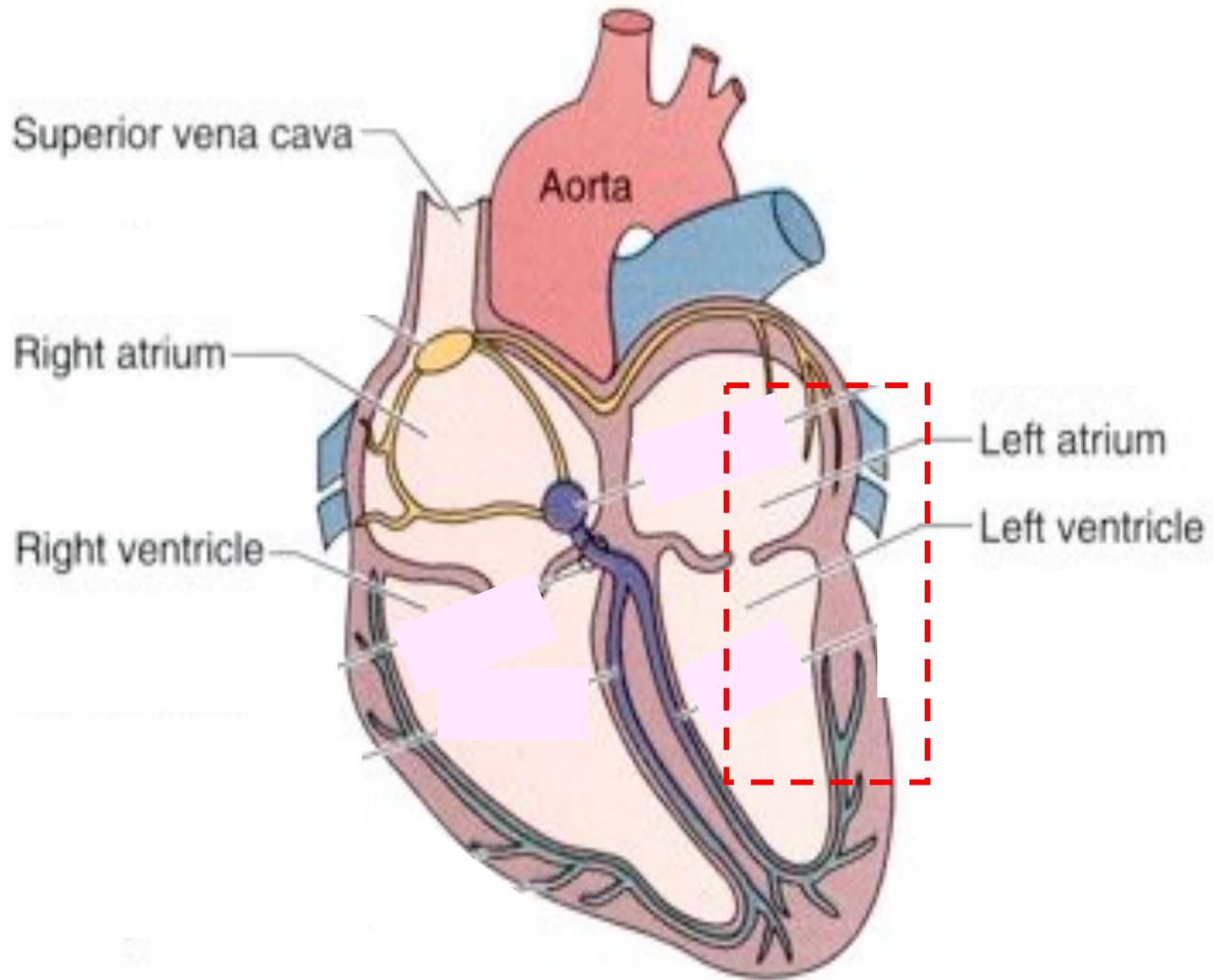
ECTODERM

- | <u>NERVOUS TISSUE</u> | | <u>EPIDERMIS</u> |
|-----------------------|-----------------------------|------------------|
| Neural tube | Neural crest | Hair |
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| Pineal gland | Cranial and sensory ganglia | Ant. pituitary |
| | | Teeth enamel |
| | | Inner ear |
| | | Eye lens |

When does the heart form?



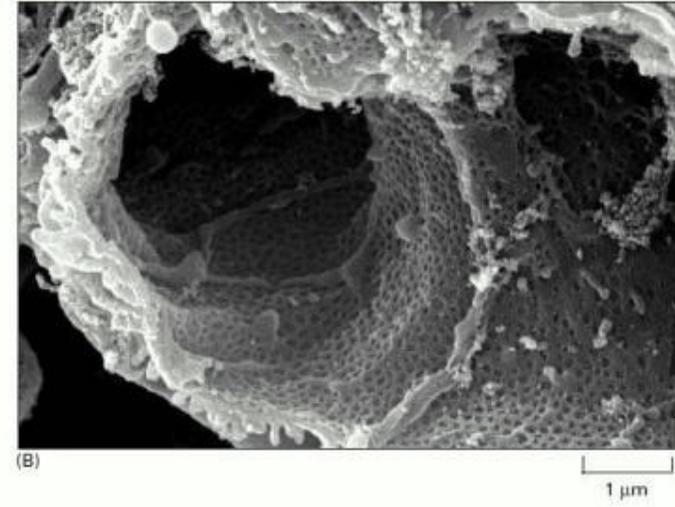
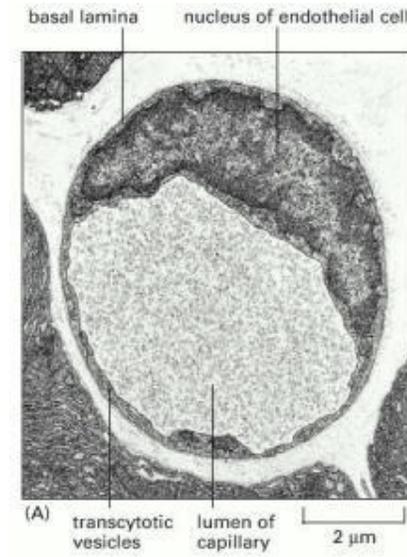
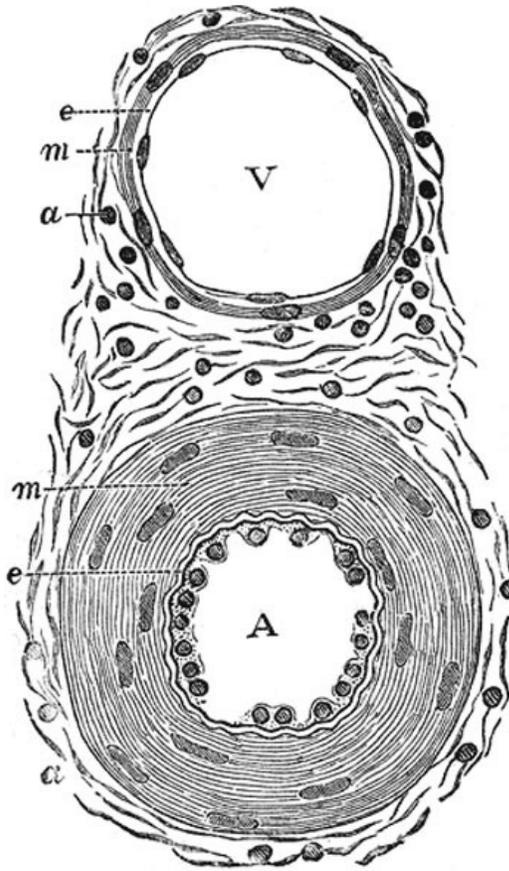
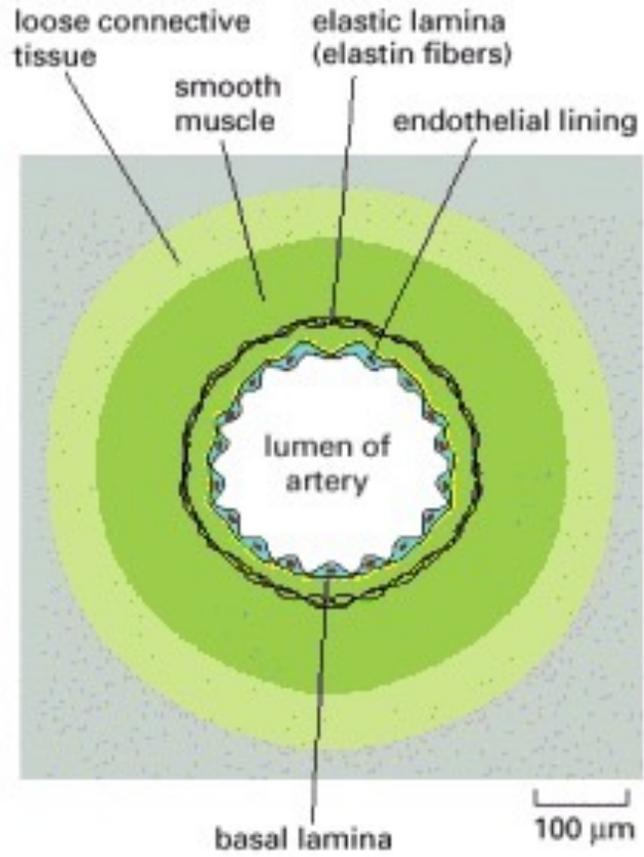
Looking at the Heart by H&E



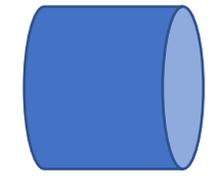
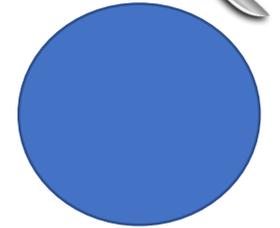
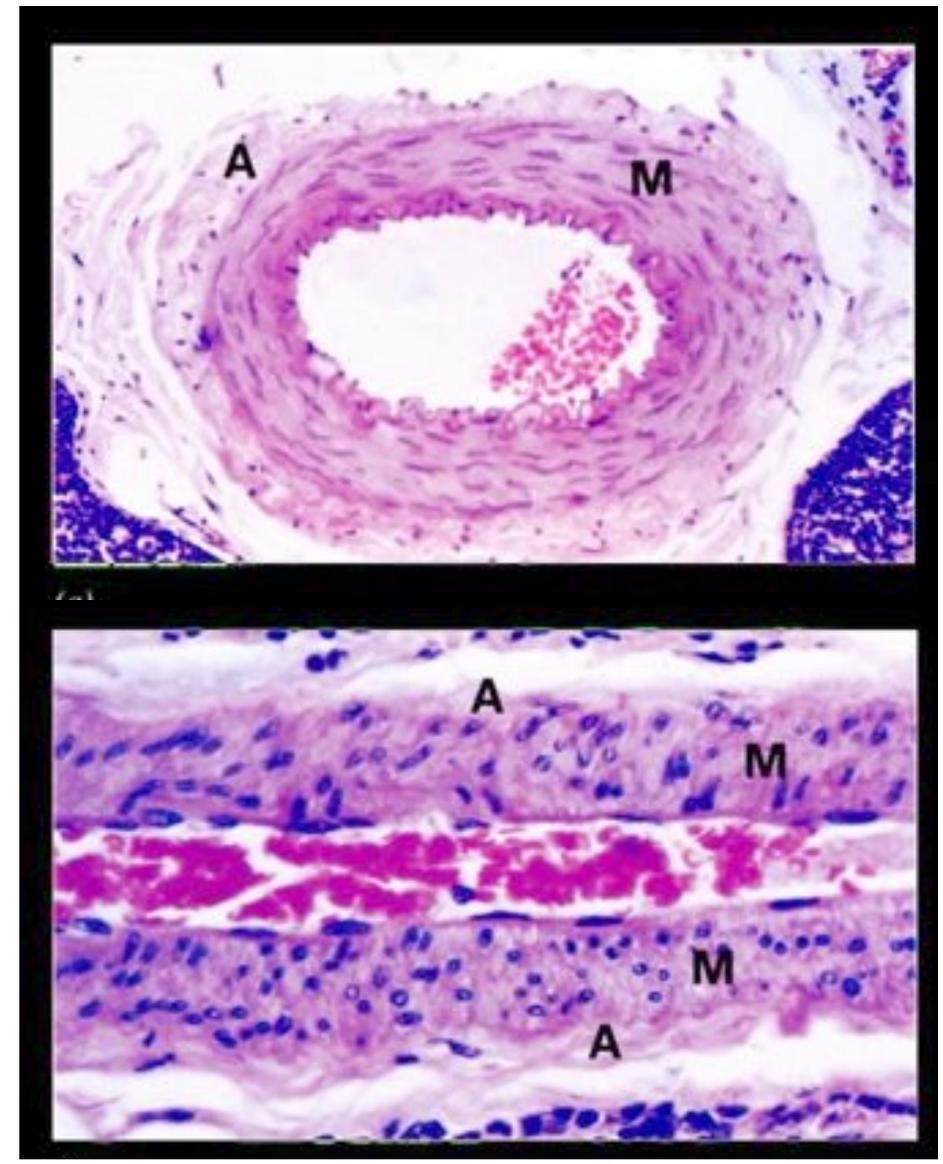
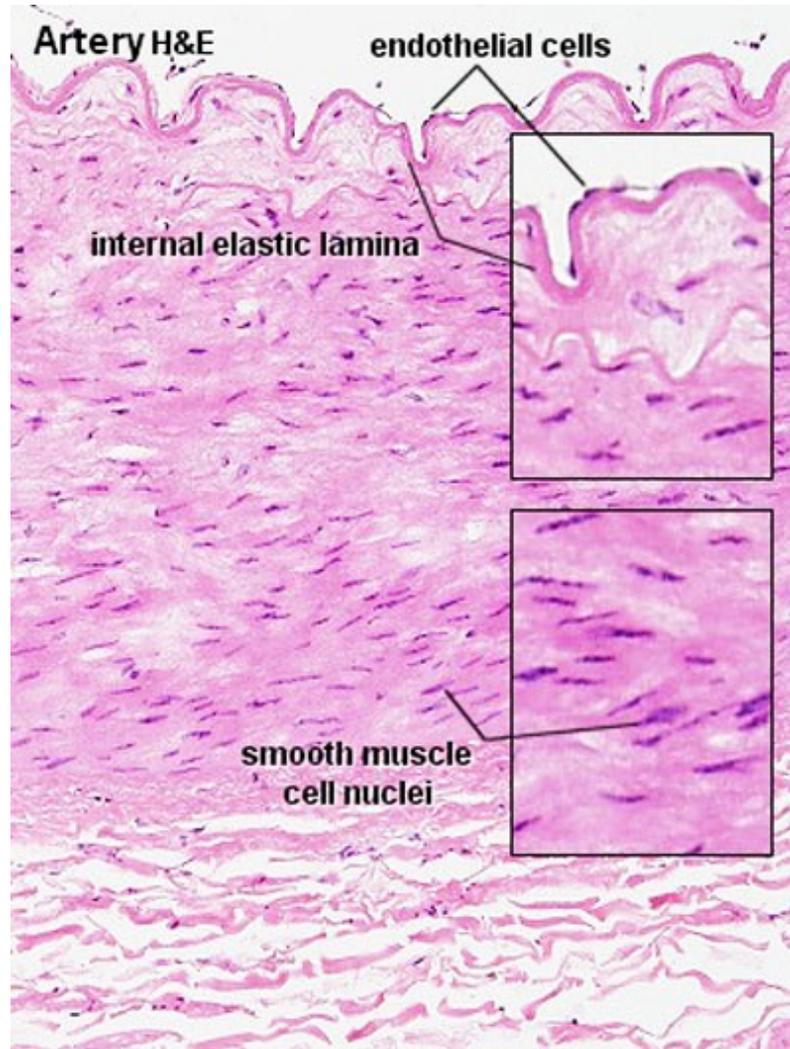
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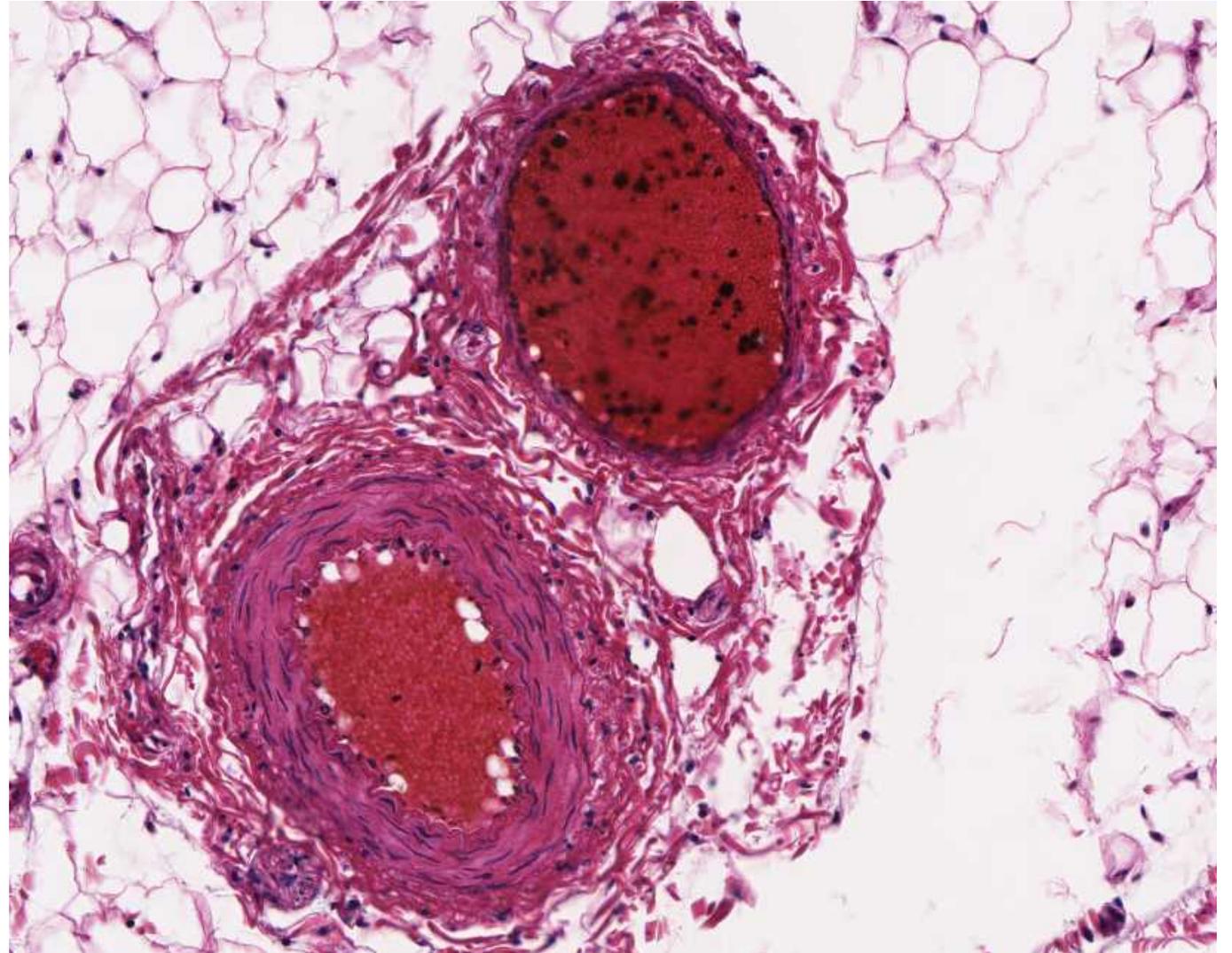
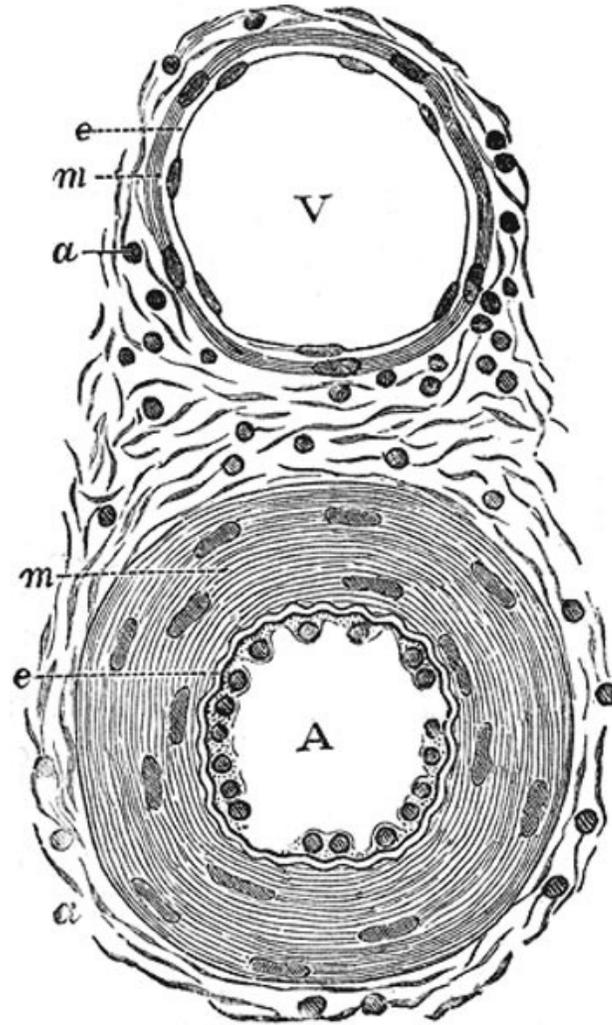
What are the cellular components of the peripheral vasculature?



What are the cellular components of the peripheral vasculature?



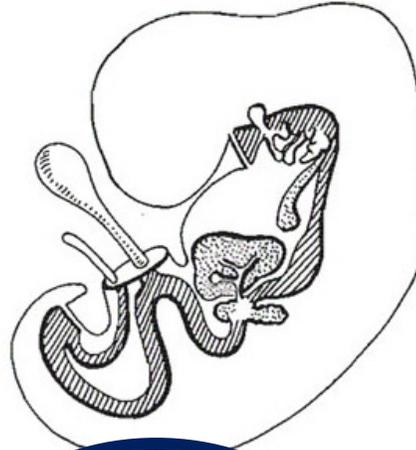
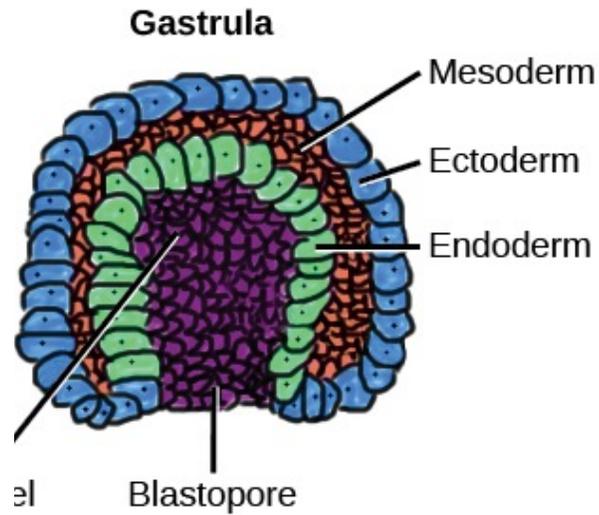
What are the cellular components of the peripheral vasculature?



Goals for today's class!

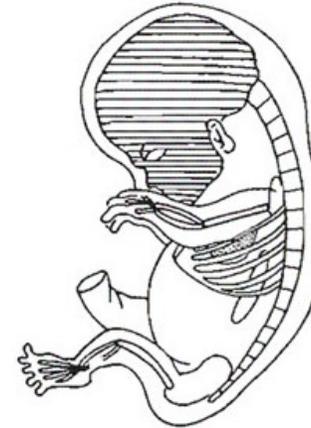
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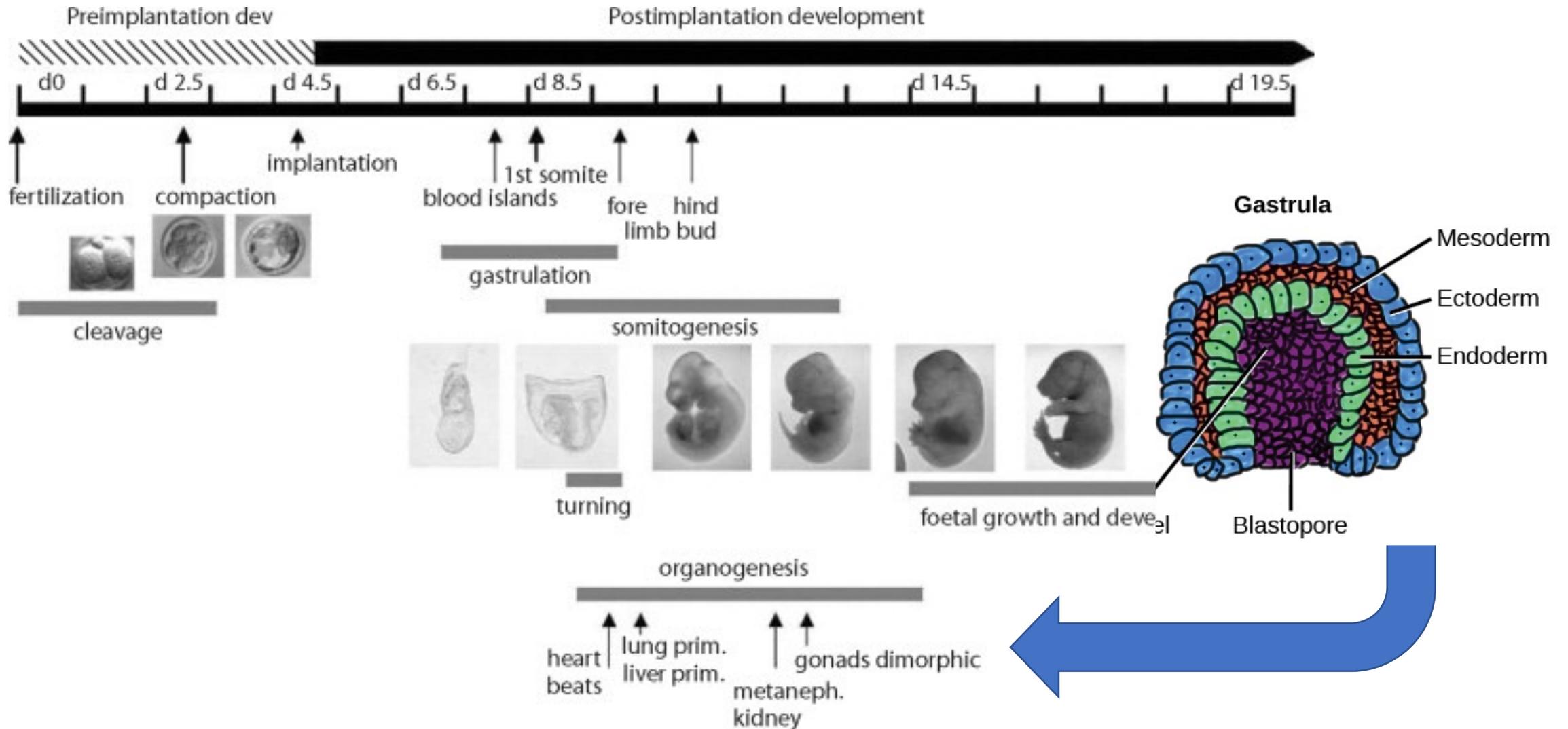


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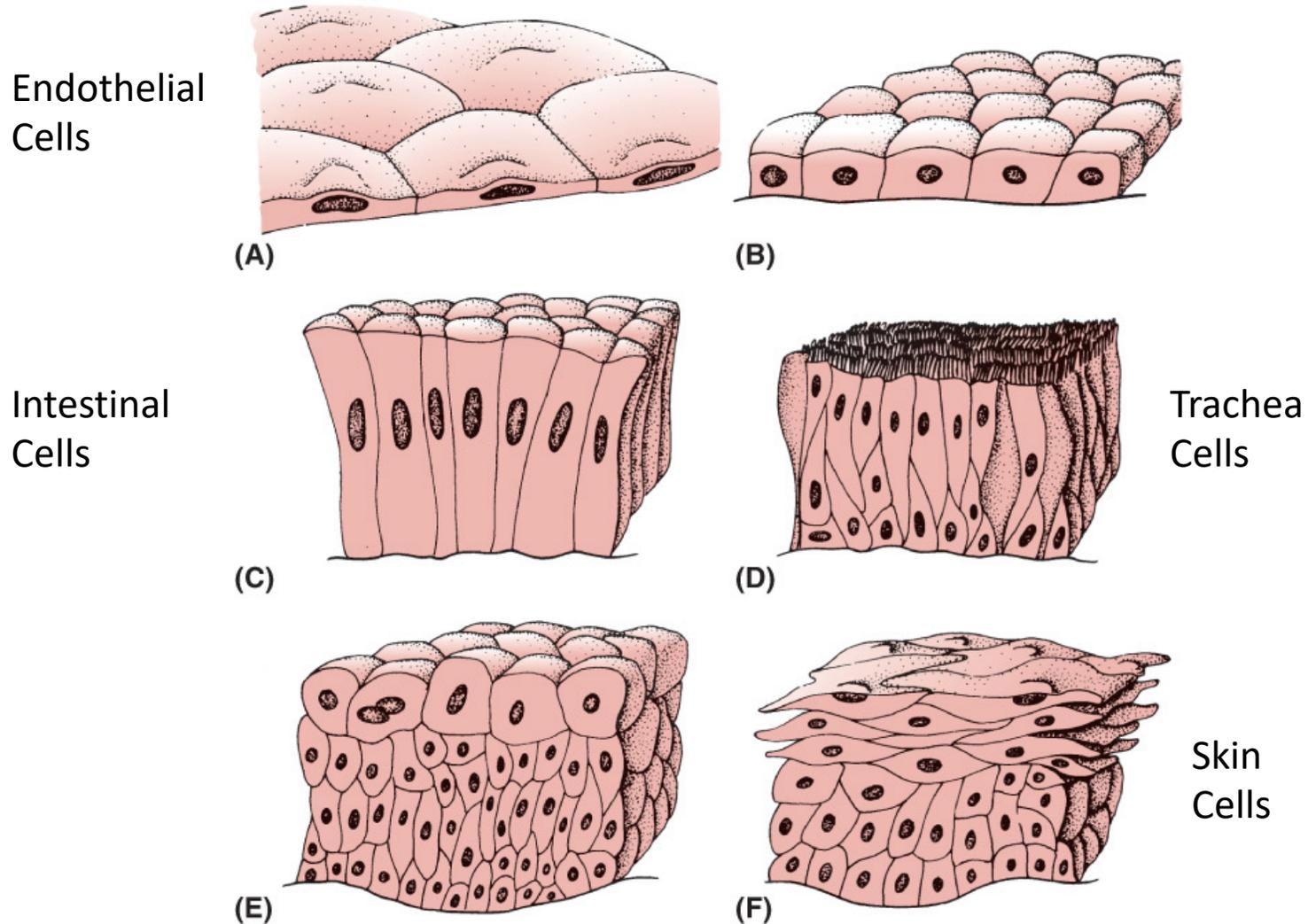
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- | | | |
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When does the gut form?



MacCord, Kate, "Germ Layers". *Embryo Project Encyclopedia*, 2013.

Different Types of Epithelial Tissues

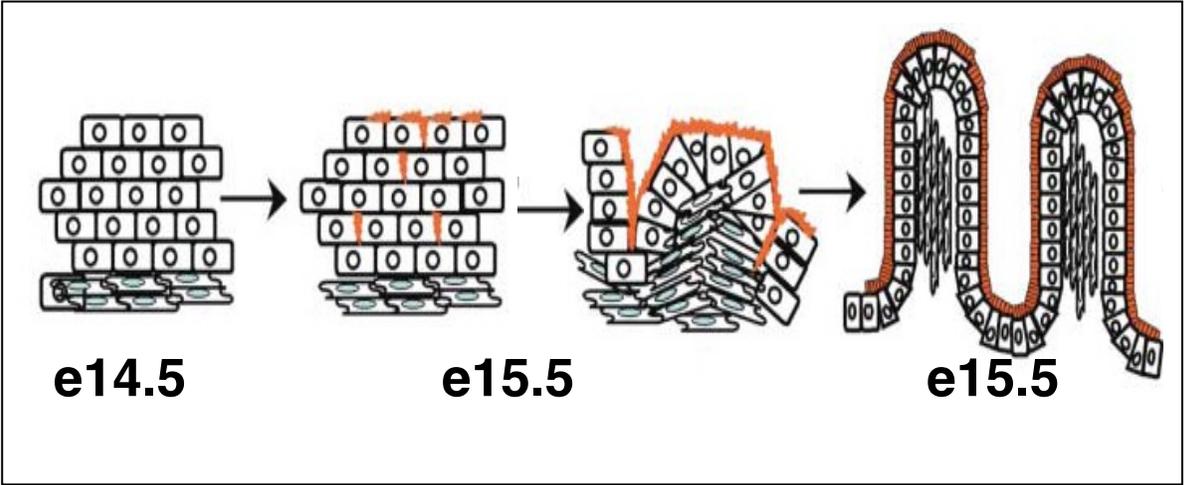


02.F04: Common types of epithelium: (A) simple squamous, (B) cuboidal, (C) columnar, (D) pseudostratified columnar (ciliated), (E) transitional, and (F) stratified squamous.

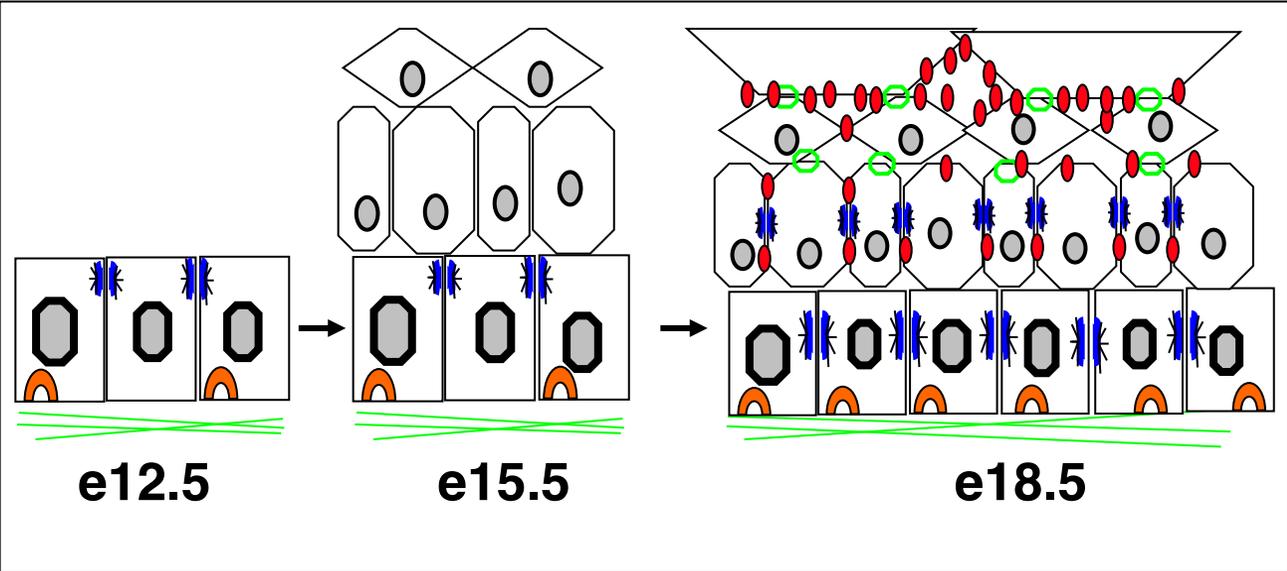
From Reisner and Reisner, *An Introduction to Human Disease*. 2022, Jones and Bartlett Learning

Tail of Two Epithelial Developmental Processes

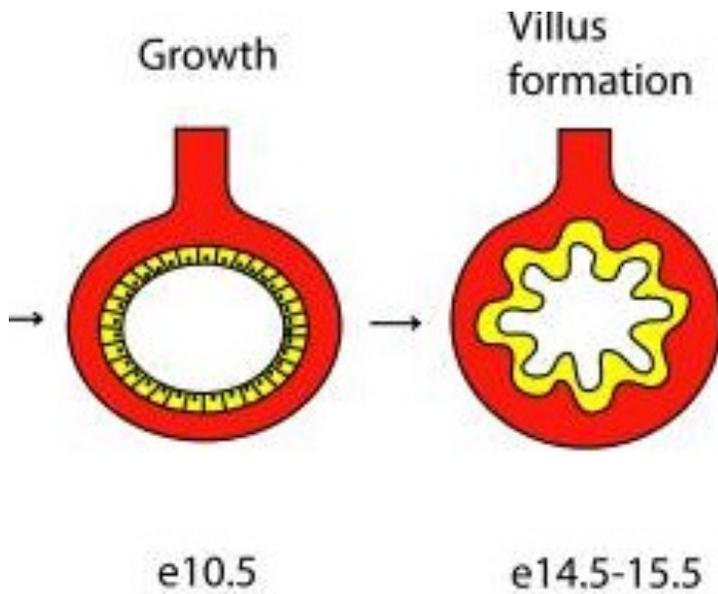
Intestinal Development



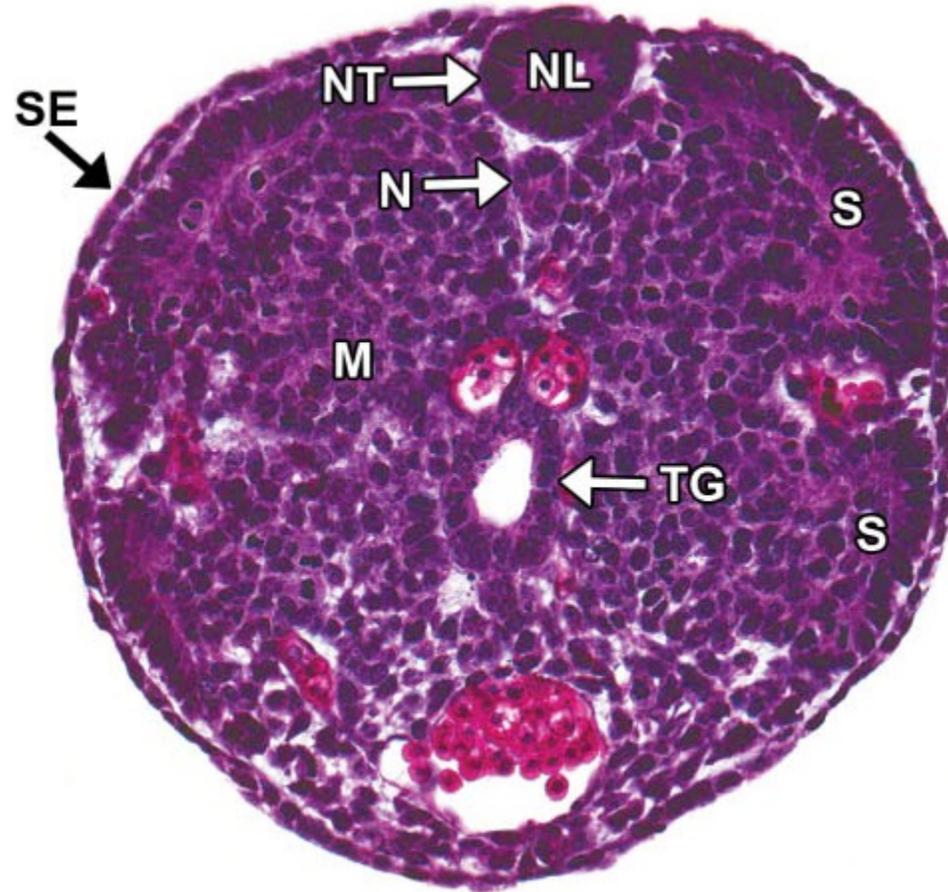
Epidermal Development



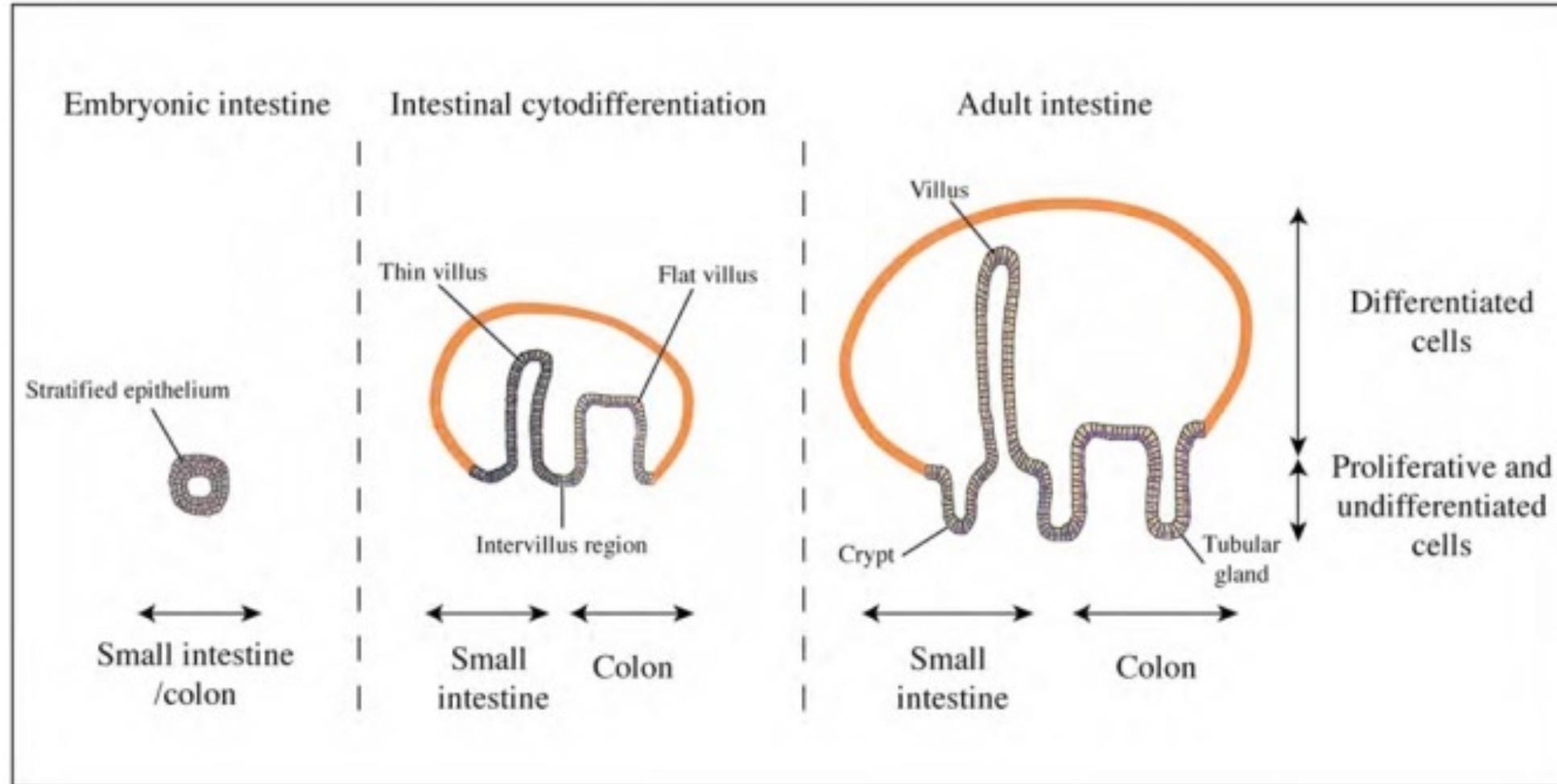
How does the gut form?



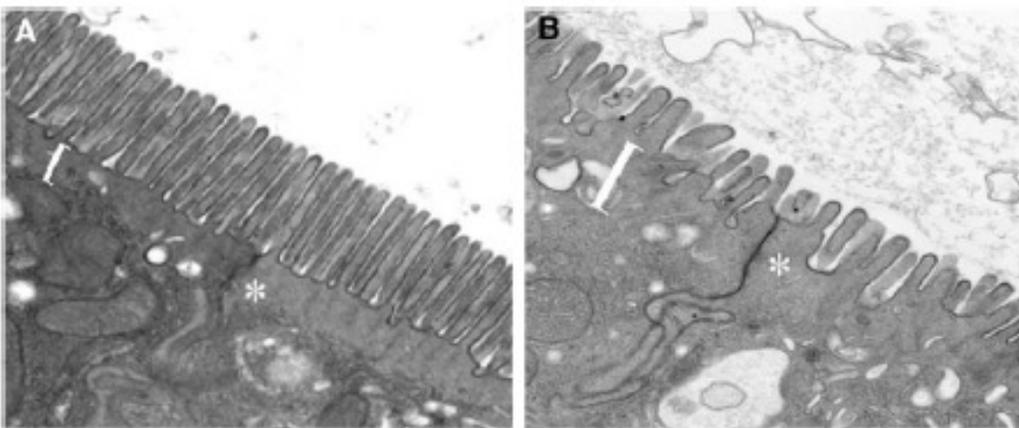
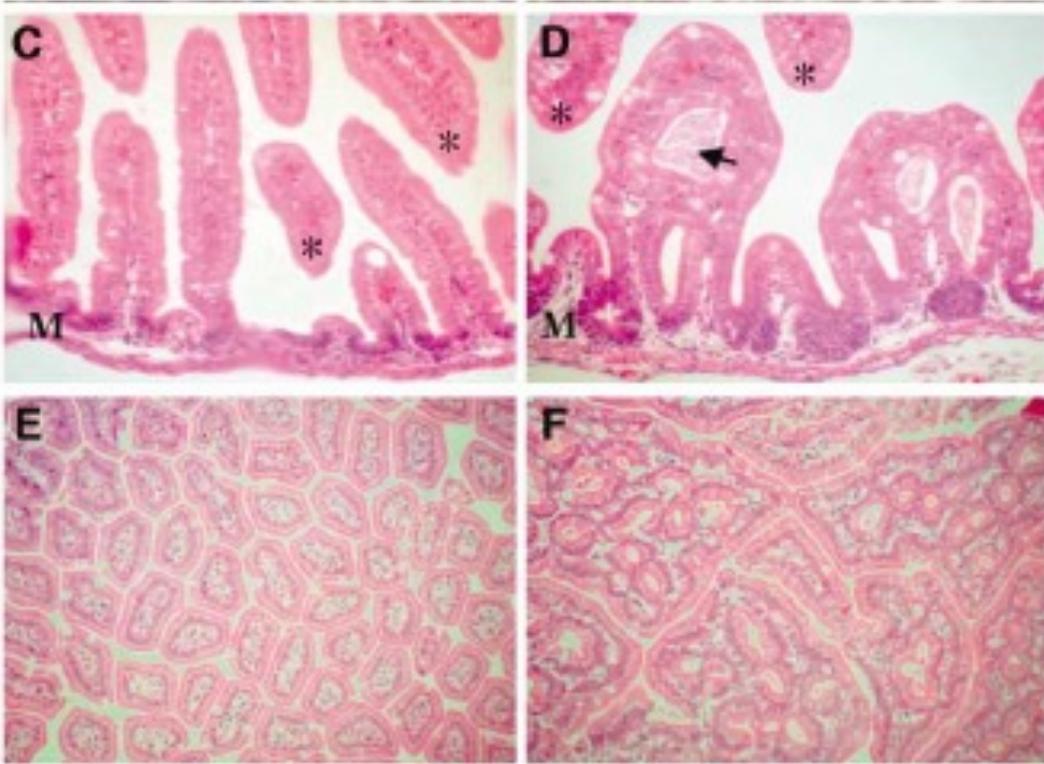
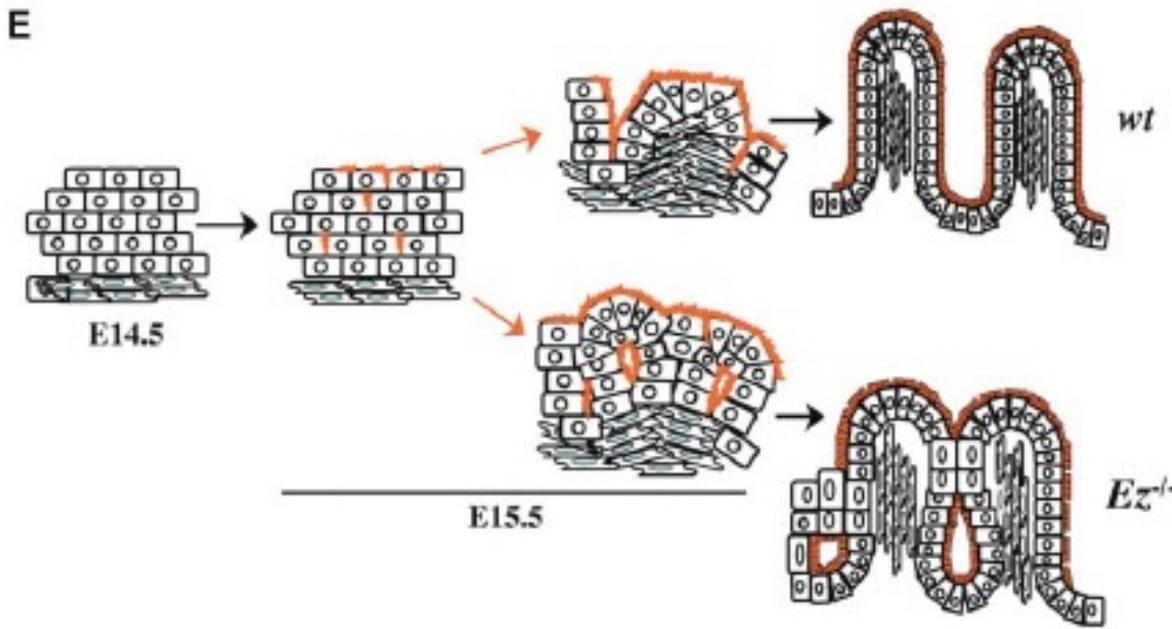
- Mesoderm
- Endoderm
- Ectoderm



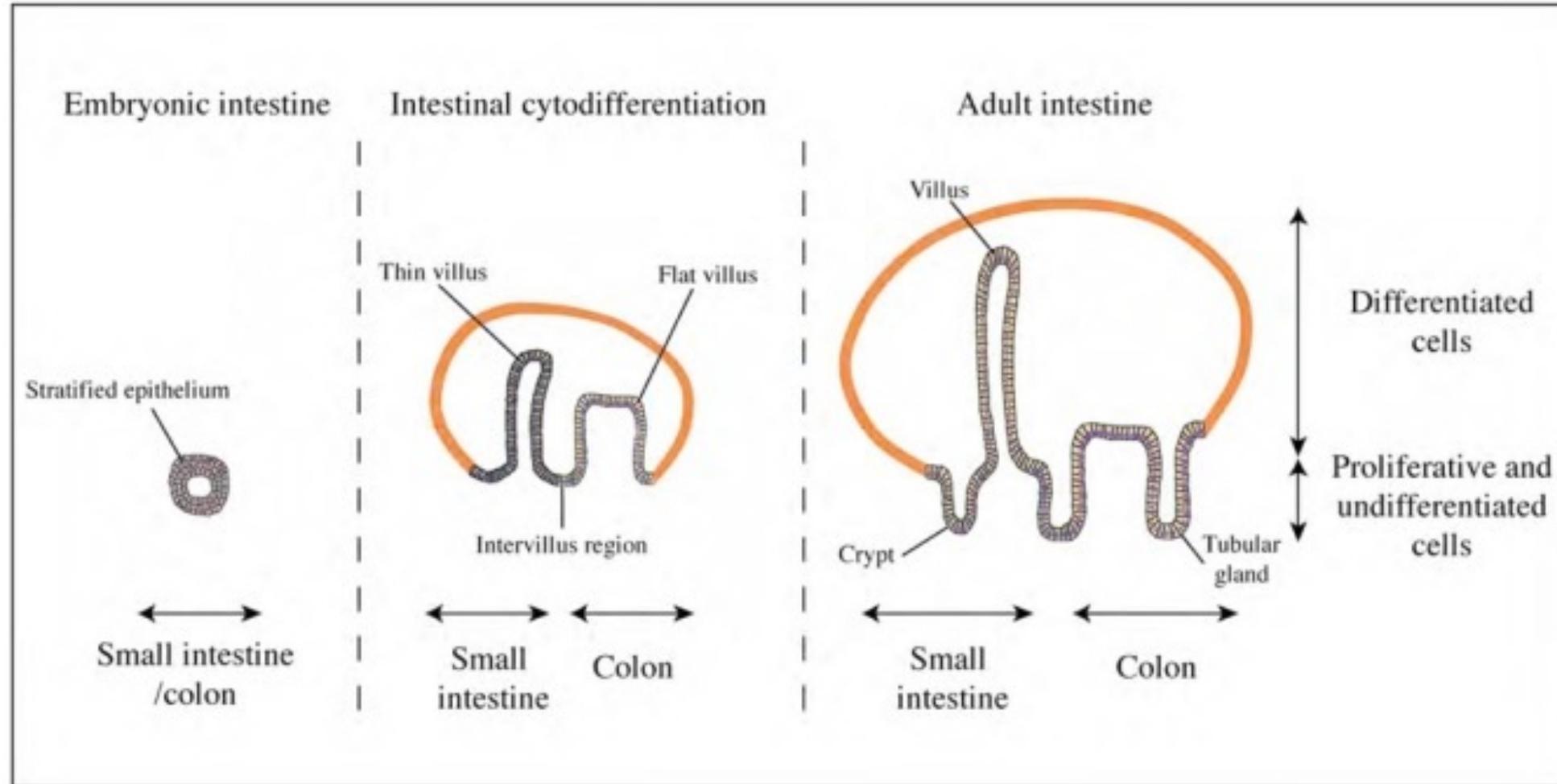
How does the gut form?



What happens when villus formation is disrupted?



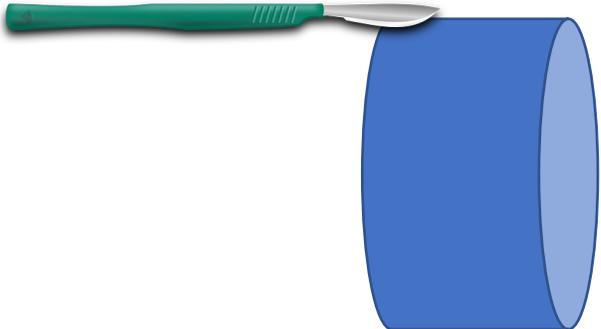
Forming different sections of the gut?



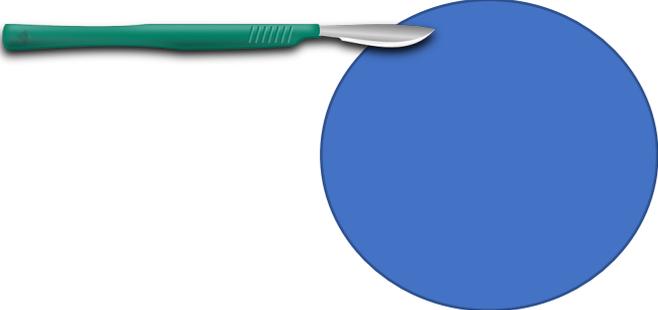
Histology of different orientations of the gut



Small Intestine (lateral)



Small Intestine (transverse)



Histology of different sections of the gut



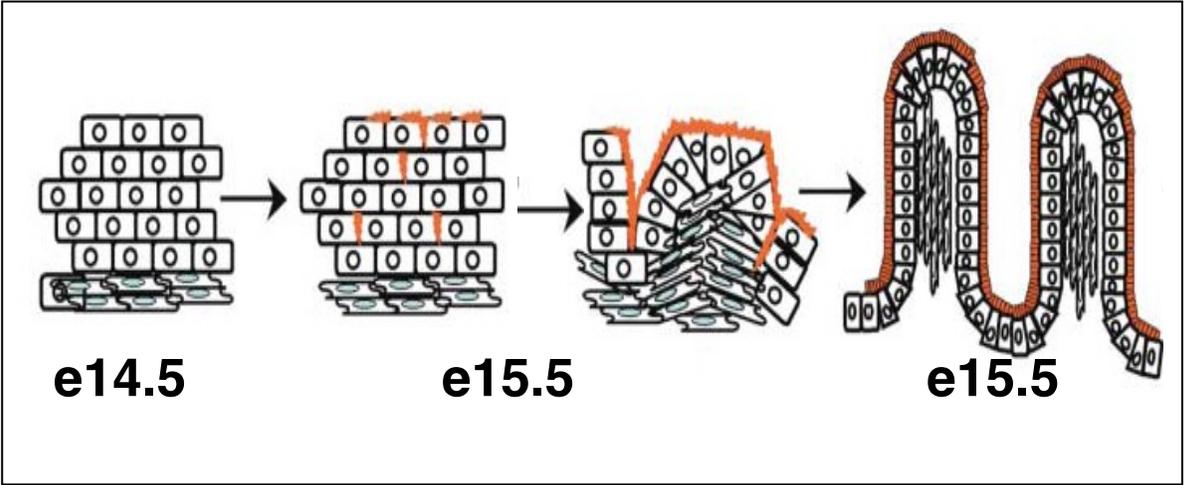
Small Intestine



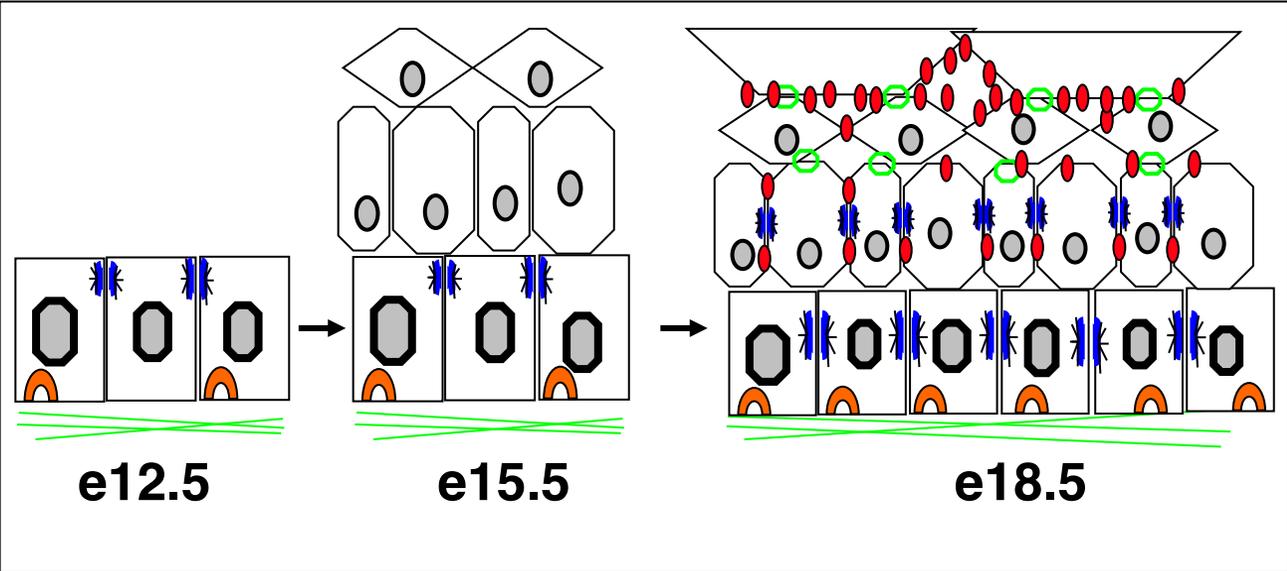
Large Intestine (colon)

Tail of Two Epithelial Developmental Processes

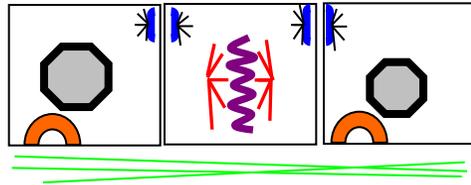
Intestinal Development



Epidermal Development

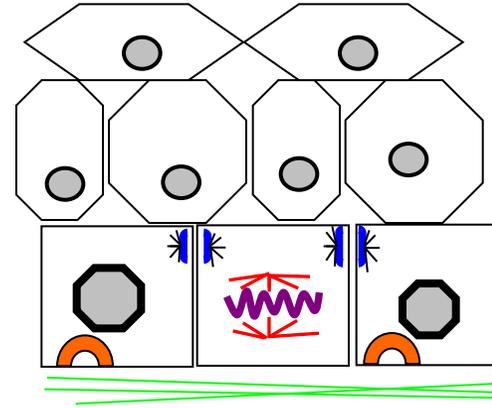


Initiation of Stratification in the Embryonic Epidermis



e12.5

Ratio of symmetric to asymmetric
spindle orientation in wild type
basal cells: 70% to 30%

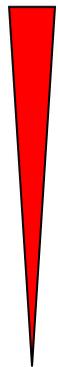
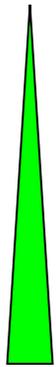


e15.5

Ratio of symmetric to asymmetric
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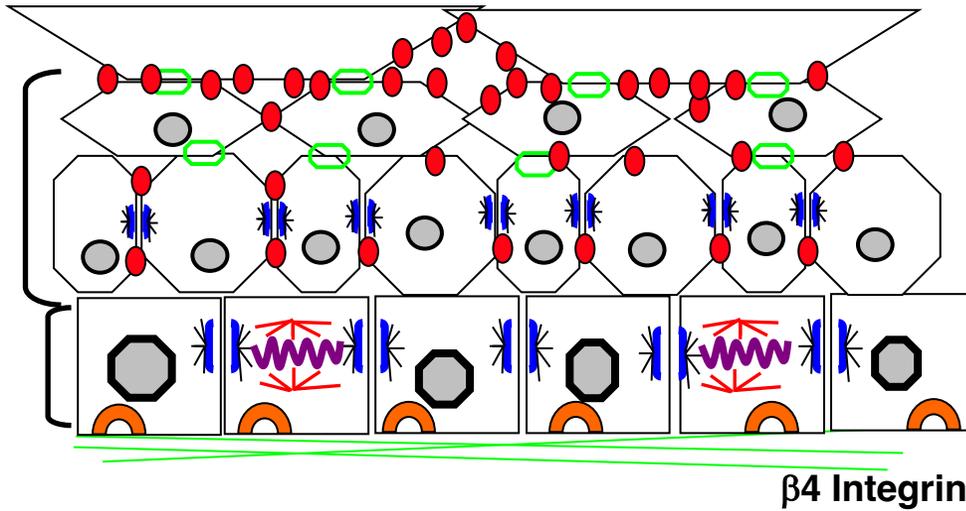
Developmental Process of the Developing Epidermis

Differentiation



Keratin 1

Keratin 14



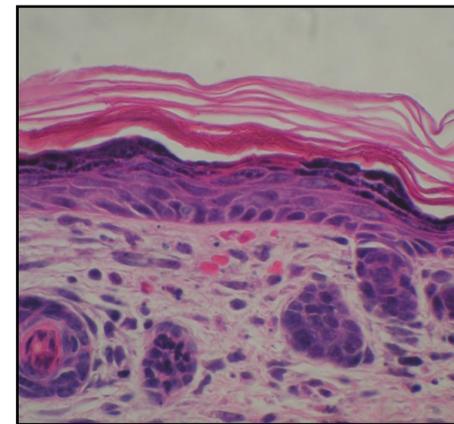
$\beta 4$ Integrin

Proliferation

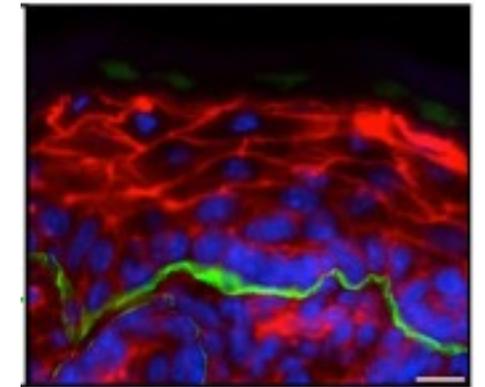
● :Tight Junctions

⌈ ⌋ :Adherens Junctions

wild-type



wild-type

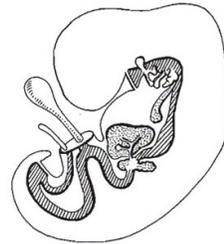
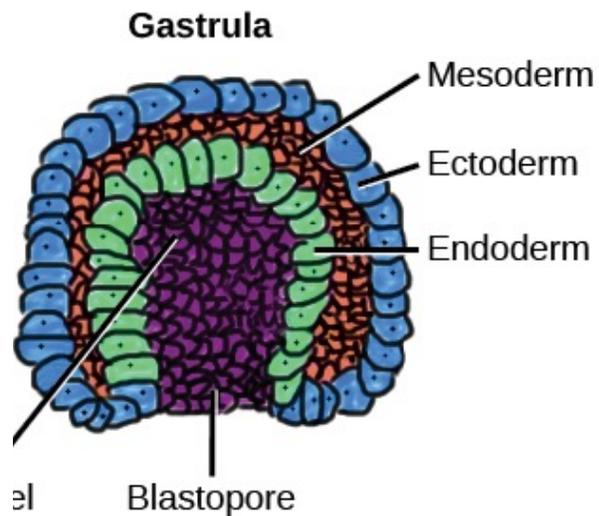


Red:
Actin

Green:
 $\beta 4$ -Integrin

Conclusions

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Questions:
Email: agladden@email.unc.edu