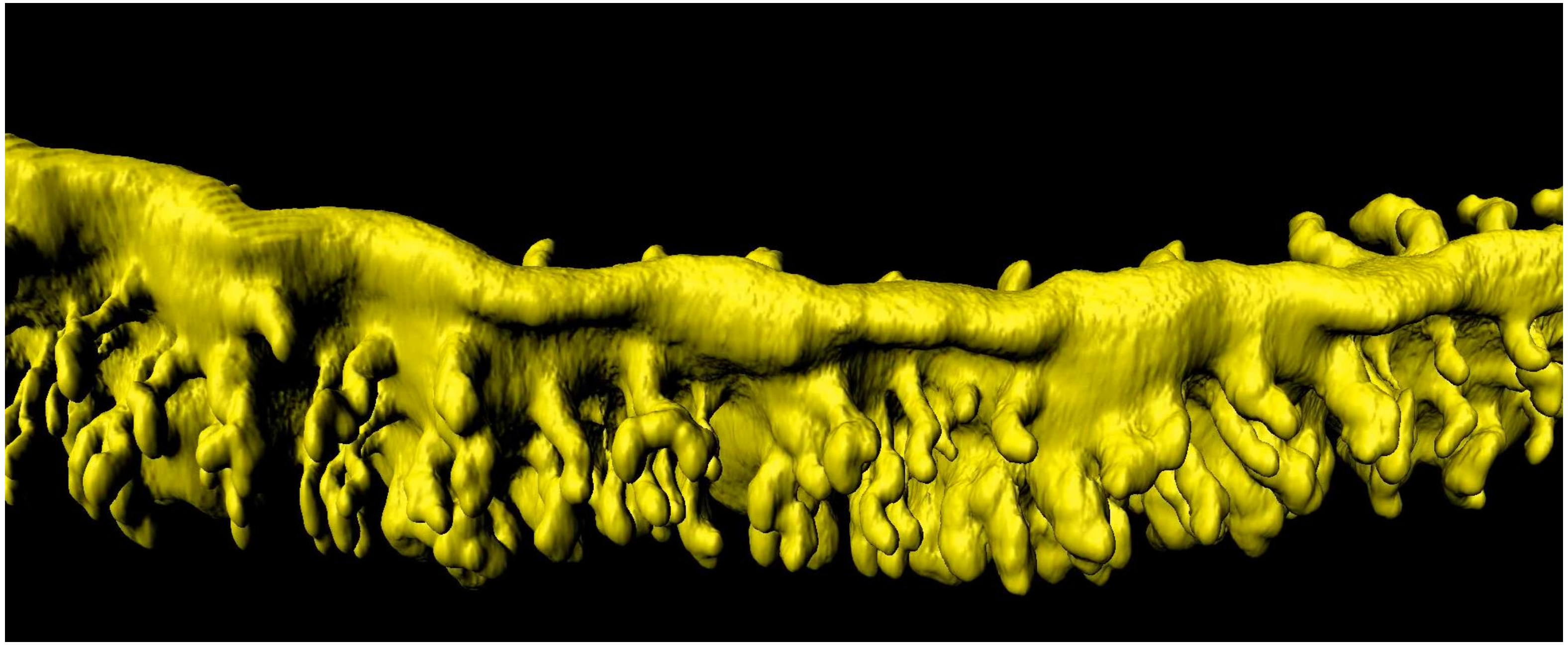
Tissue Organization; How do vertebrates make a spine?



Andrew B. Gladden, PhD; Associate Professor
Department of Pathology & Laboratory Medicine
University of North Carolina at Chapel Hill
Introduction to Pathology of Disease
August 28, 2025

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.
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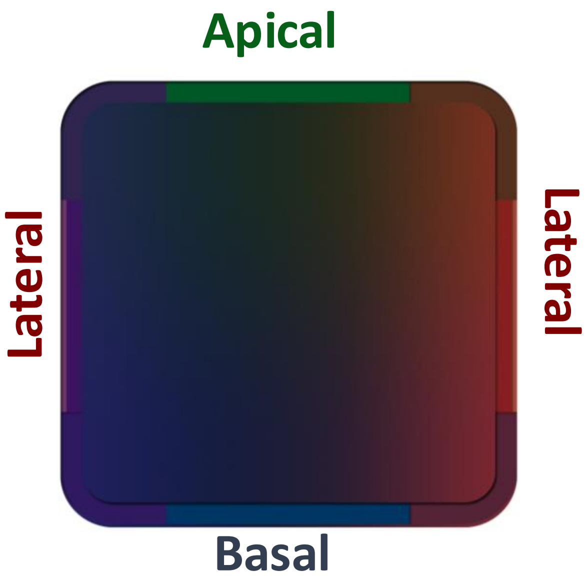
- Define the different types of epithelial tissues and how the gut and skin develops.

Try to Think in 3D!
How Can the Cans be Organized?

Poll 1

Try to Think in 3D! Like This?

How do you describe orientation in tissue?



Individual Cells

Organisms

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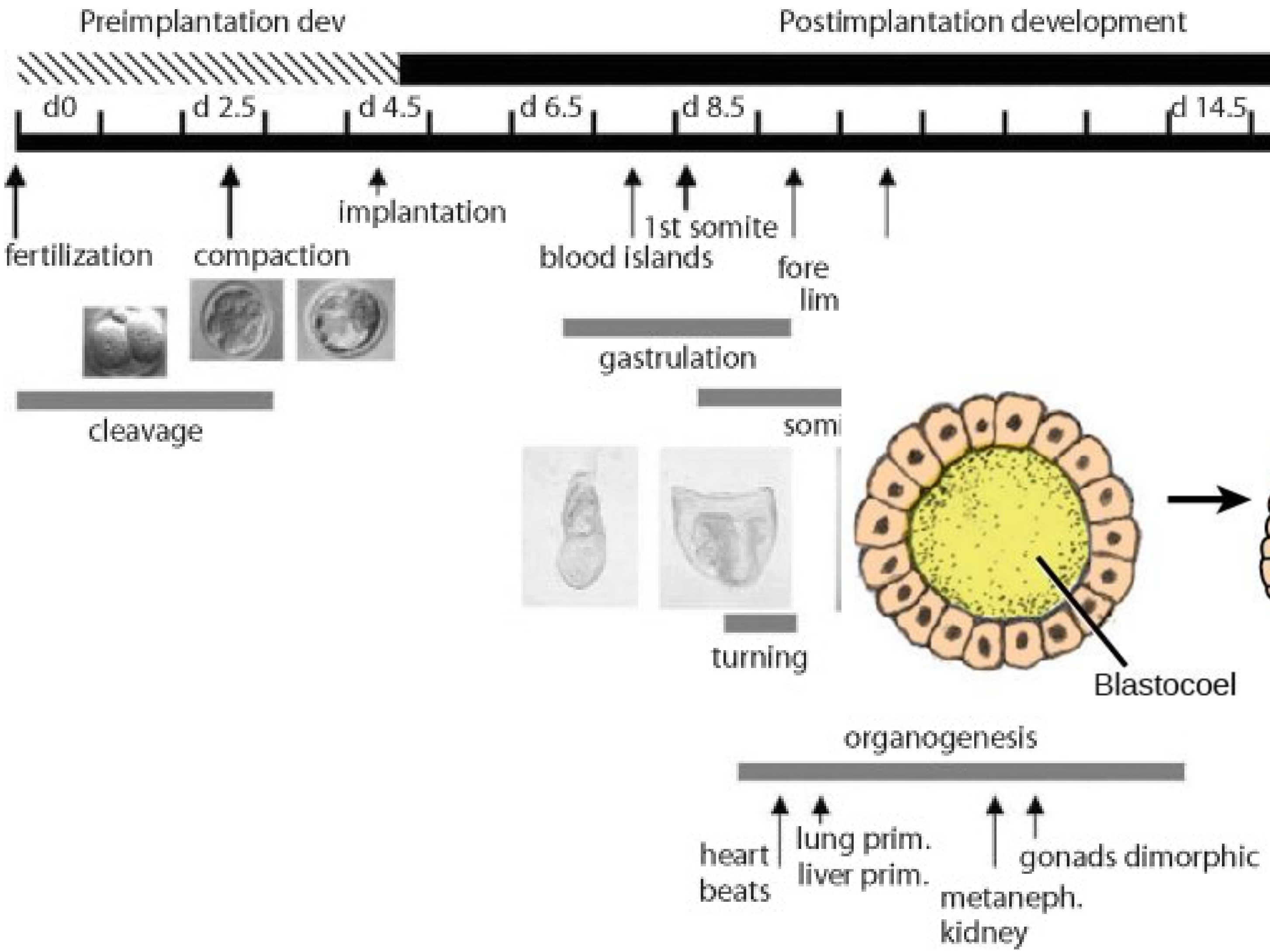
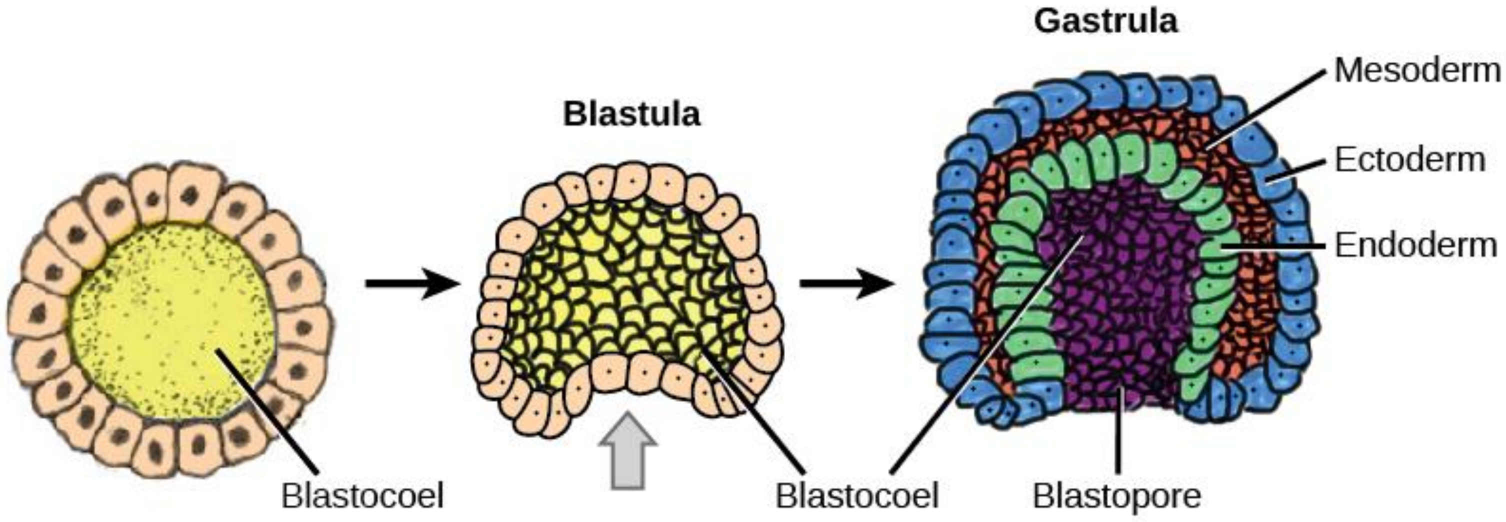
The Three Germ Layers

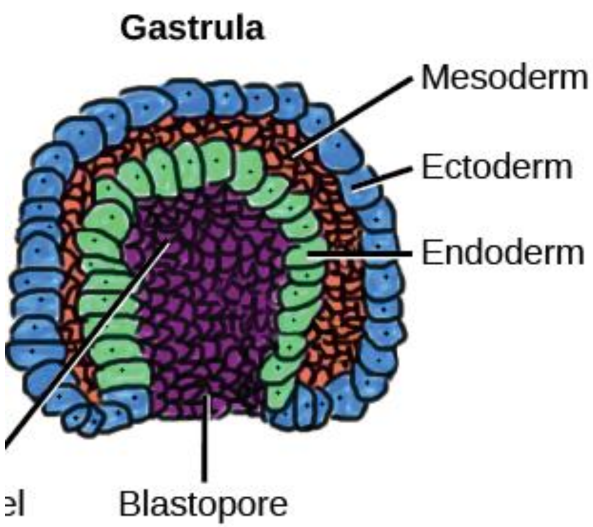


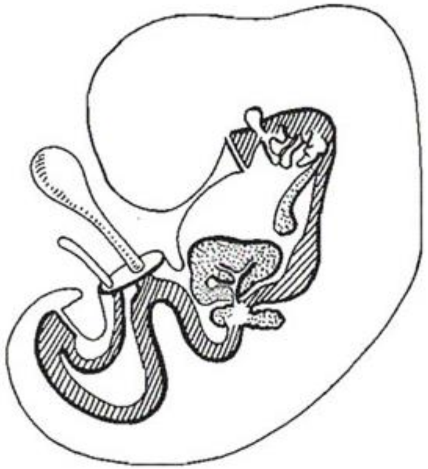


MacCord, Kate, "Germ Layers". *Embryo Project Encyclopedia, 2013*.

Poll 2

Germ Layer Derivatives



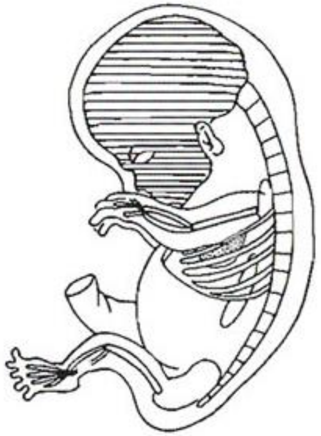


ENTODERM

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

NERVOUS TISSUE

Neural tube
- CNS
- Retina
- Post. pituitary
- Pineal gland

Neural crest
- Pigment cells
- Adrenal medulla
- Cranial and sensory nn.
- Cranial and sensory ganglia

EPIDERMIS

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Mammary glands
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Pansky, B. Review of Medical Embryology, 1982.

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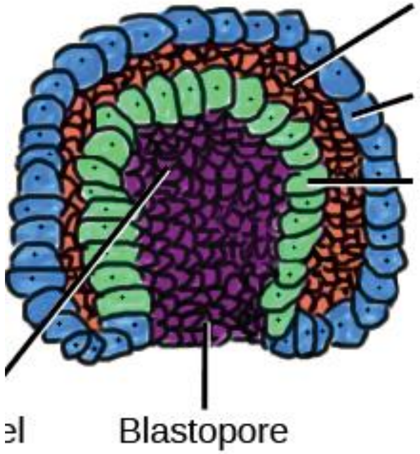

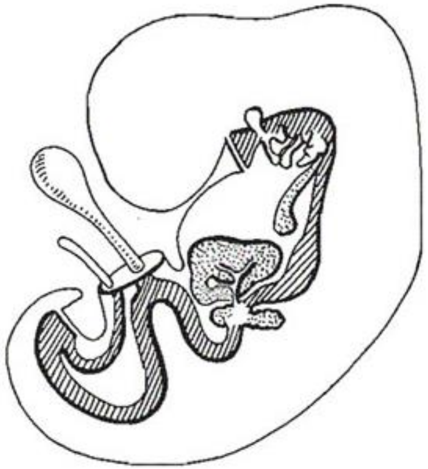

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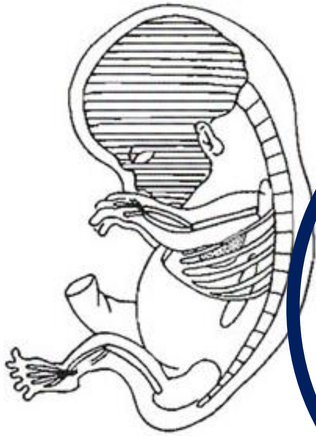

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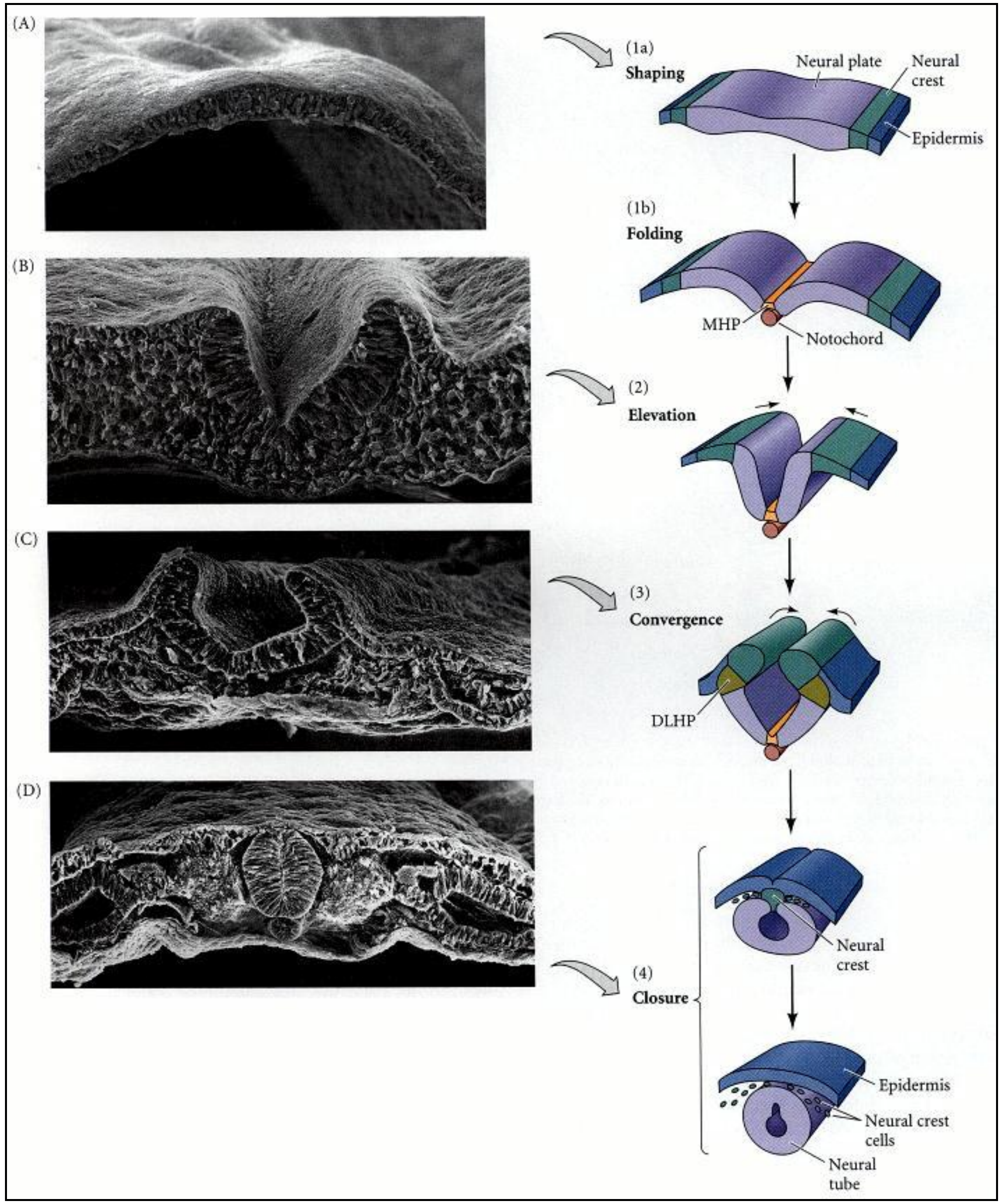
The Beginning of a Spine!

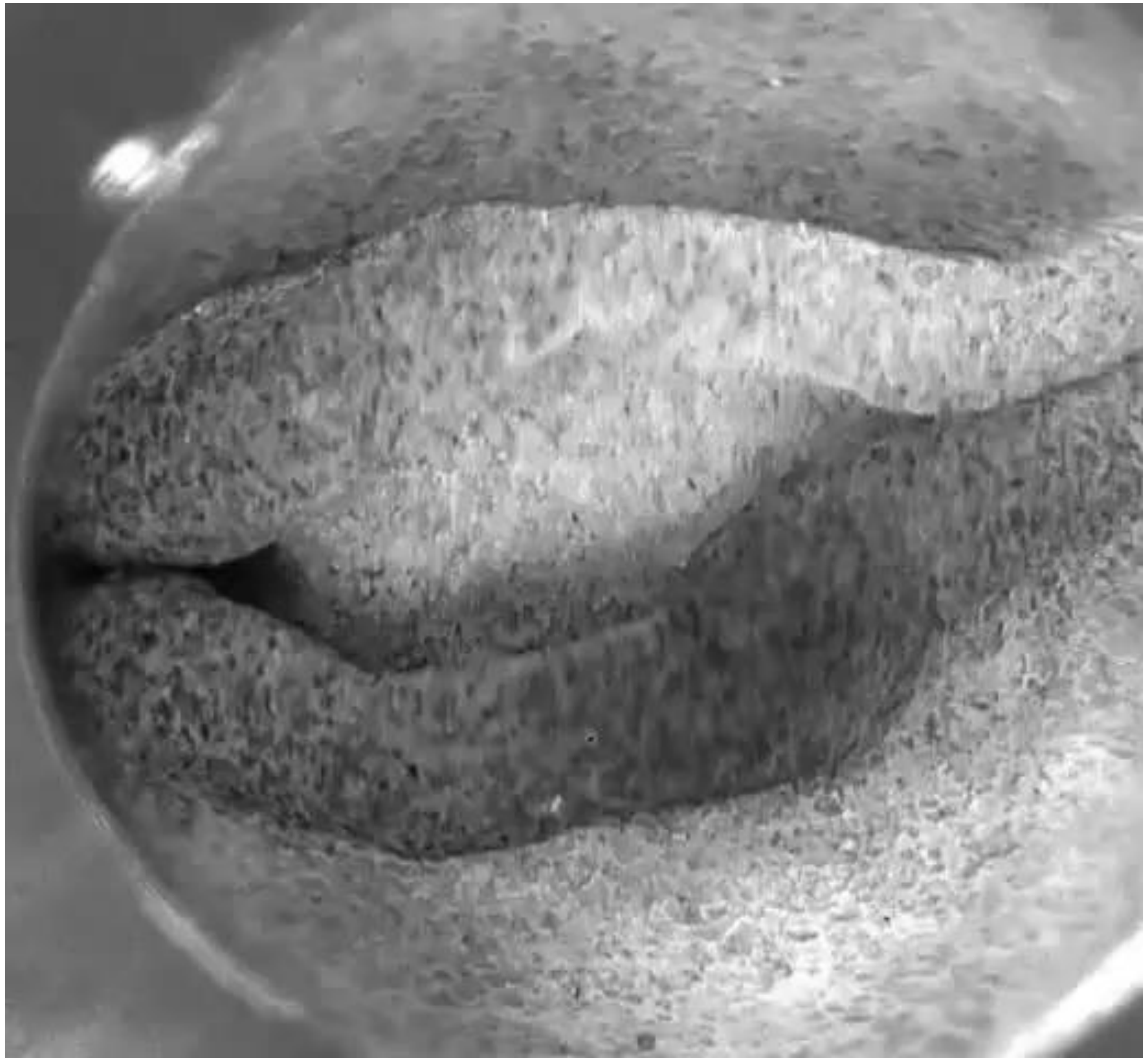


Starts at e8.5 in mouse, completed at e10.5.

Completed the fourth week of pregnancy in humans.

Gilbert SF. Developmental Biology. 6th edition. Sunderland (MA): Sinauer Associates; 2000. Formation of the Neural Tube.

The Beginning of a Spine! In Real Time!



Axoloti embryo:
Tiger Salamander or
Mexican Salamander

Wallingford, J.B., Harland, R.M. Development, 2002, 12:5815-5825.

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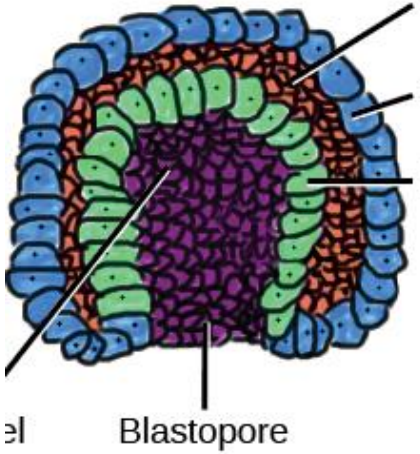

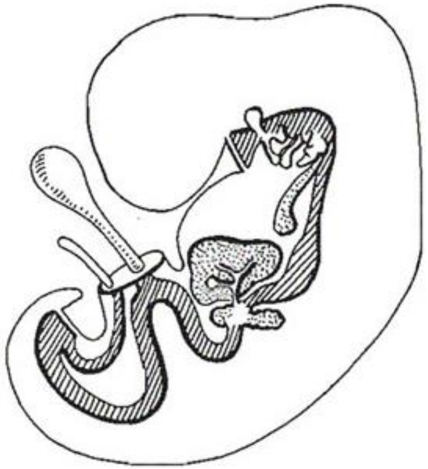

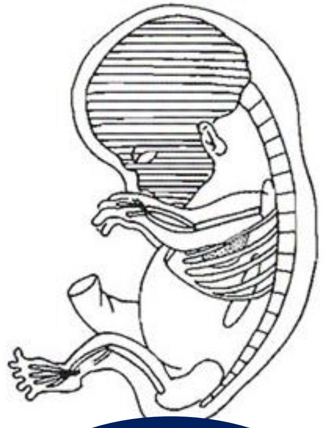

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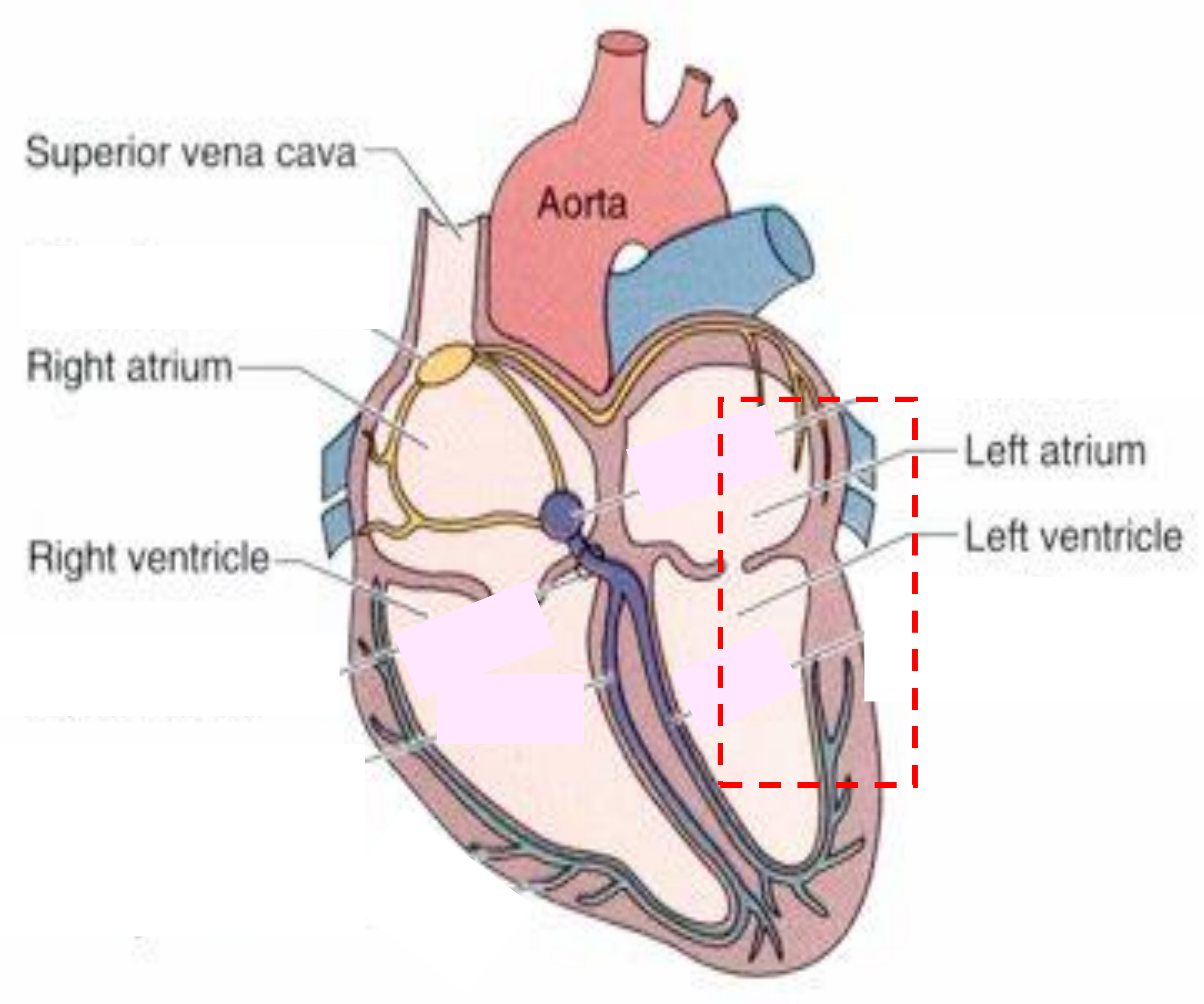
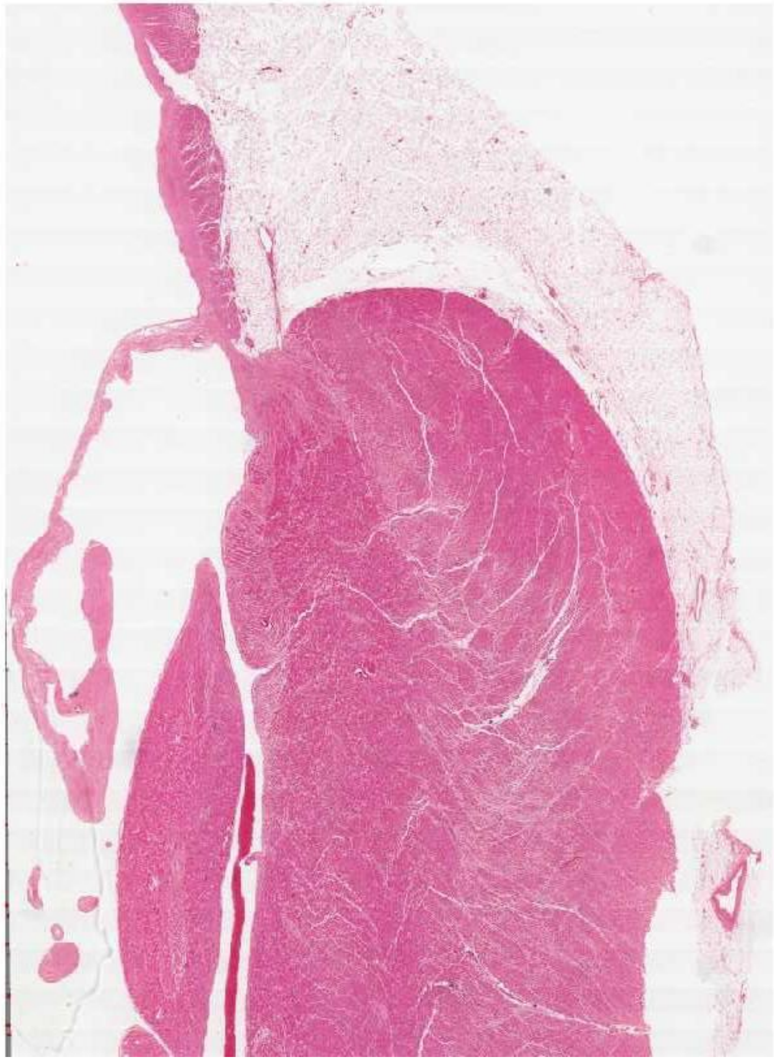
Looking at the Heart by H&E





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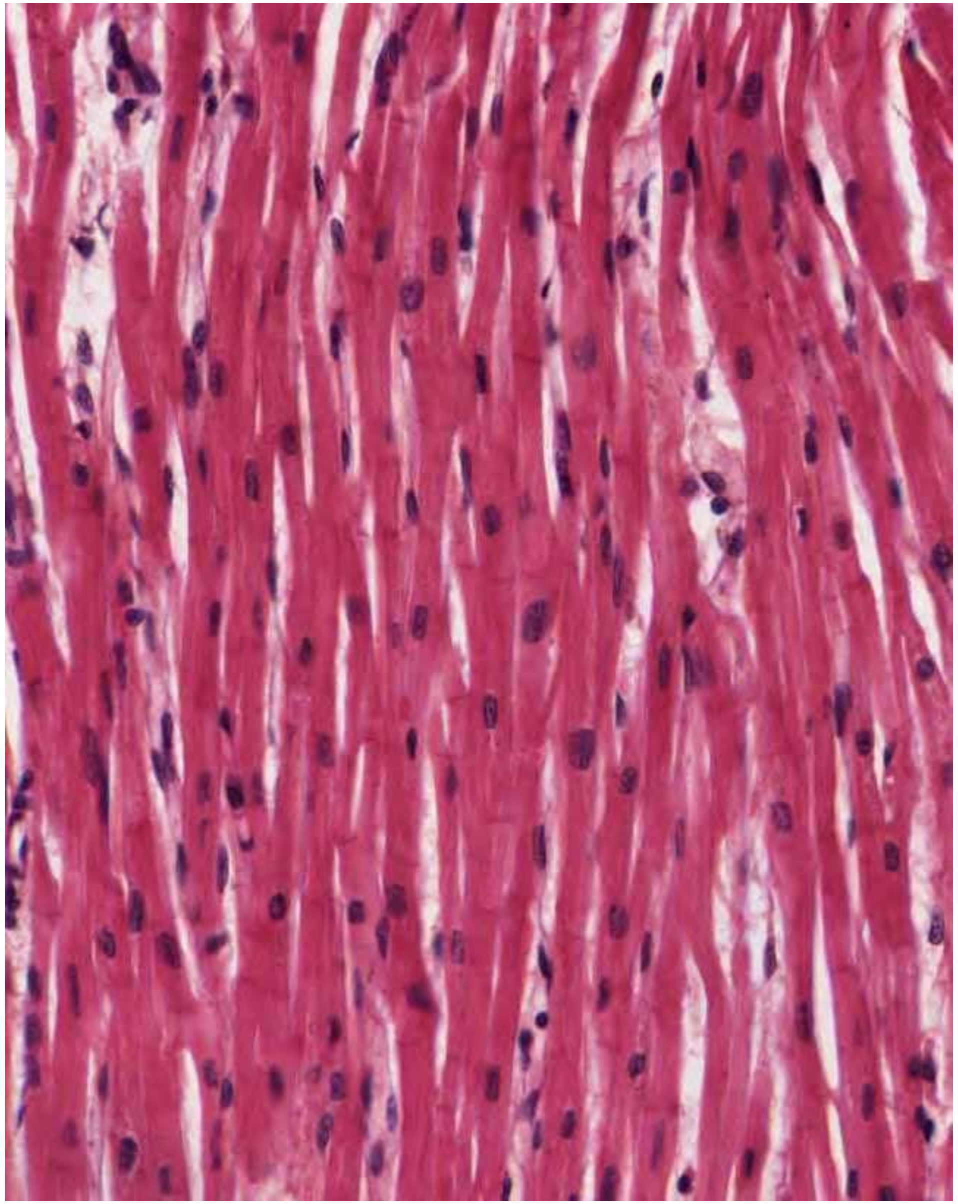
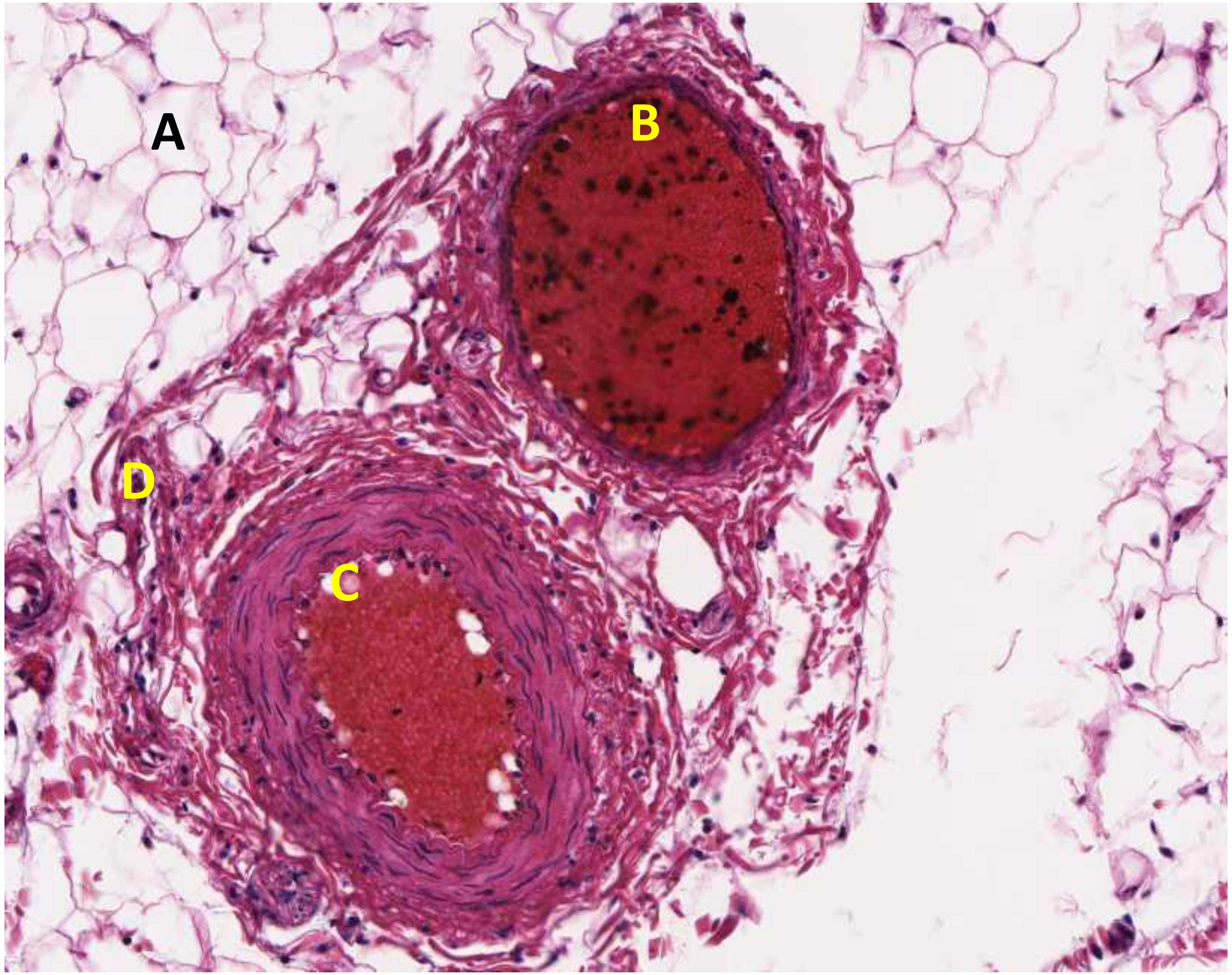


What are the cellular components of the peripheral vasculature?



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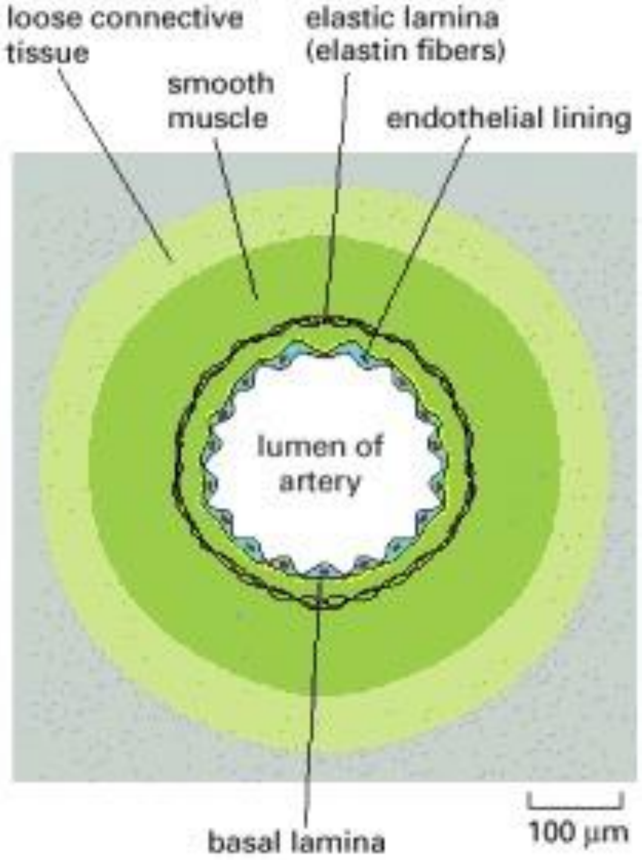

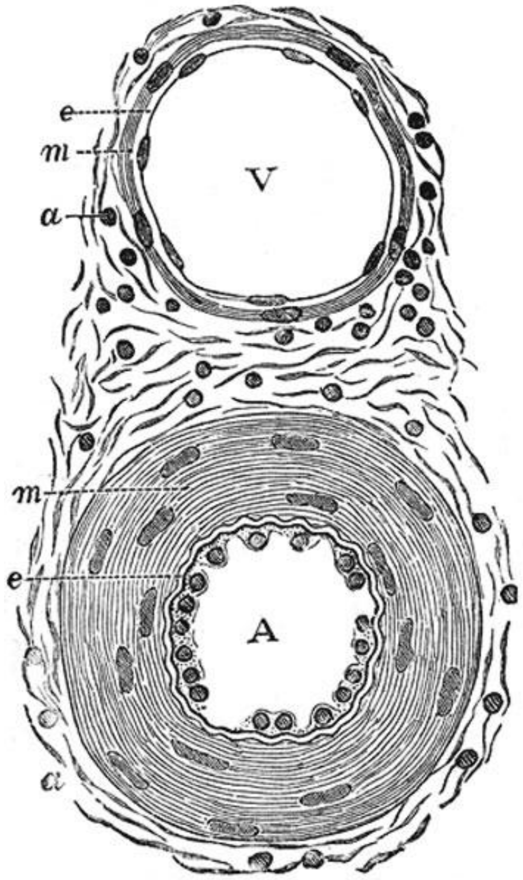

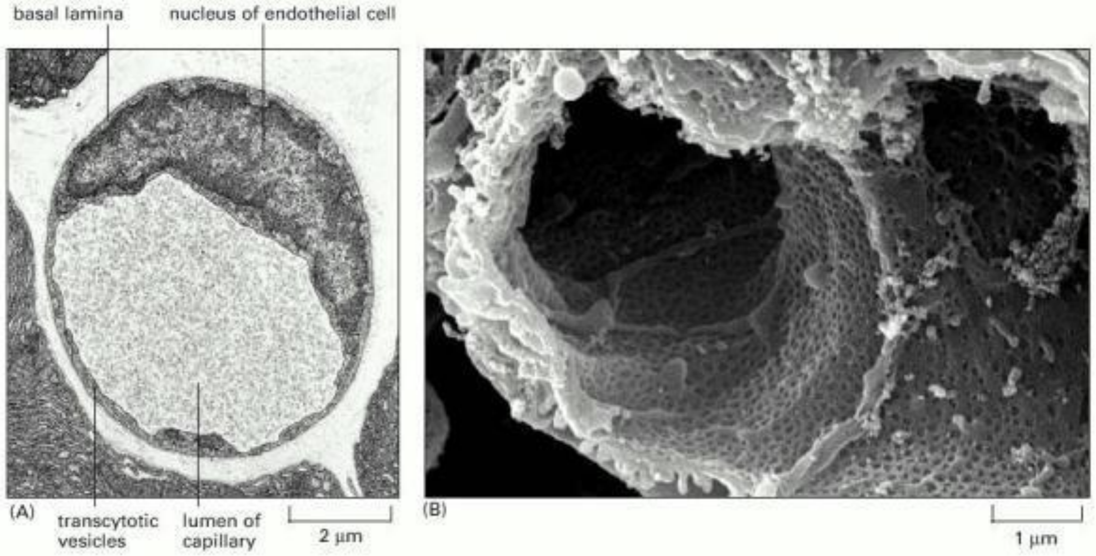

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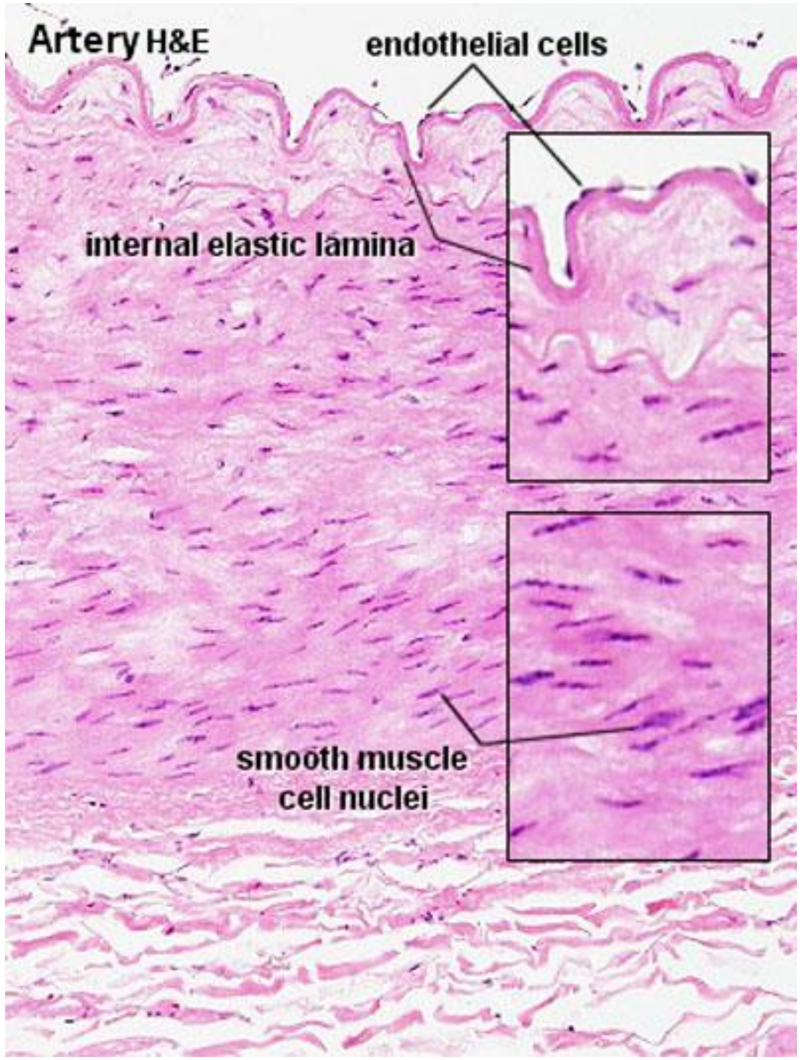

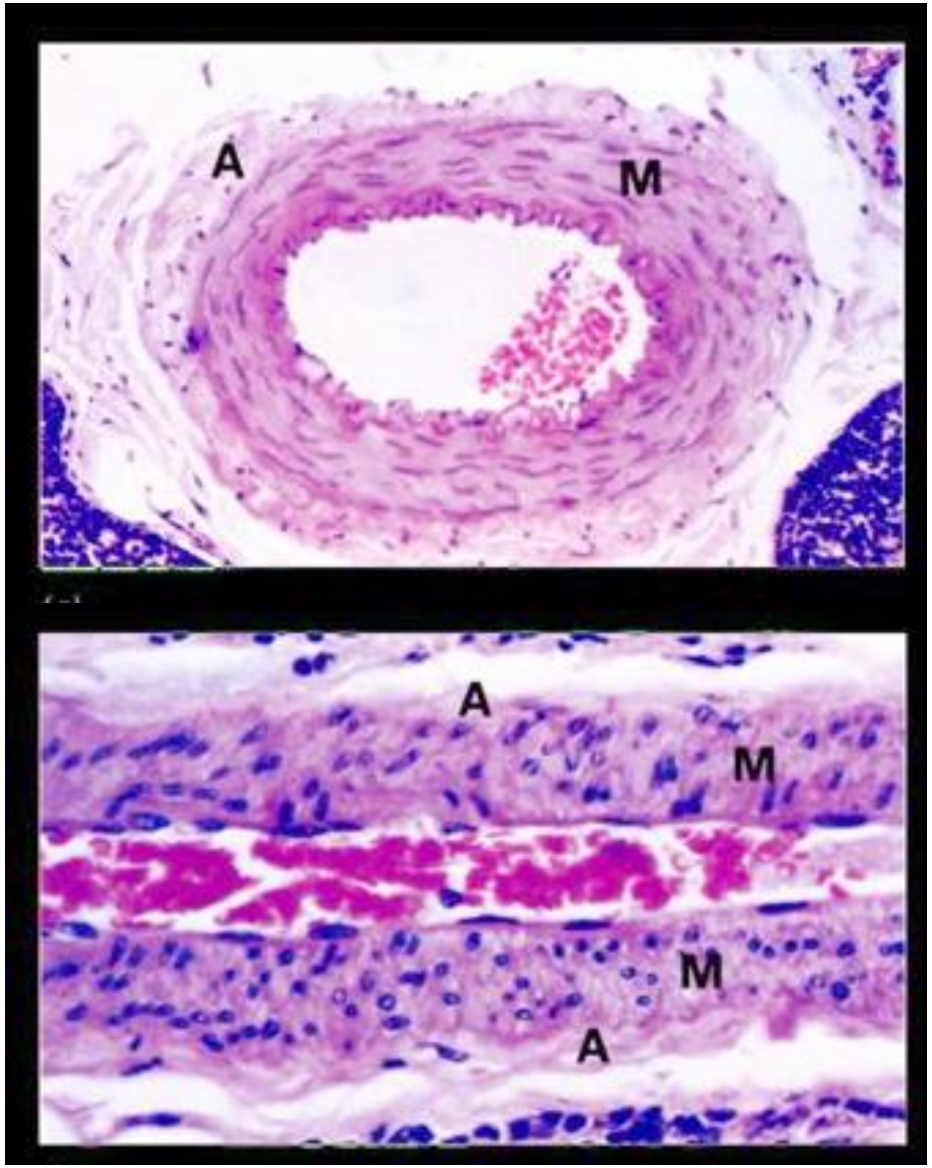

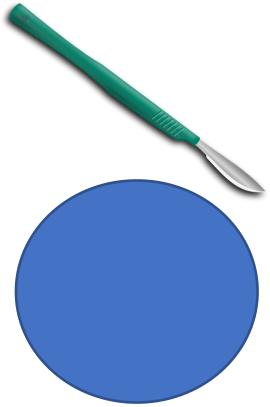

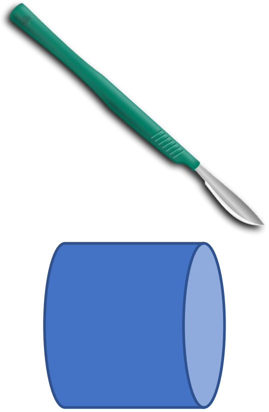

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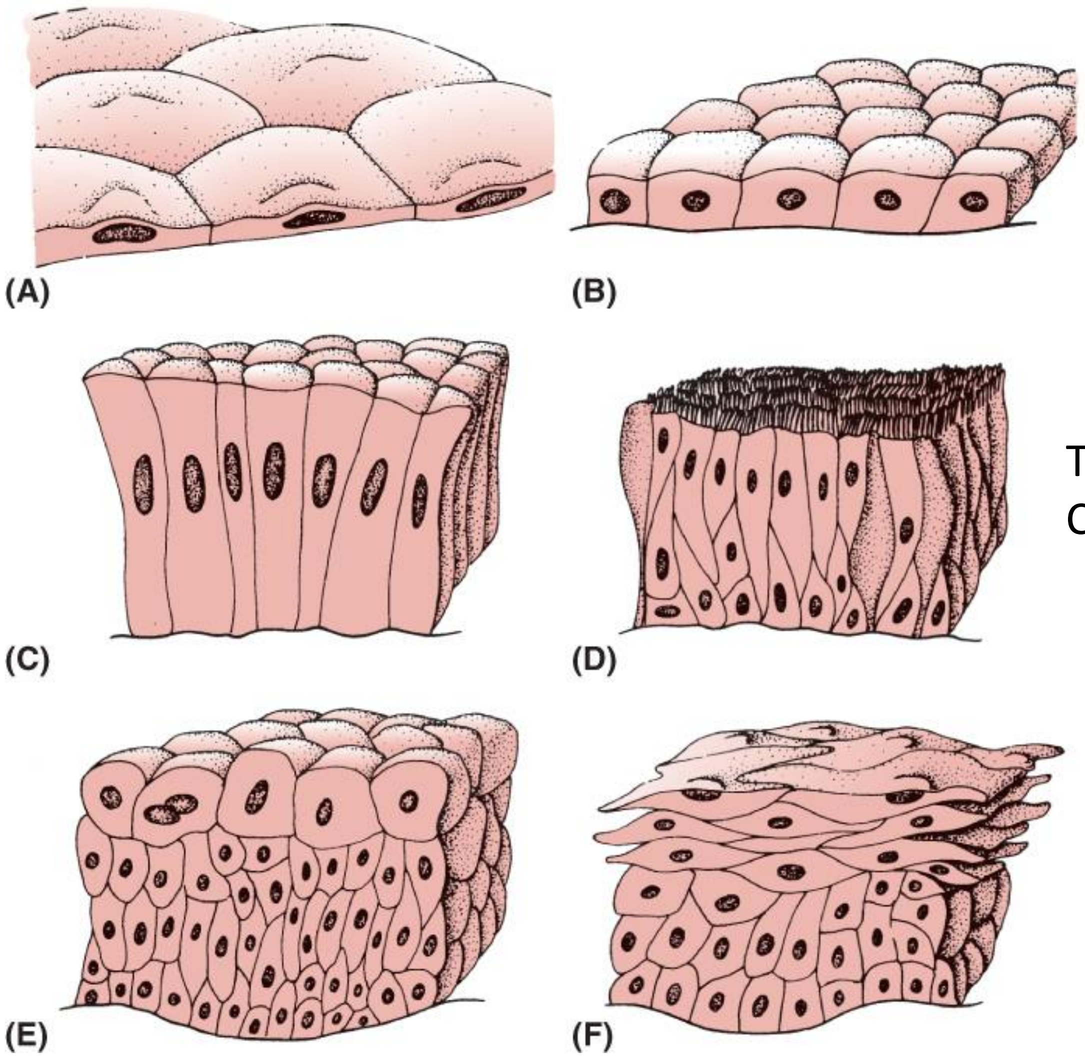
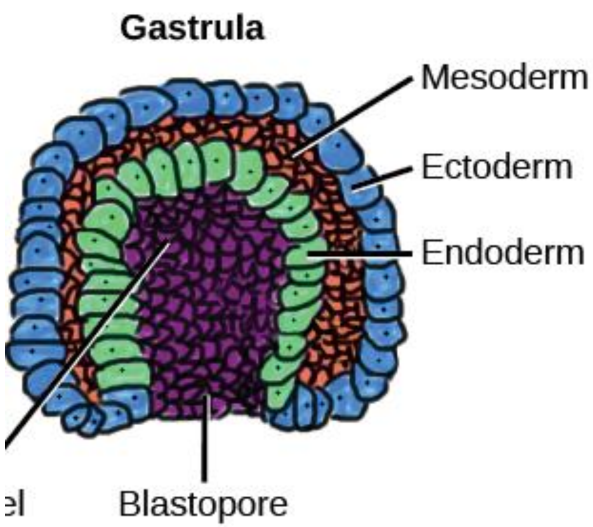
Different Types of Epithelial Tissues

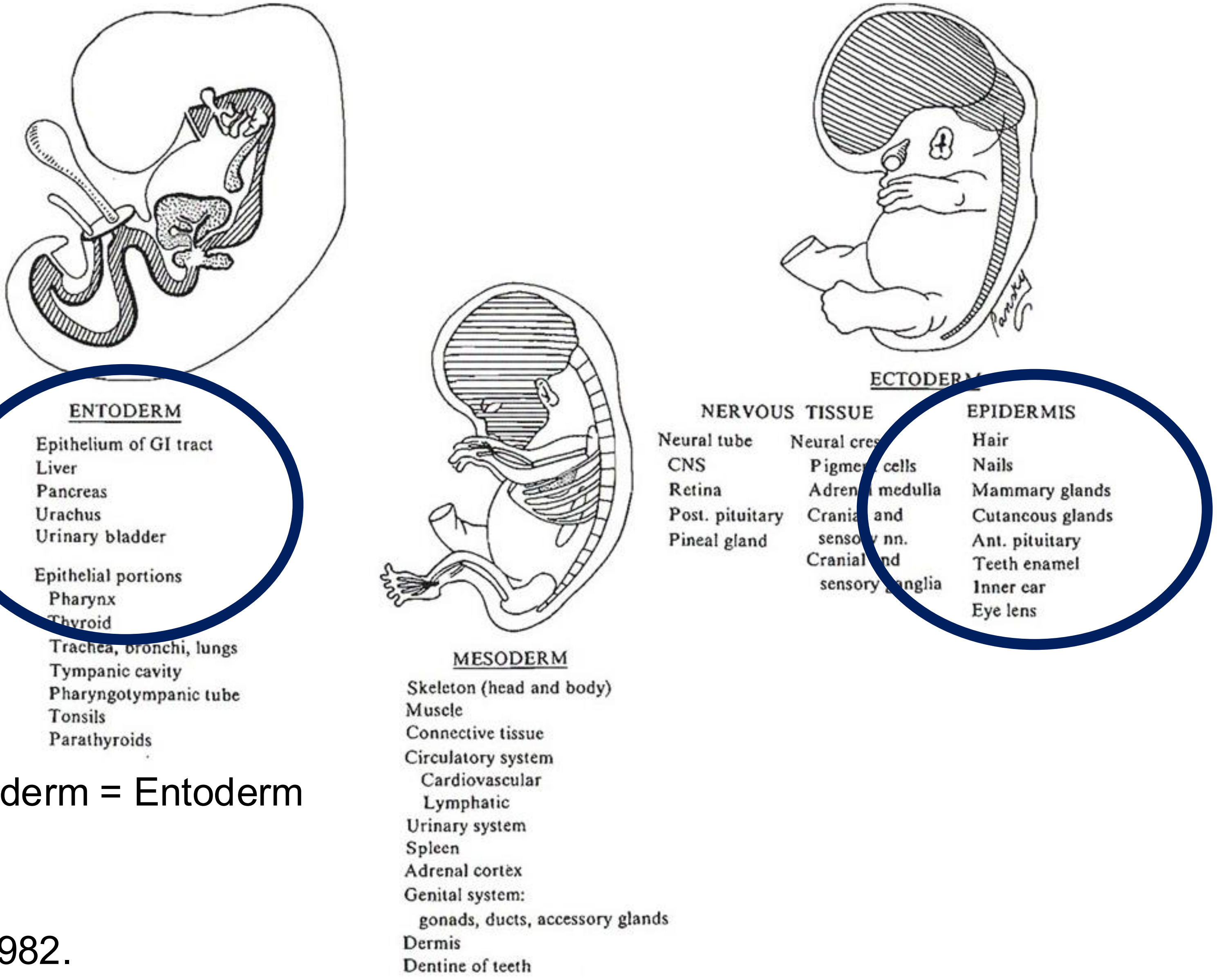


02.F04: Common types of epithelium: (A) simple squamous, (B) cuboidal, (C) columnar, (D) pseudostratified columnar (ciliated), (E) transitional, and (F) stratified squamous.

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

Germ Layer Derivatives





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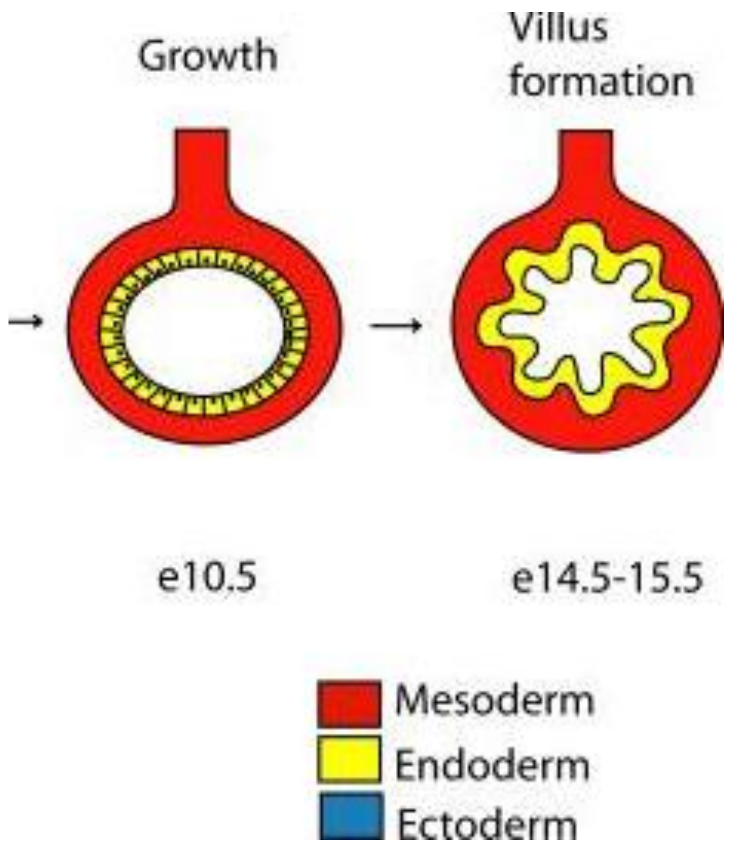
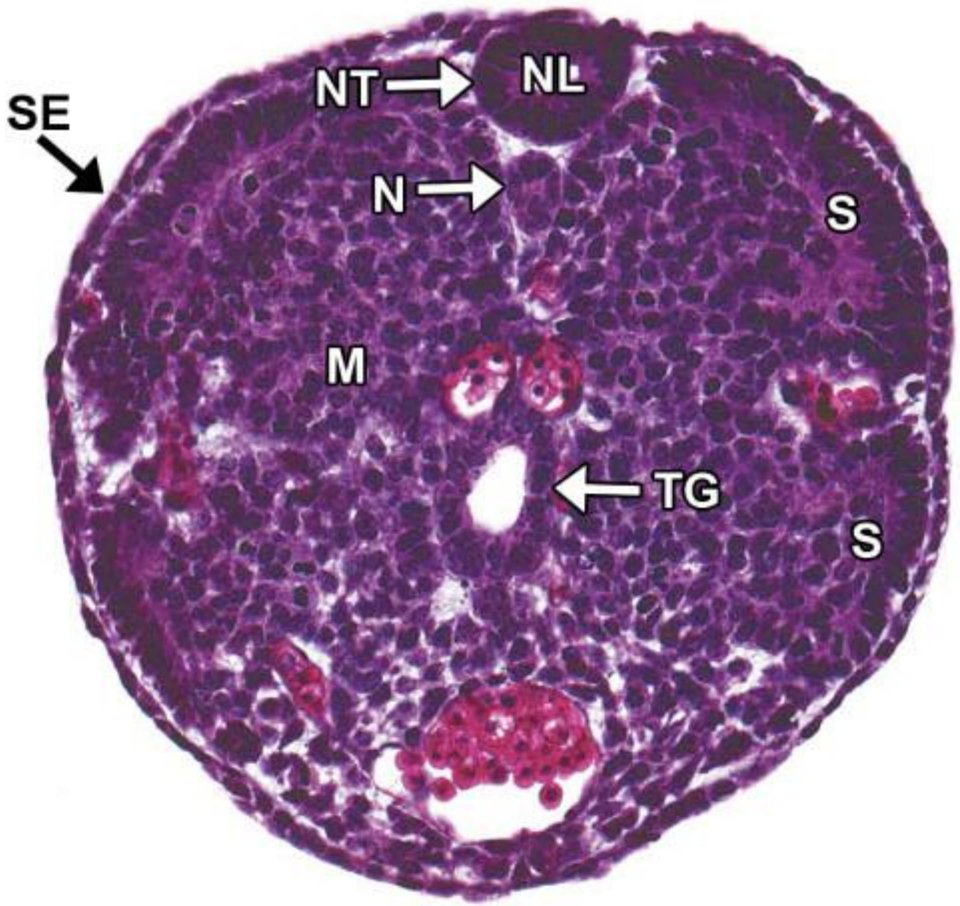
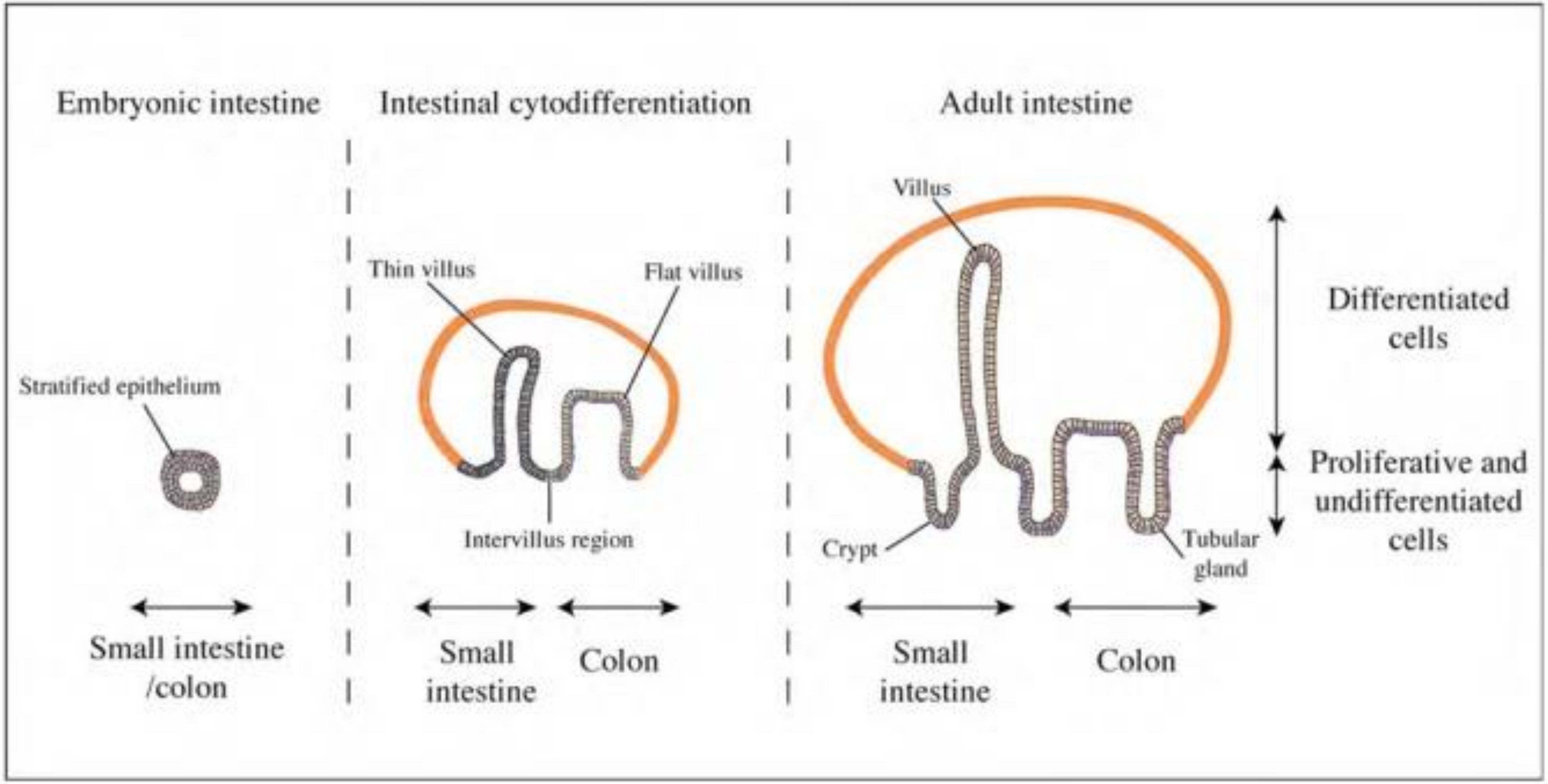
Pansky, B. Review of Medical Embryology, 1982.

How does the gut form?



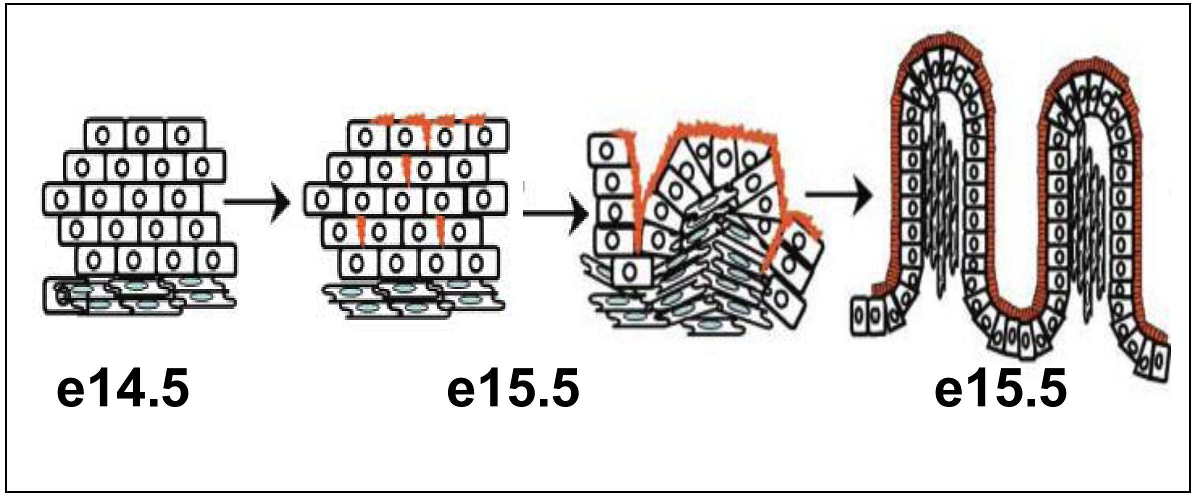


How does the gut form?

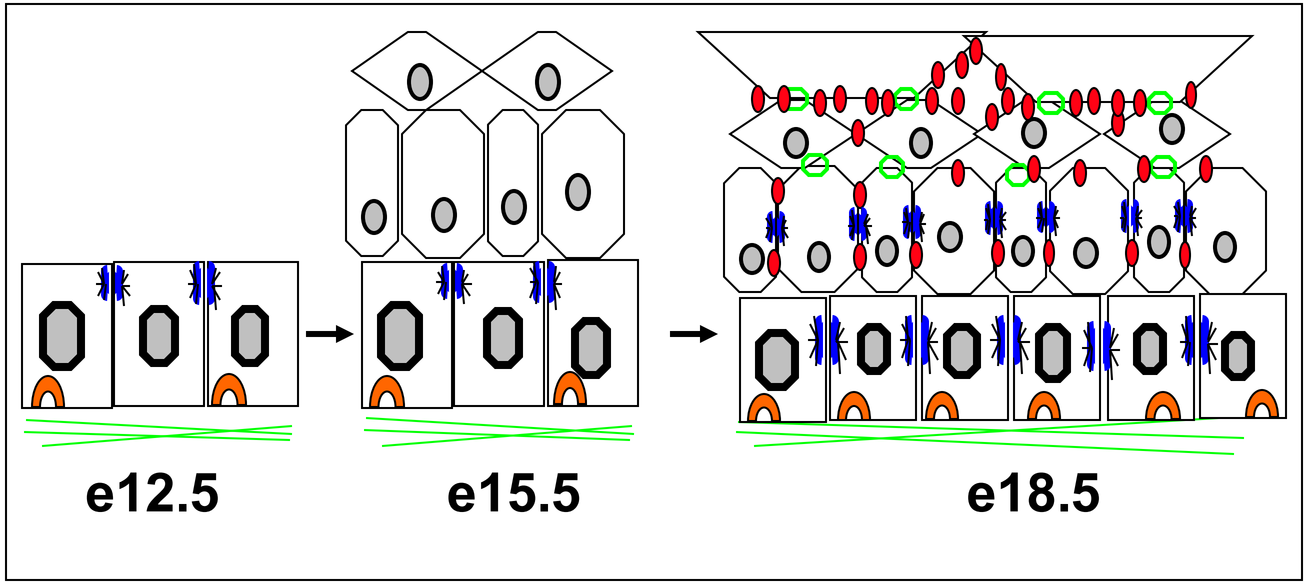


Tail of Two Epithelial Developmental Processes

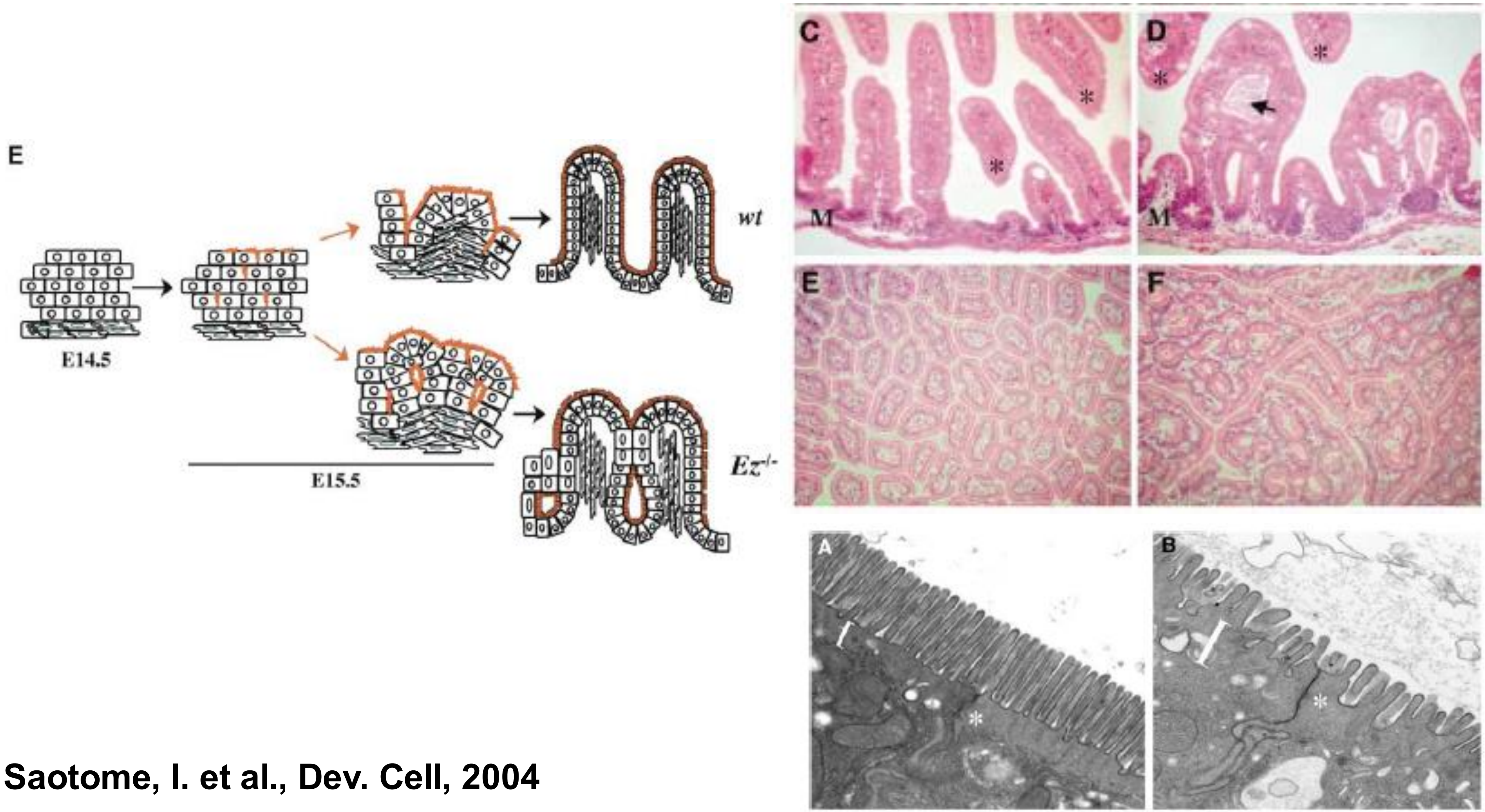
Intestinal Development



Epidermal Development



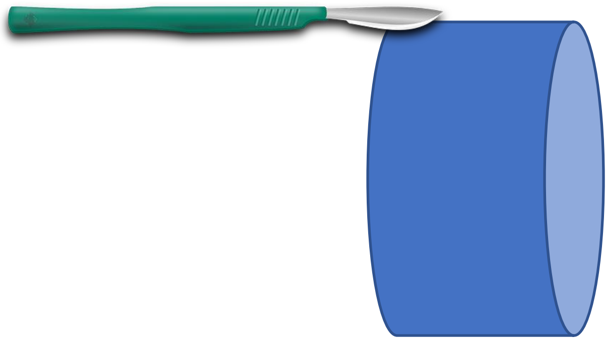
What happens when villus formation is disrupted?

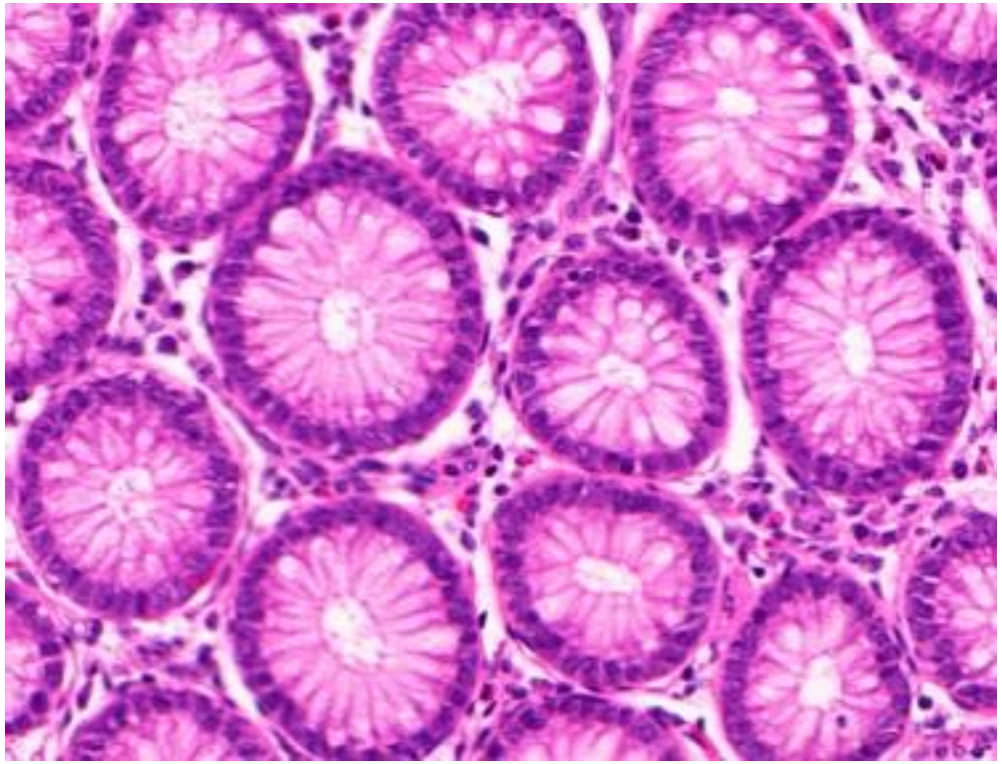


Saotome, I. et al., Dev. Cell, 2004

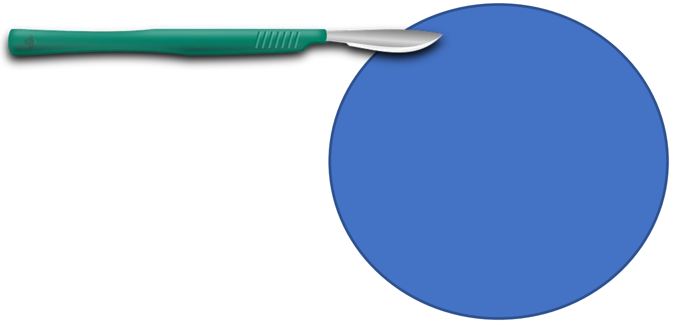
Histology of different orientations of the gut

Small Intestine (lateral)





Small Intestine (transverse)



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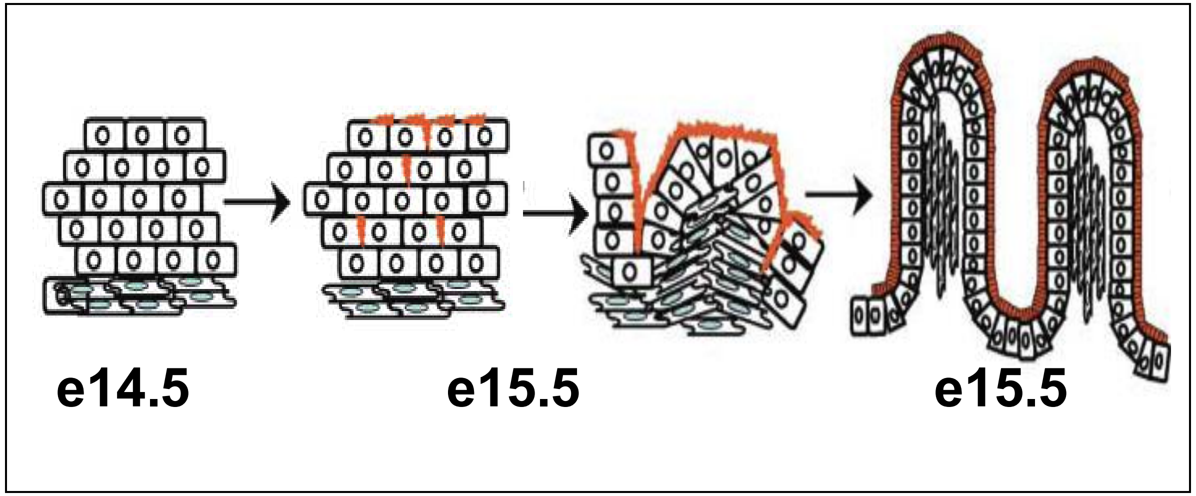

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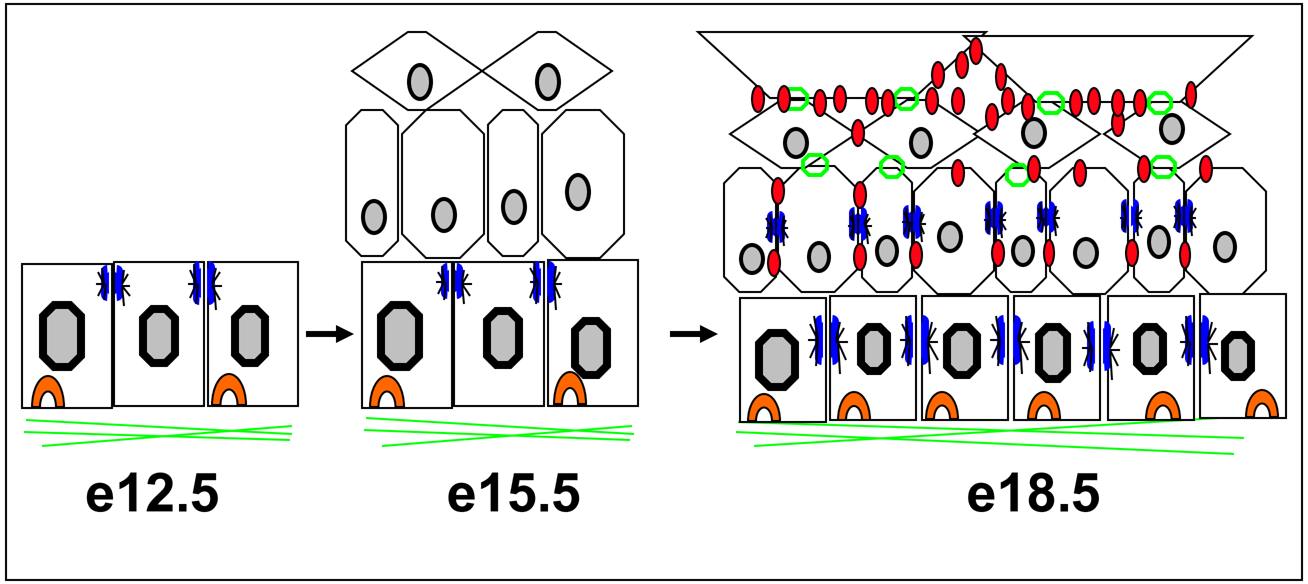
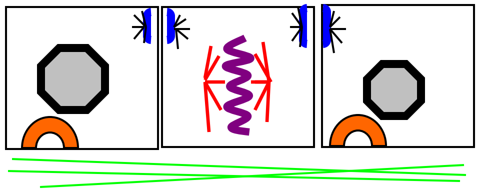
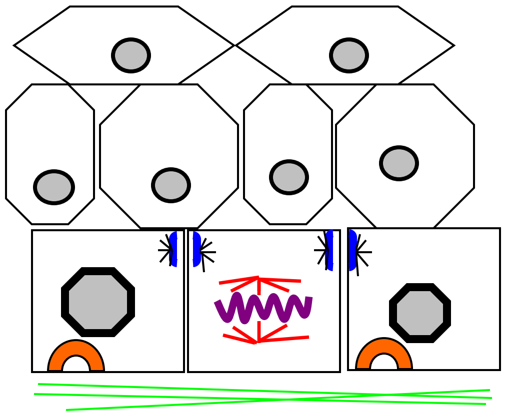


Initiation of Stratification in the Embryonic Epidermis



e12.5

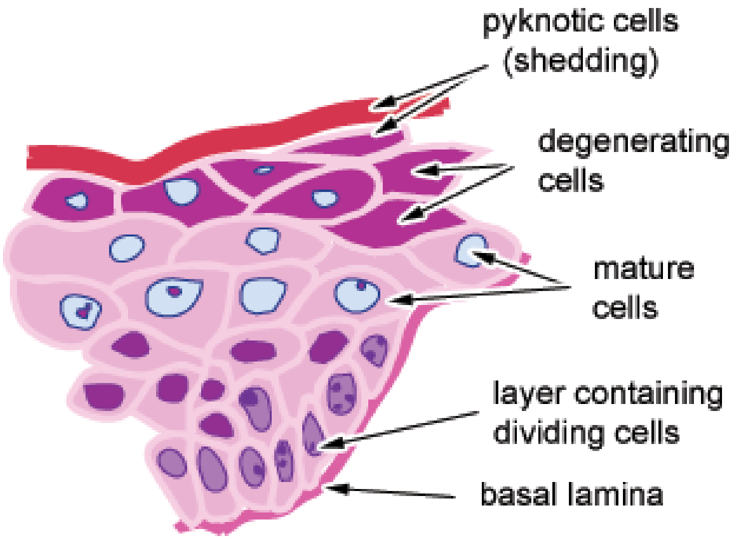
Ratio of symmetric to asymmetric spindle orientation in wild type basal cells: 70% to 30%



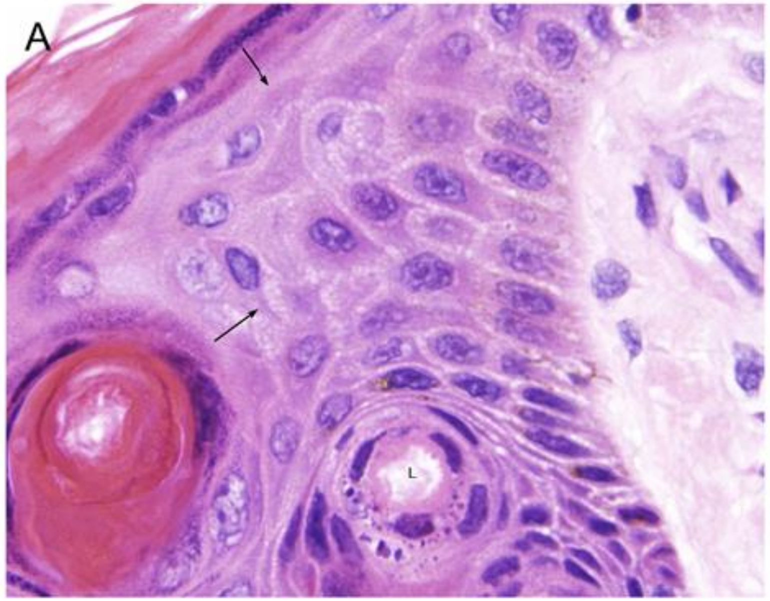
e15.5

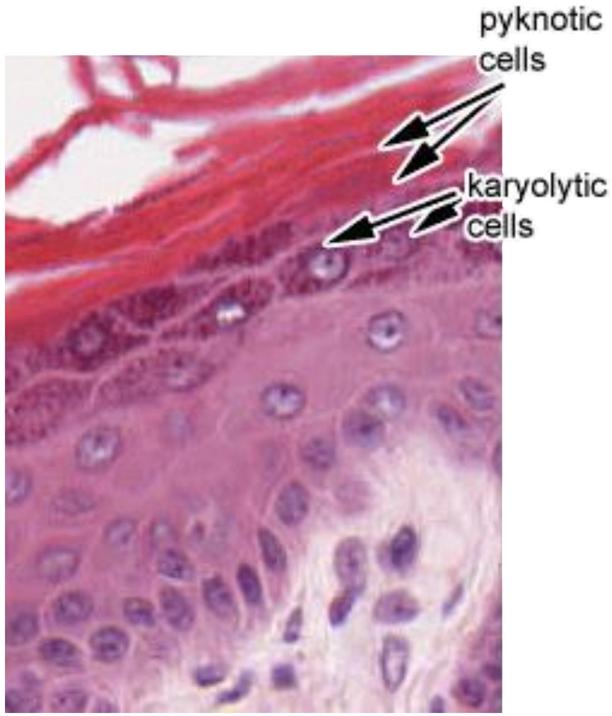
Ratio of symmetric to asymmetric spindle orientation in wild type basal cells: 30% to 70%

Terminology for Chromatin Changes



The Process of Differentiation
Observable in One Tissue



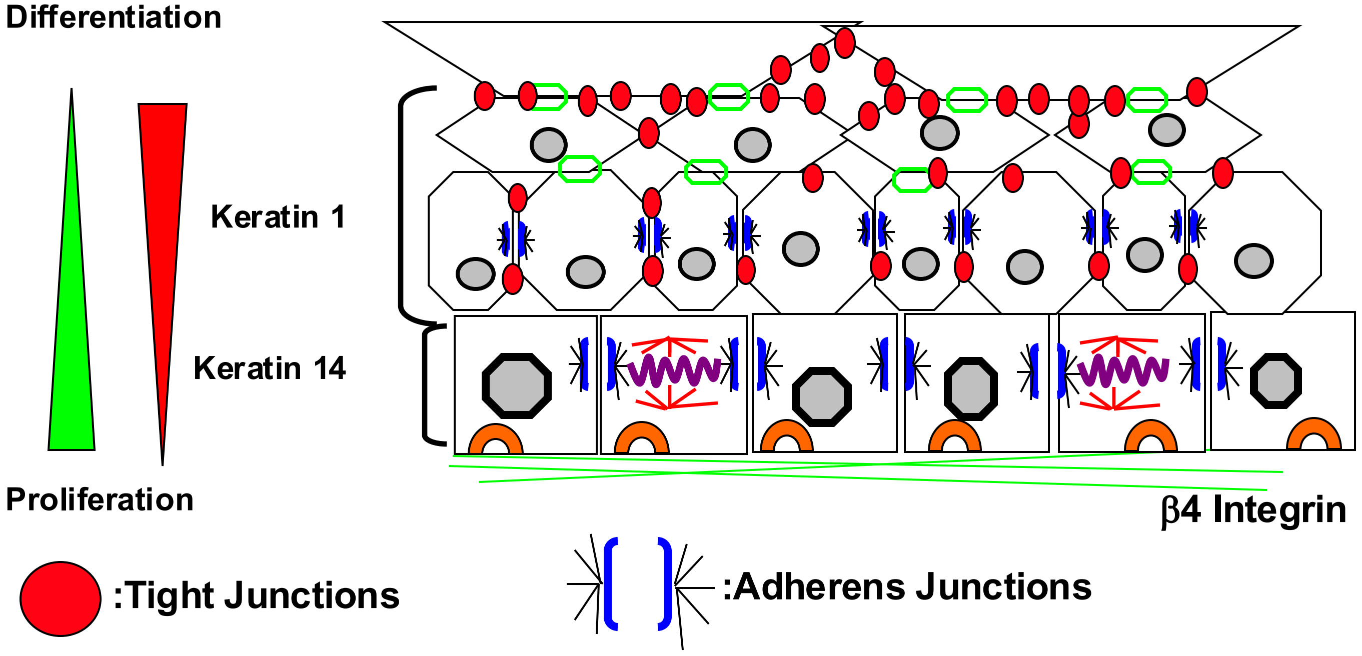


Defects in Differentiation
Can Lead to Disease

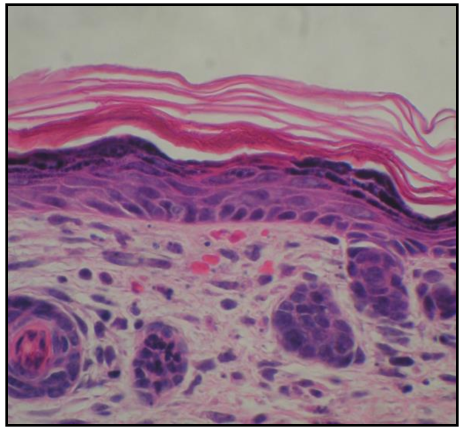
Karyolytic – dissolving chromatin

Pyknotic – <u>irreversible</u> chromatin condensation

Developmental Process of the Developing Epidermis



wild-type



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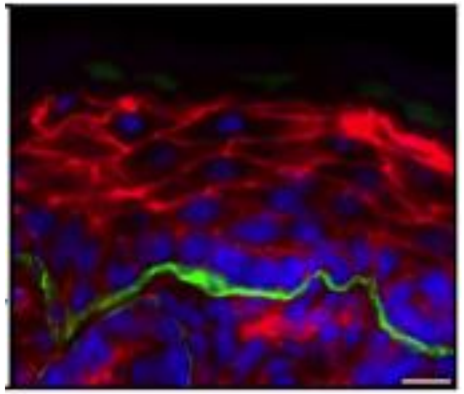

Red: Actin

Green: β4-Integrin

Conclusions

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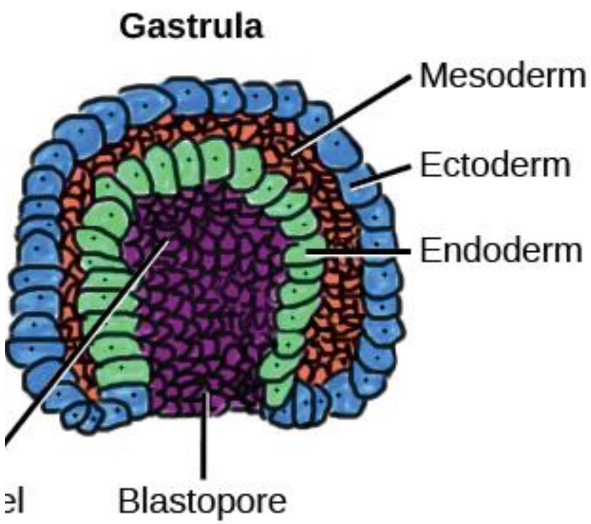

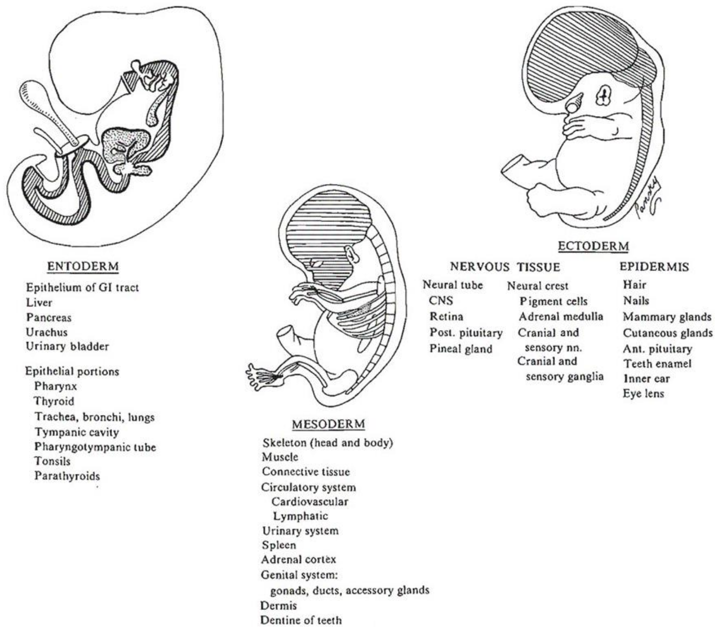

Questions:
Email: agladden@email.unc.edu