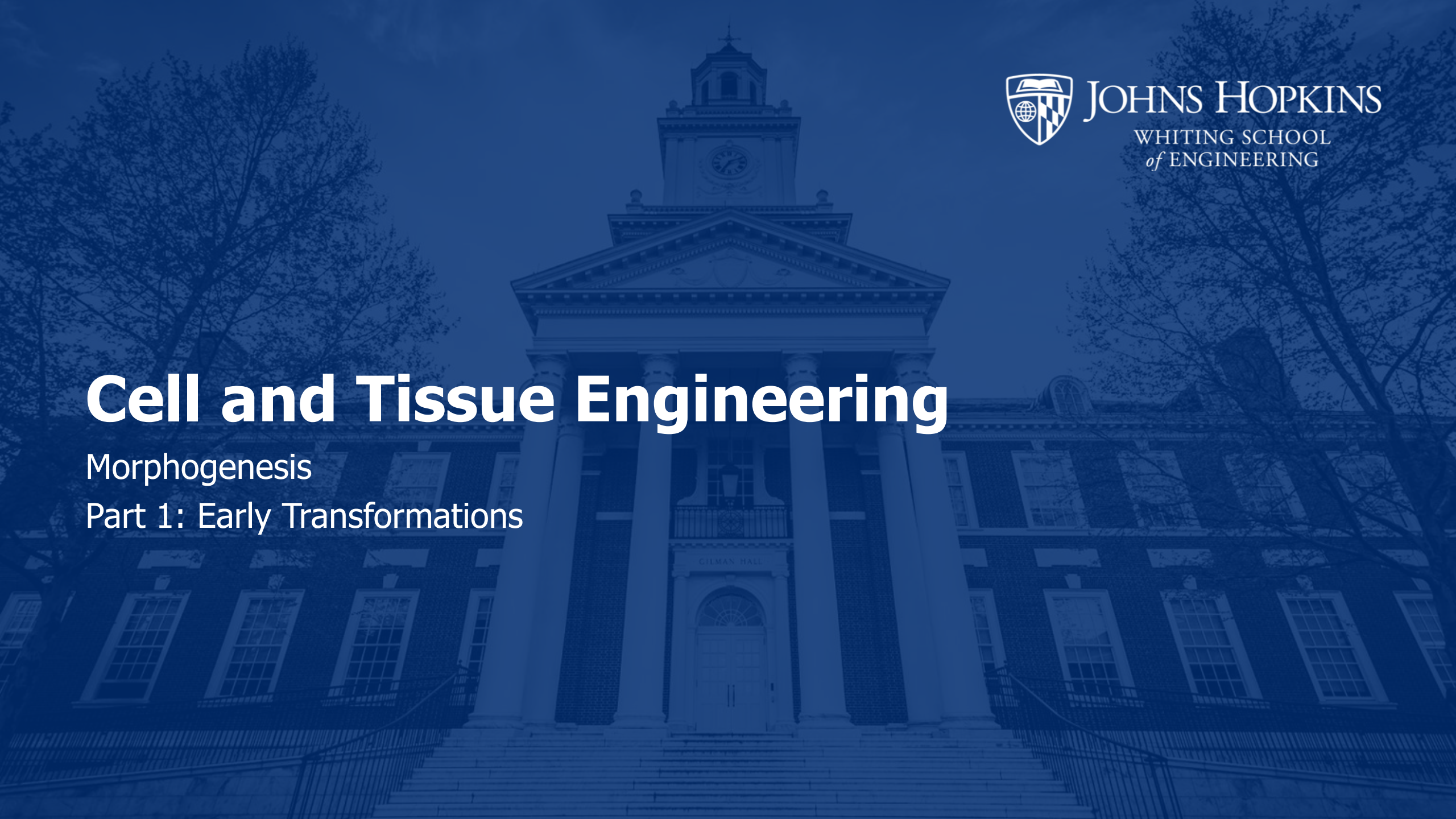


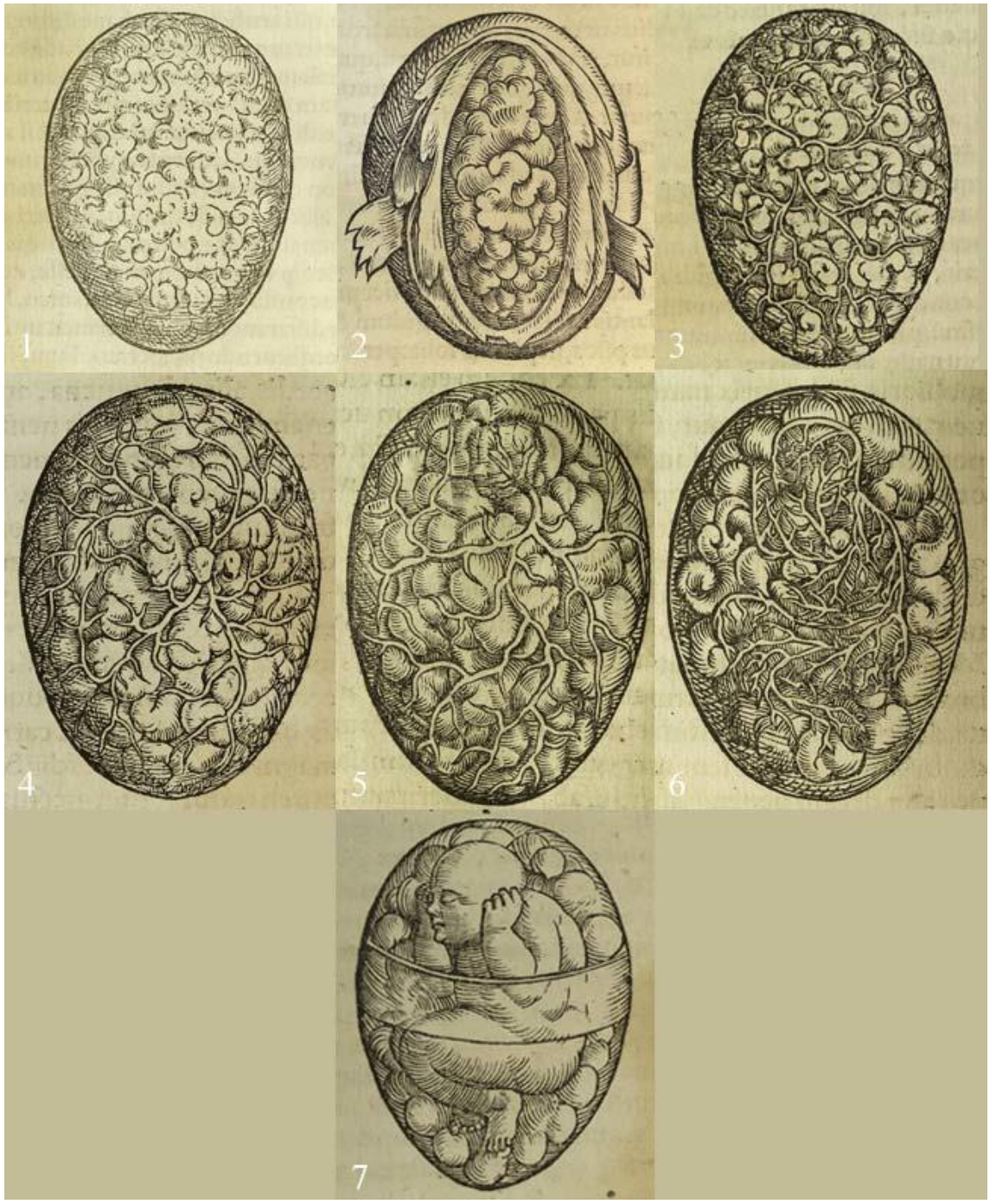
JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Cell and Tissue Engineering

Morphogenesis

Part 1: Early Transformations

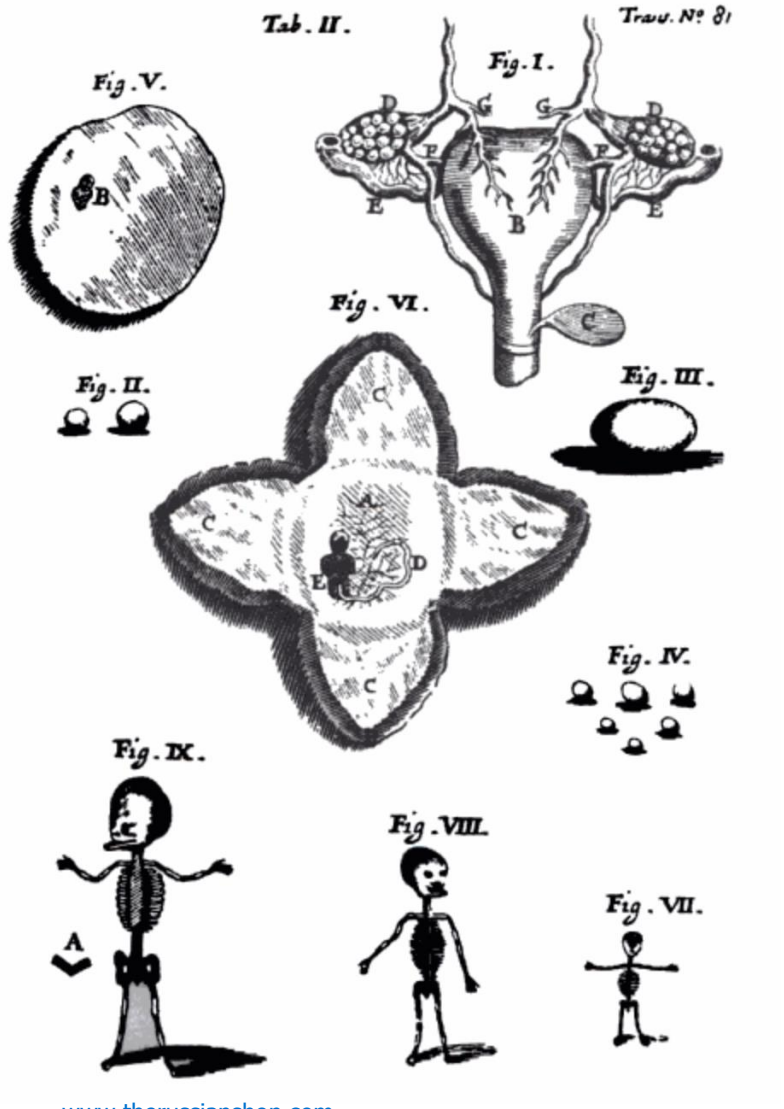
Epigenesis

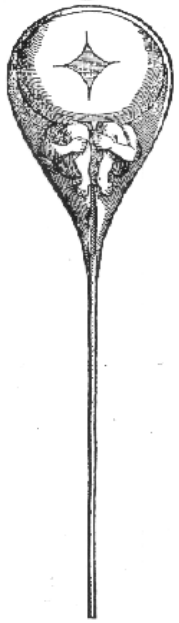


http://www.hps.cam.ac.uk/visibleembryos/s1_3.html
www.iep.utm.edu

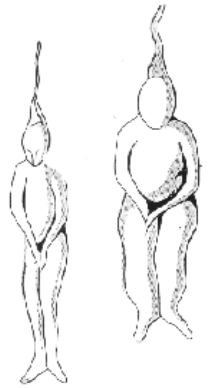
Preformation

Ovist View
Theodore Kerckring, late 1600s



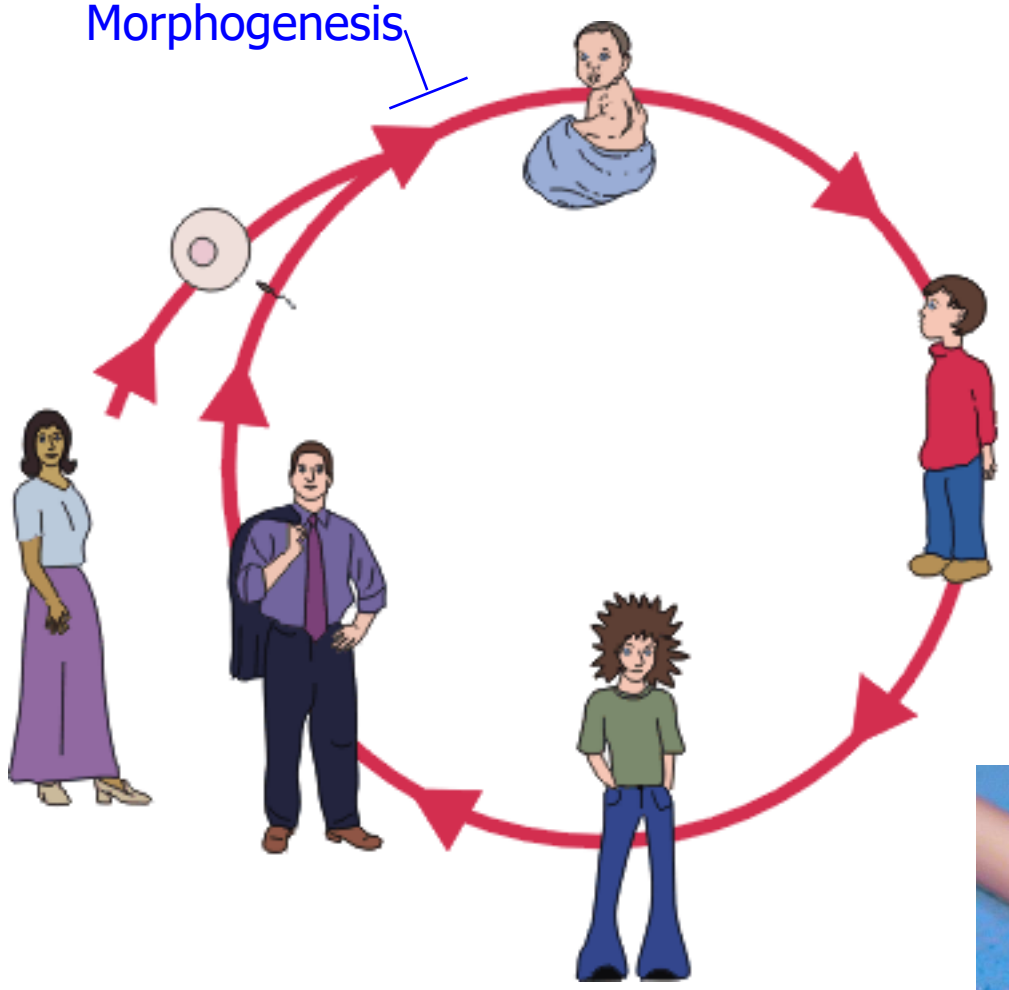


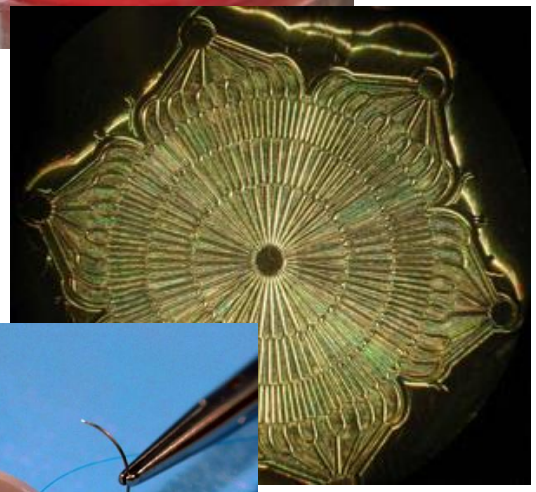
Spermist view
N. Hartsoecker, 1695

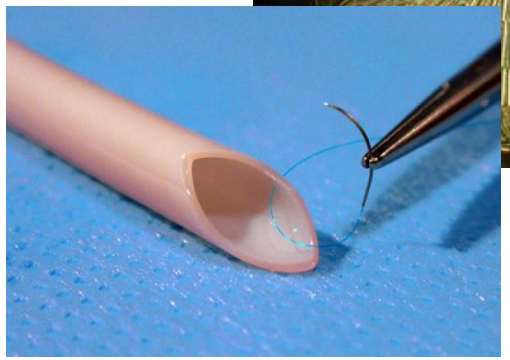


www.therussianshop.com
http://en.wikipedia.org/wiki/File:Preformation.GIF
Pregnant Fictions: Childbirth and the Fairy Tale in Early-modern France, Tucker

The Human Lifecycle





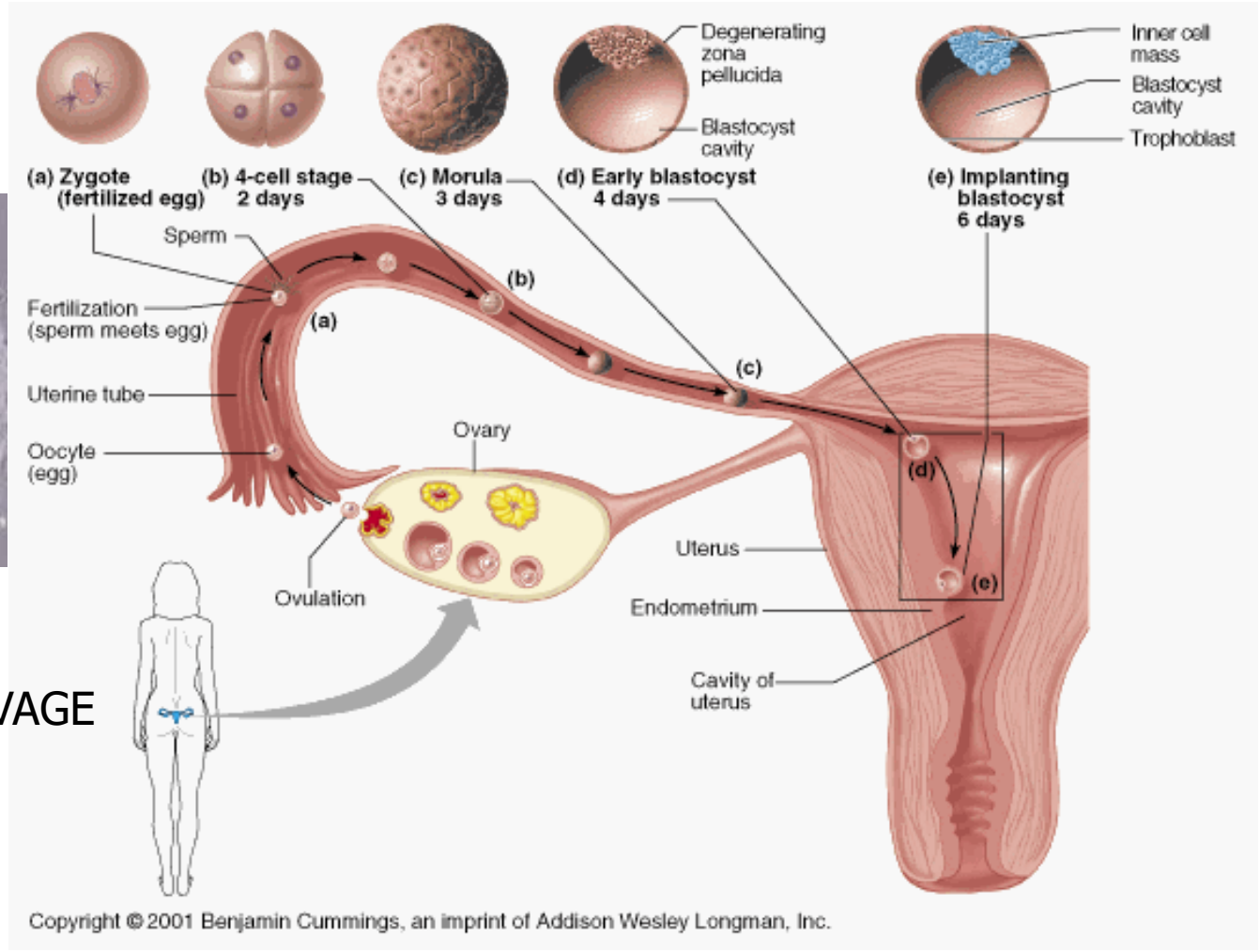


http://www.oum.ox.ac.uk/thezone/animals/life/produce.htm
http://www.childrenshospital.org/dream/dream_fall06/research_rundown.html
http://news.sciencemag.org/technology/2009/04/artificial-blood-vessels-prove-effective?ref=hp

Early transformation in the embryo

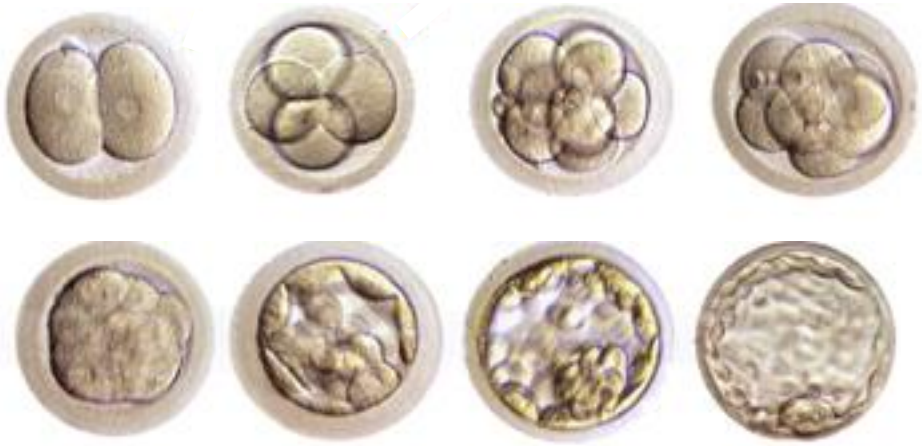
Before implantation

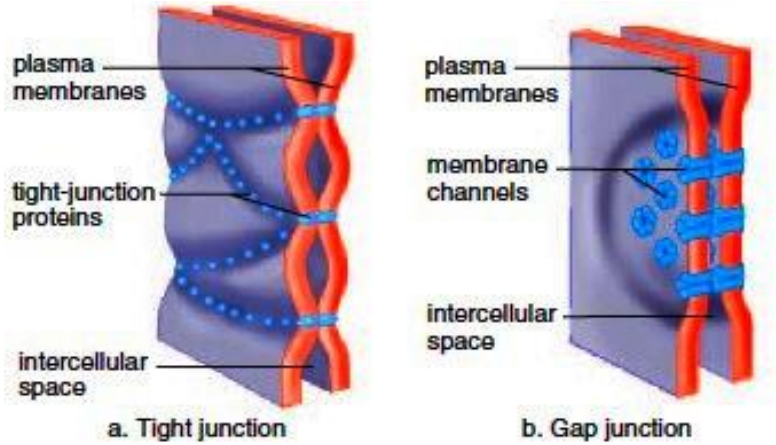
ZYGOTE
BLASTOMERE
HOLOBLASTIC CLEAVAGE



Early transformation in the embryo

Cell designation hypothesis

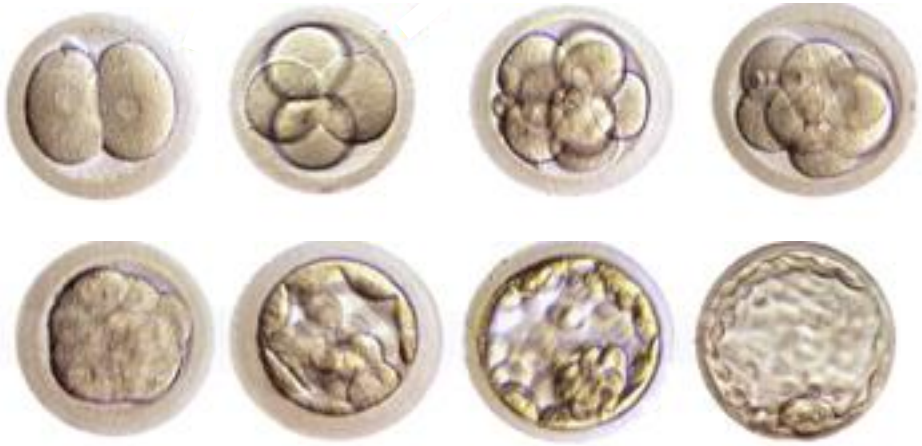


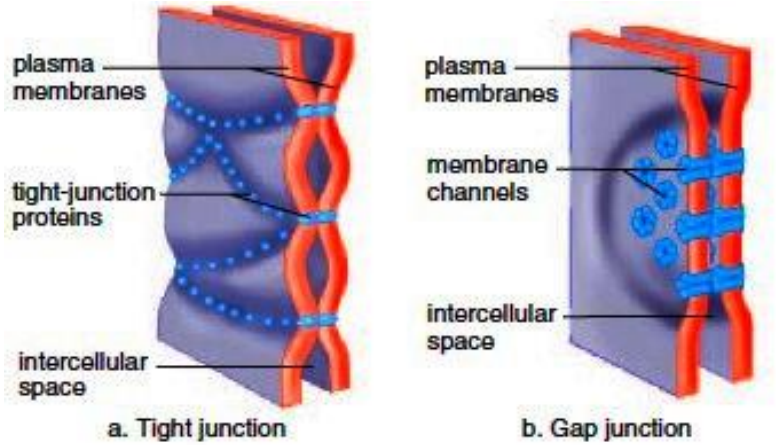


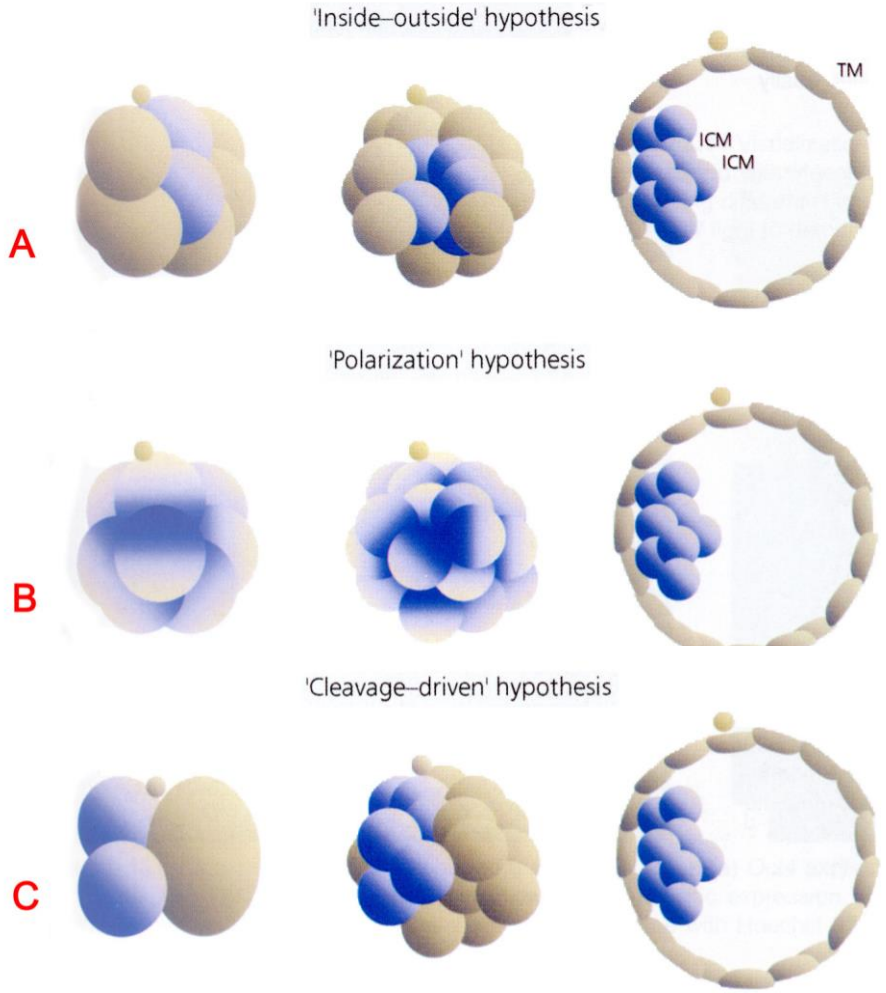
http://encyclopedia.lubopitko-bg.com
virtualhumanembryo.lsuhsc.edu

Early transformation in the embryo

Cell designation hypothesis





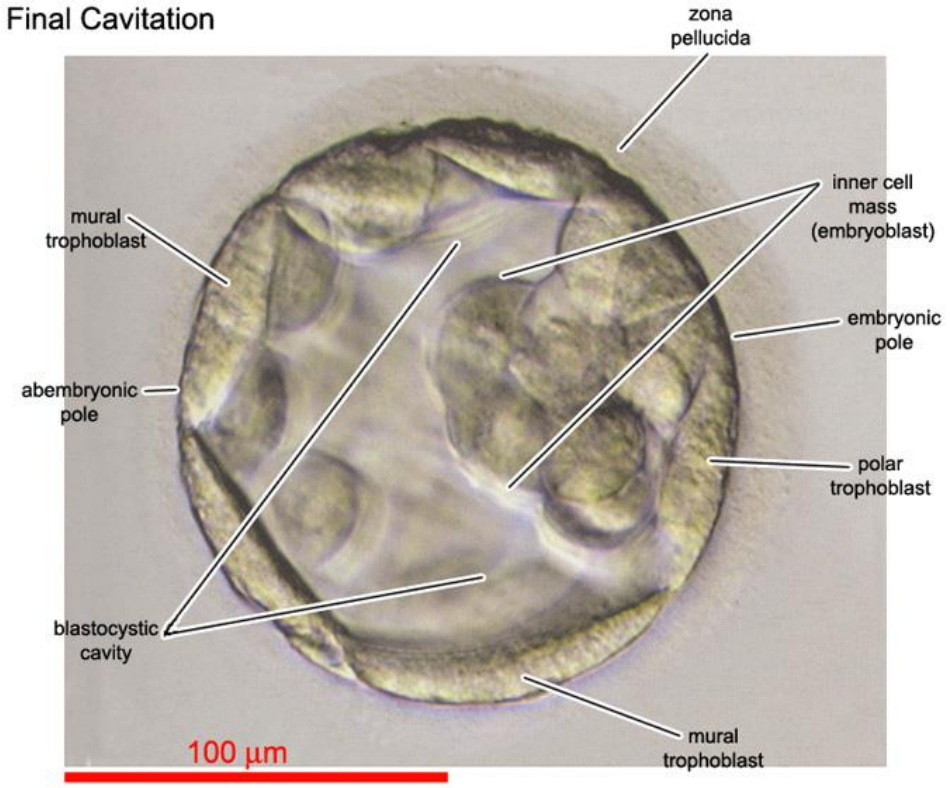


http://encyclopedia.lubopitko-bg.com
virtualhumanembryo.lsuhsc.edu

Early transformation in the embryo

Cell designation hypothesis

MORULA
BLASTOCOEL
BLASTOCYST
TROPHOBLAST
INNER CELL MASS



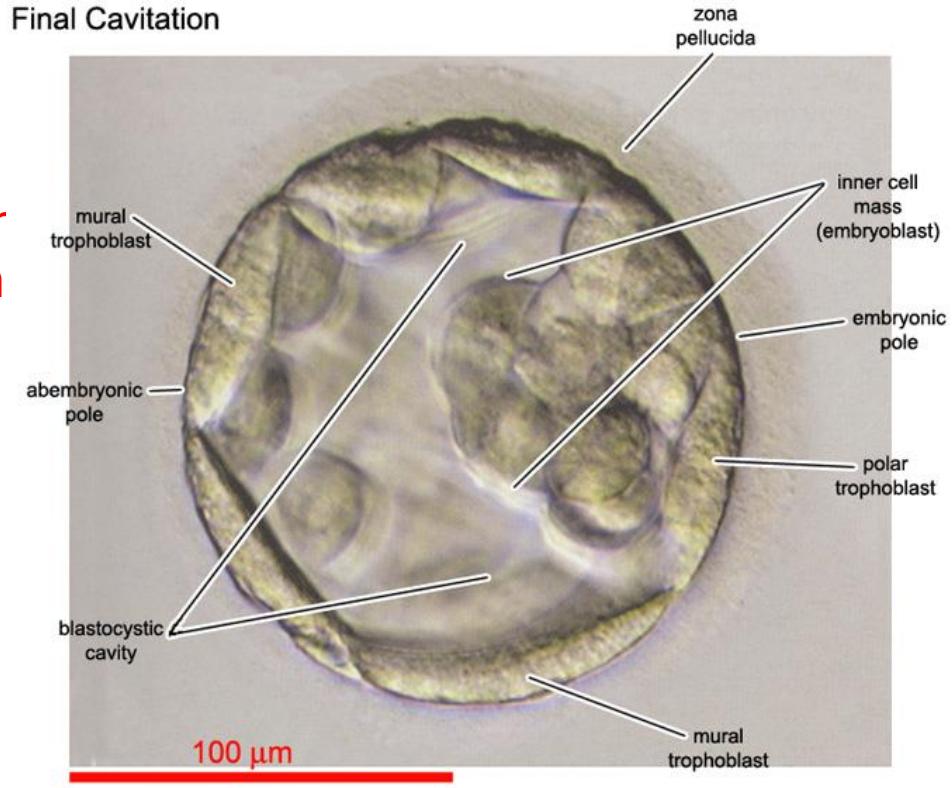
virtualhumanembryo.lsuhsc.edu

Early transformation in the embryo

Cell designation hypothesis

TROPHOBLAST
INNER CELL MASS

Variable Cleavage → Regulative Developmer
Stepwise Approximation

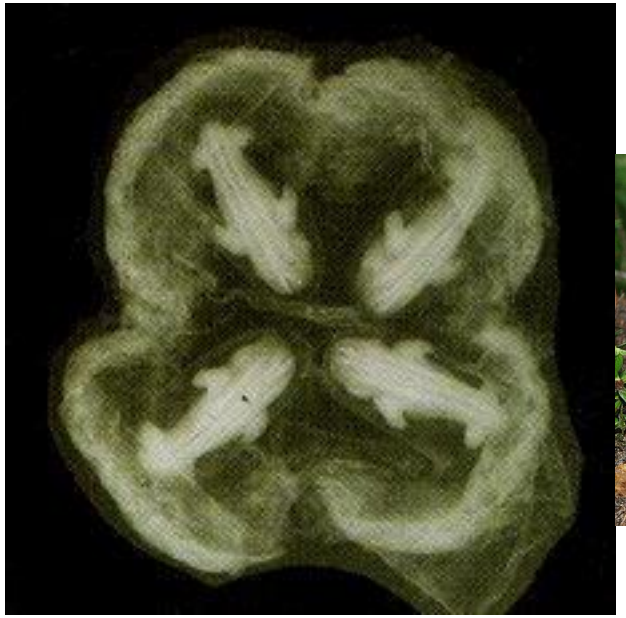


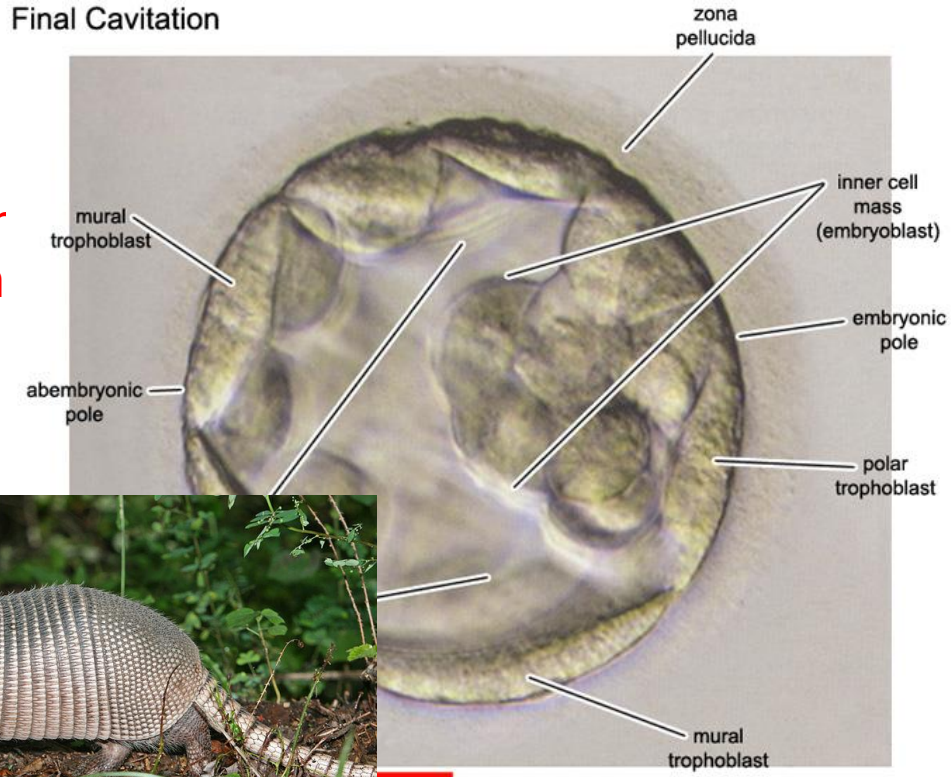
Early transformation in the embryo

Cell designation hypothesis

TROPHOBLAST
INNER CELL MASS

Variable Cleavage → Regulative Developmer
Stepwise Approximation



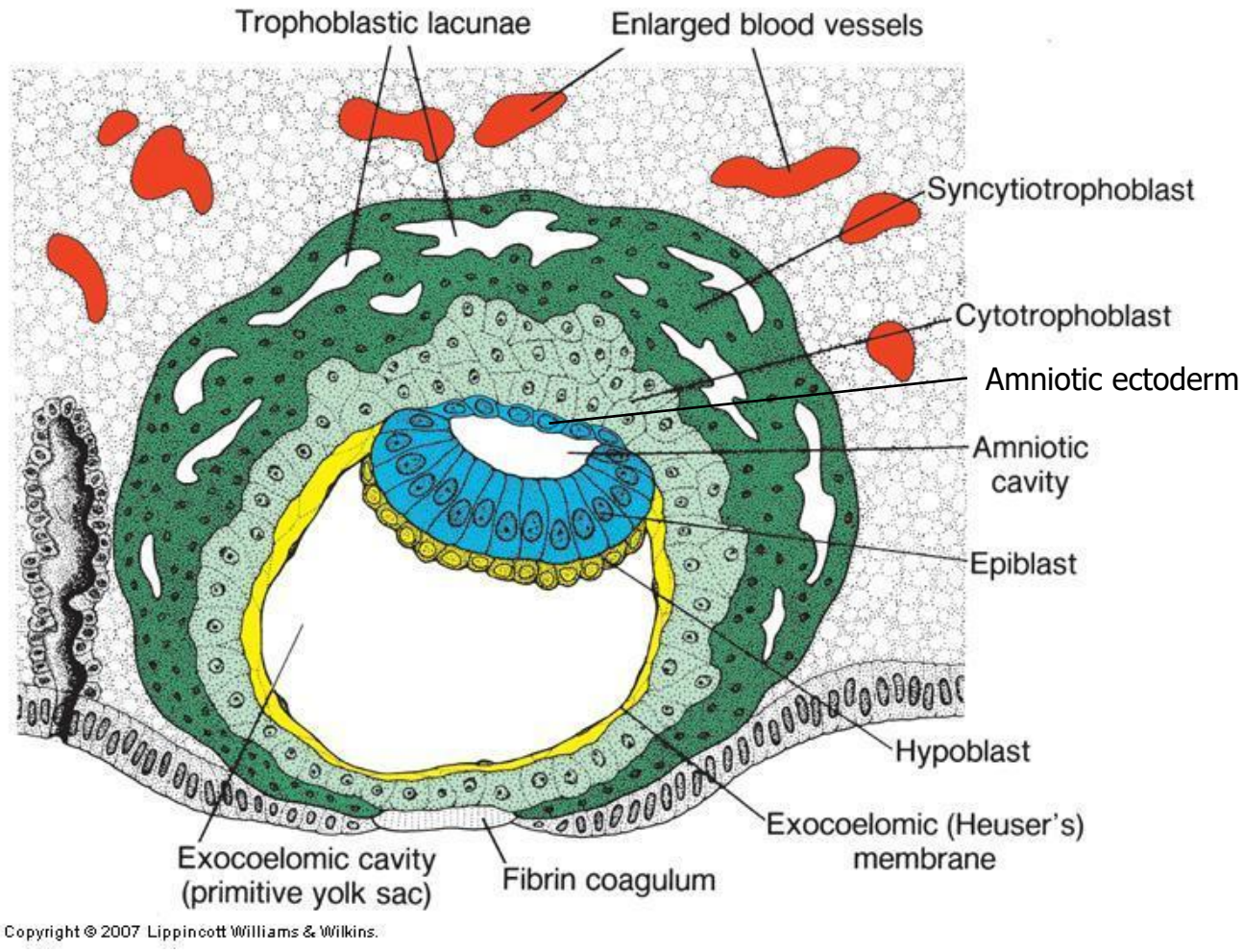


The Developmental Mechanics of Cell Specification, Gilbert 2000
http://commons.wikimedia.org/wiki/File:Nine-banded_Armadillo.jpg
virtualhumanembryo.lsuhsc.edu

Early transformation in the embryo

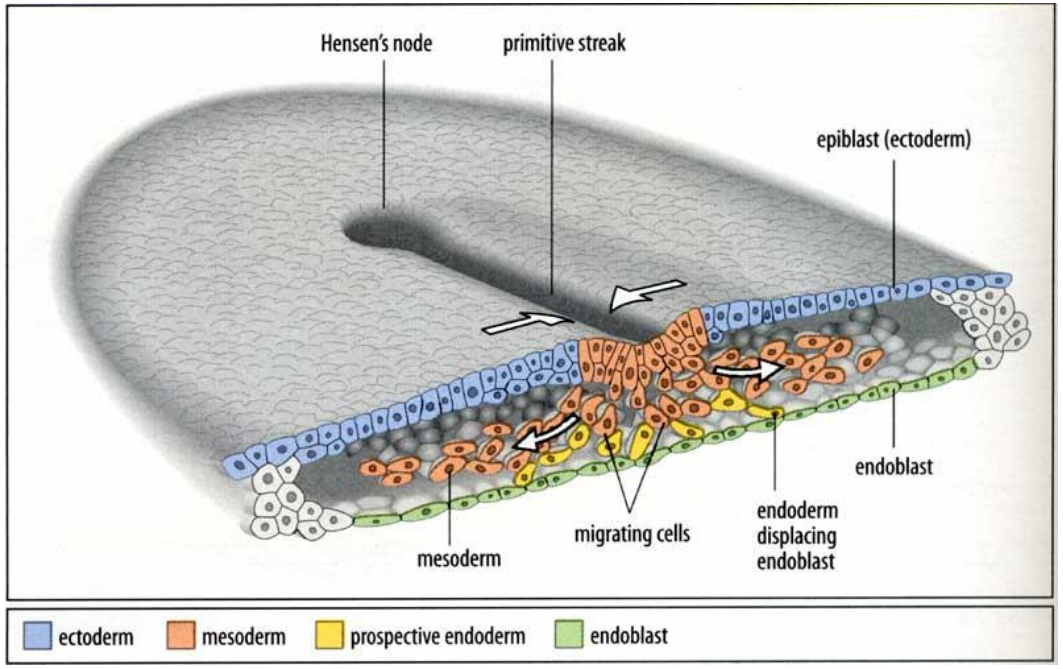
Development of germ layers

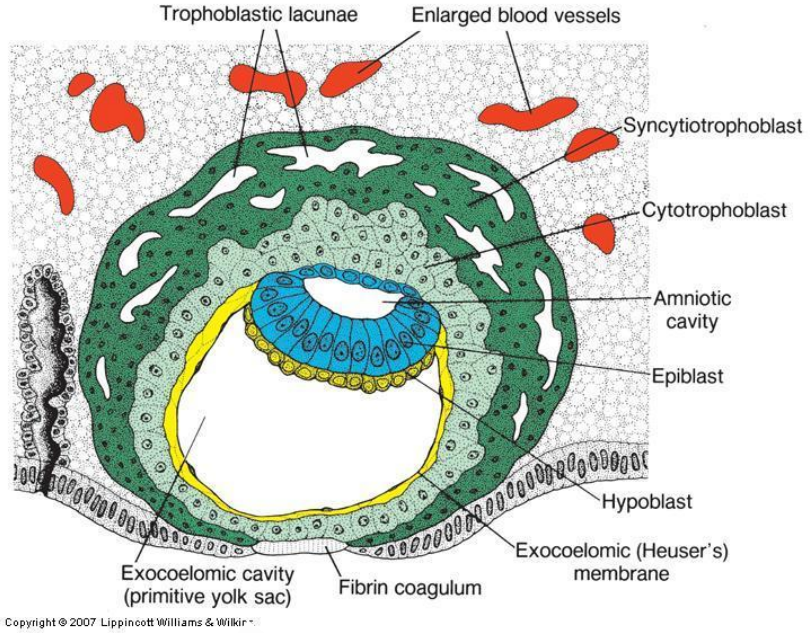
GASTRULATION
DELAMINATION
HYPOBLAST
YOLK SAC
AMNIOTIC ECTODERM
EMBRYONIC EPIBLAST

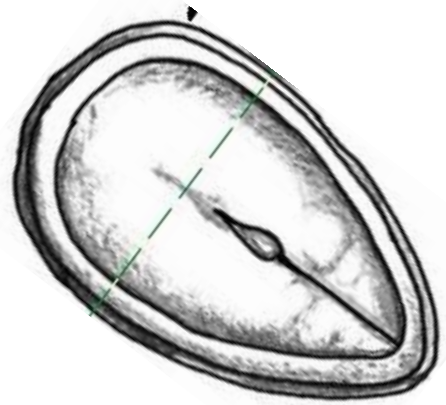


Early transformation in the embryo

Development of germ layers

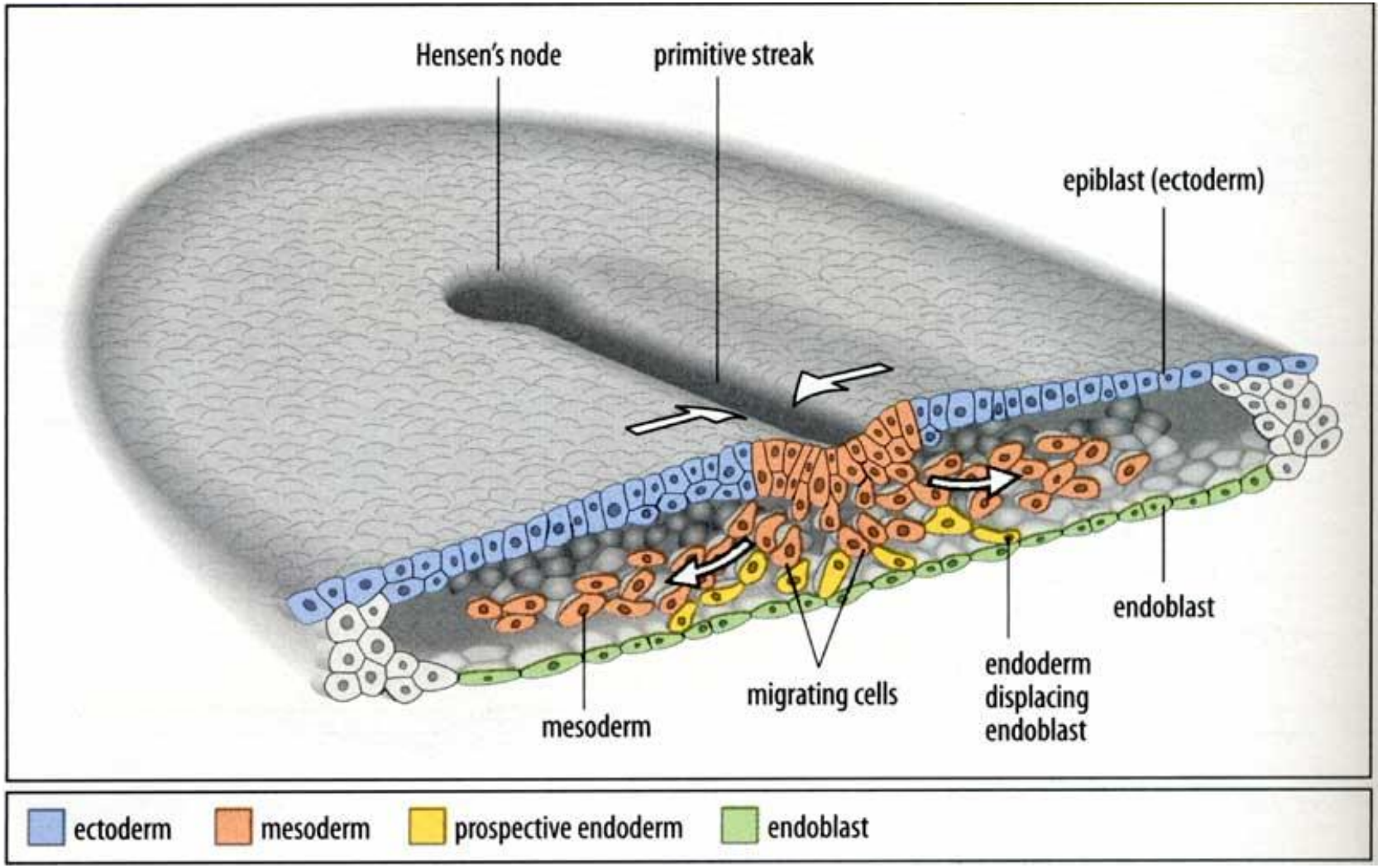






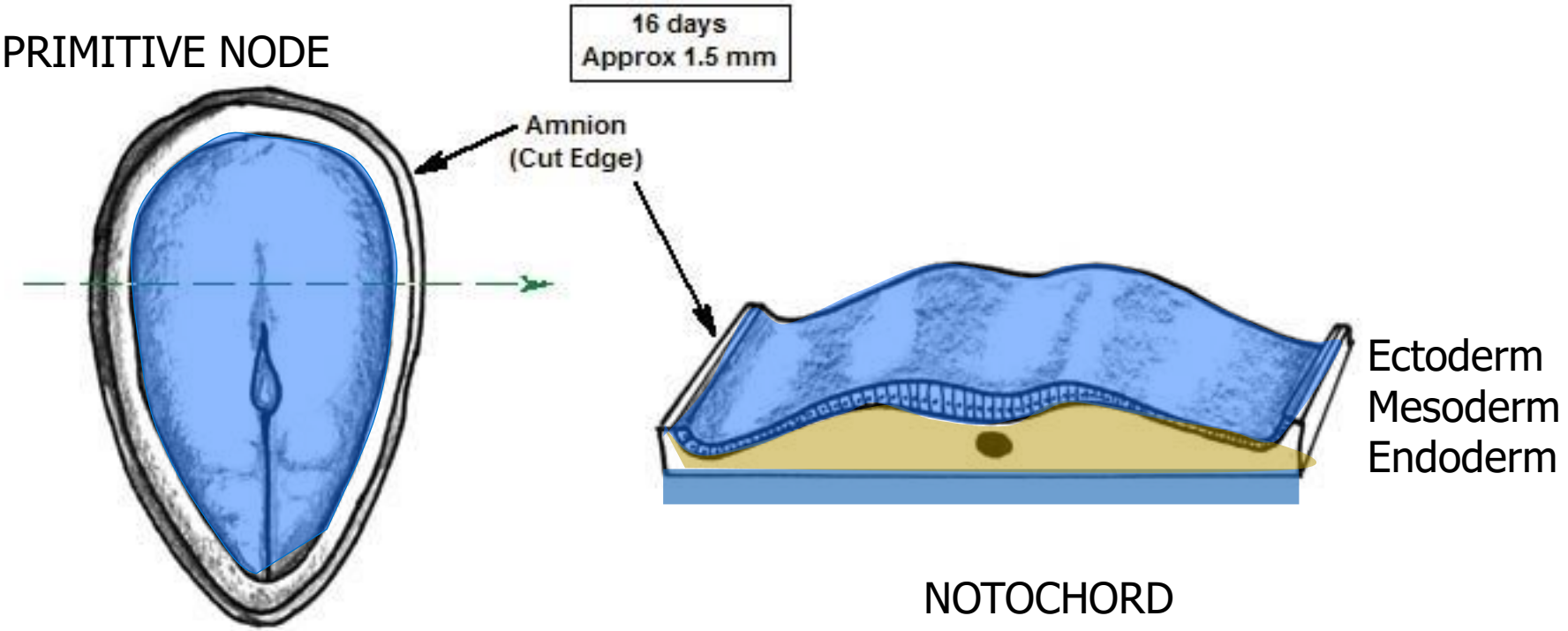
Early transformation in the embryo

Development of germ layers



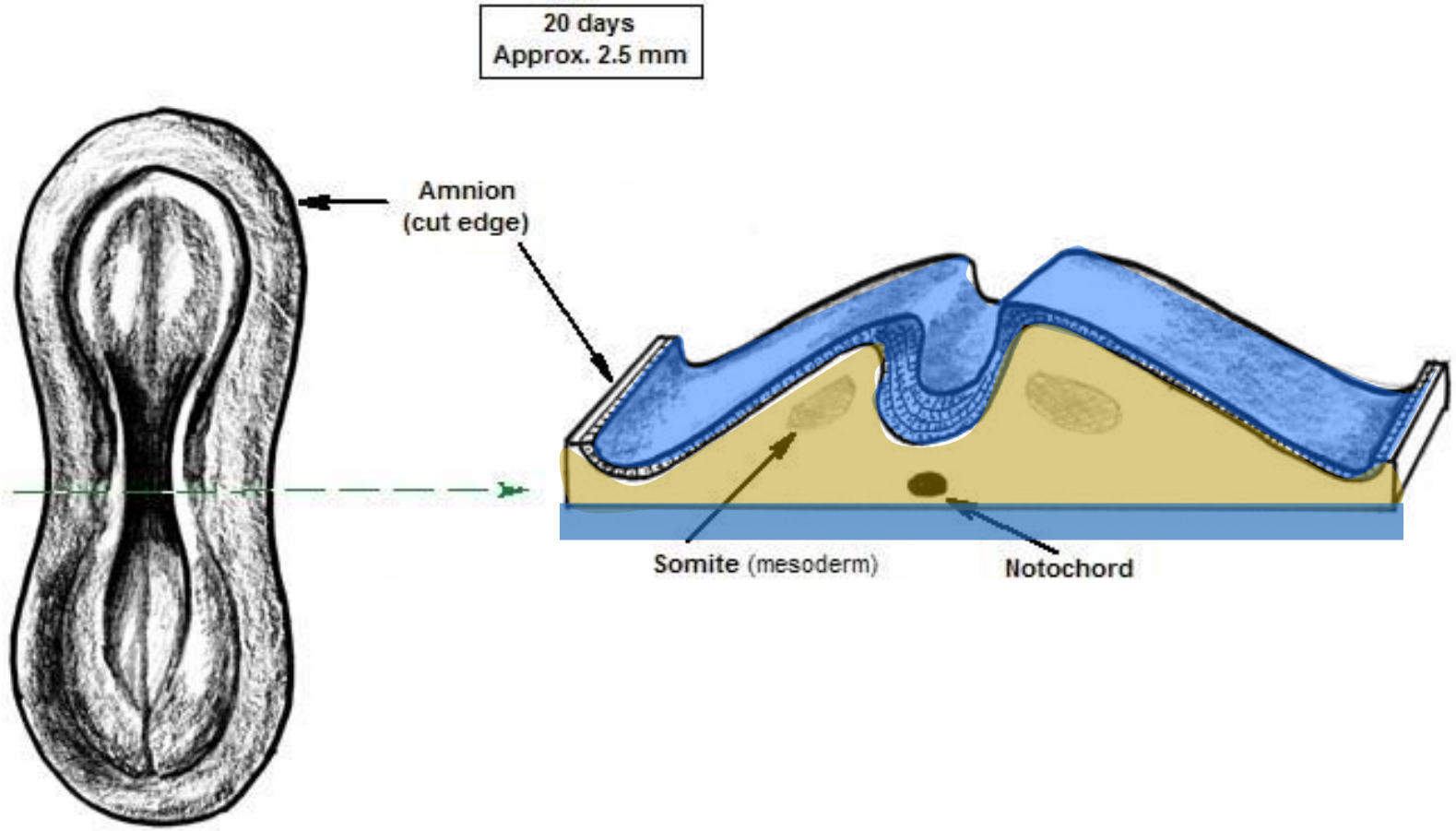
Early transformation in the embryo

Development of germ layers



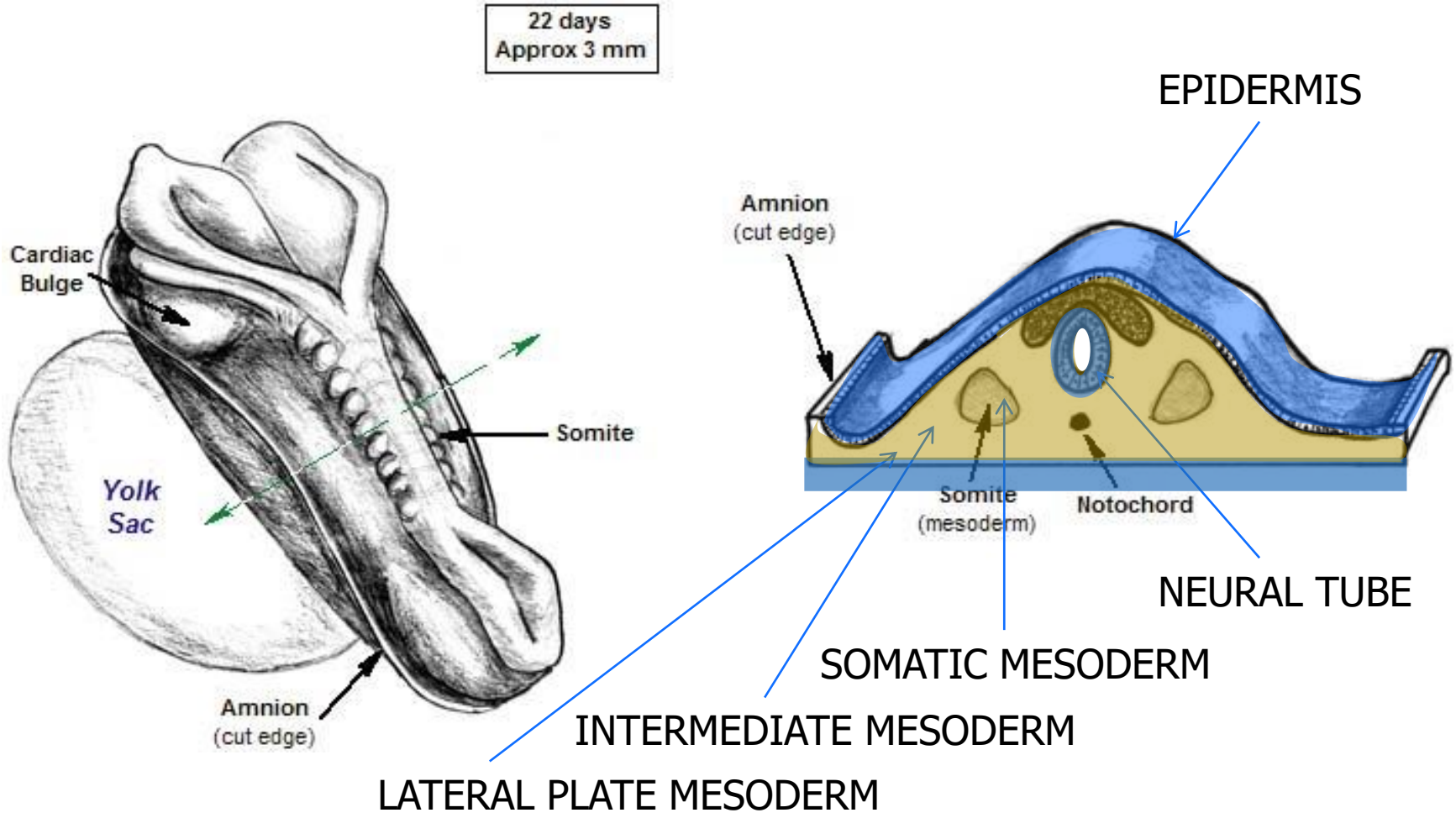
Early transformation in the embryo

Development of germ layers



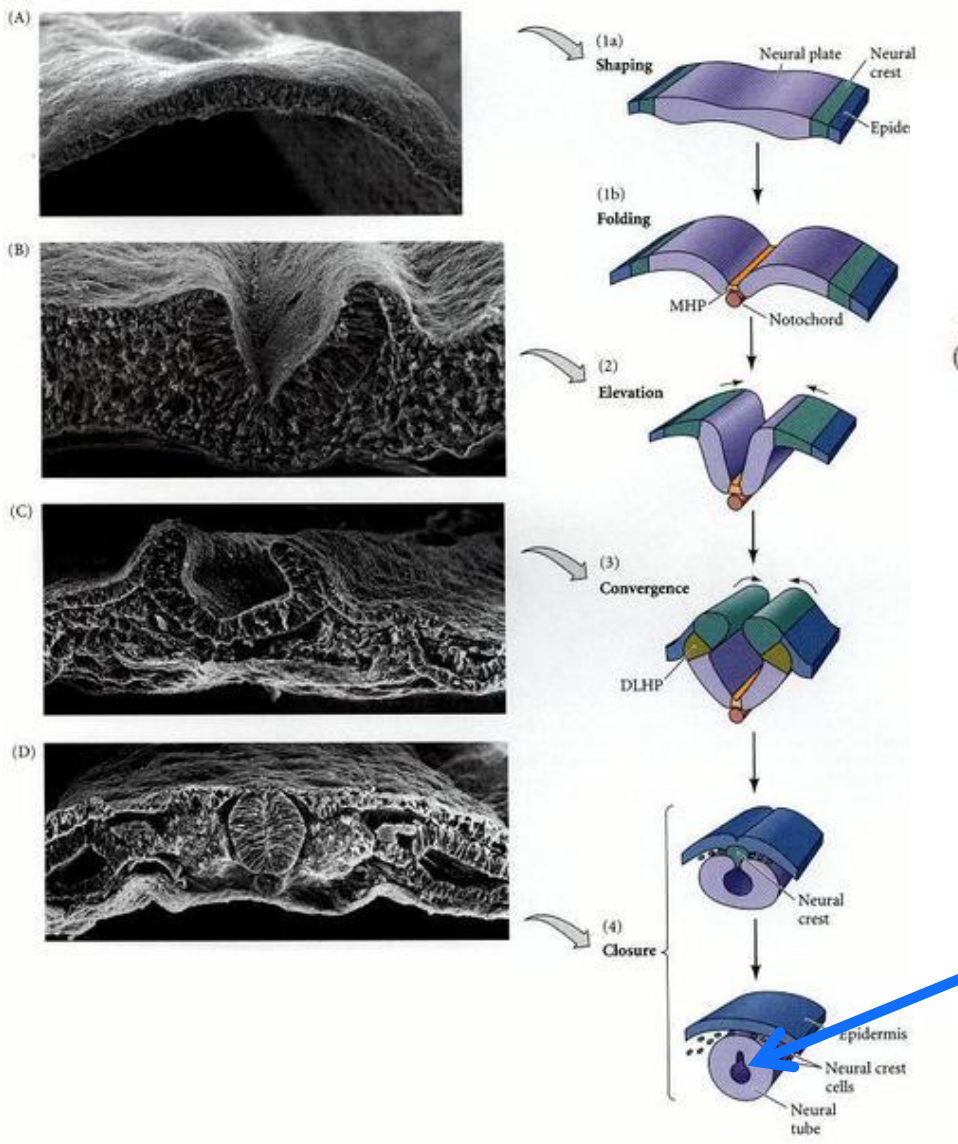
Early transformation in the embryo

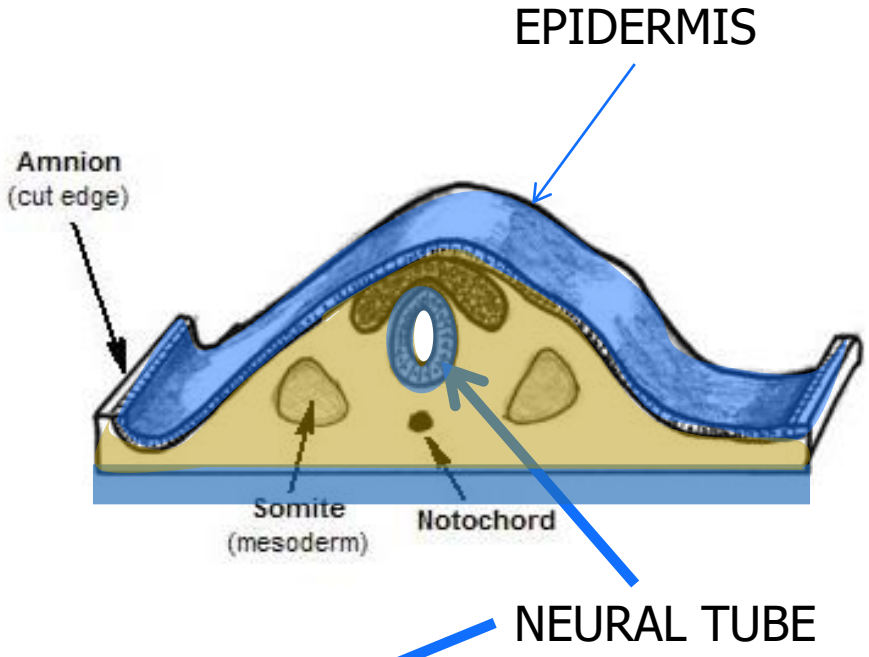
Development of germ layers



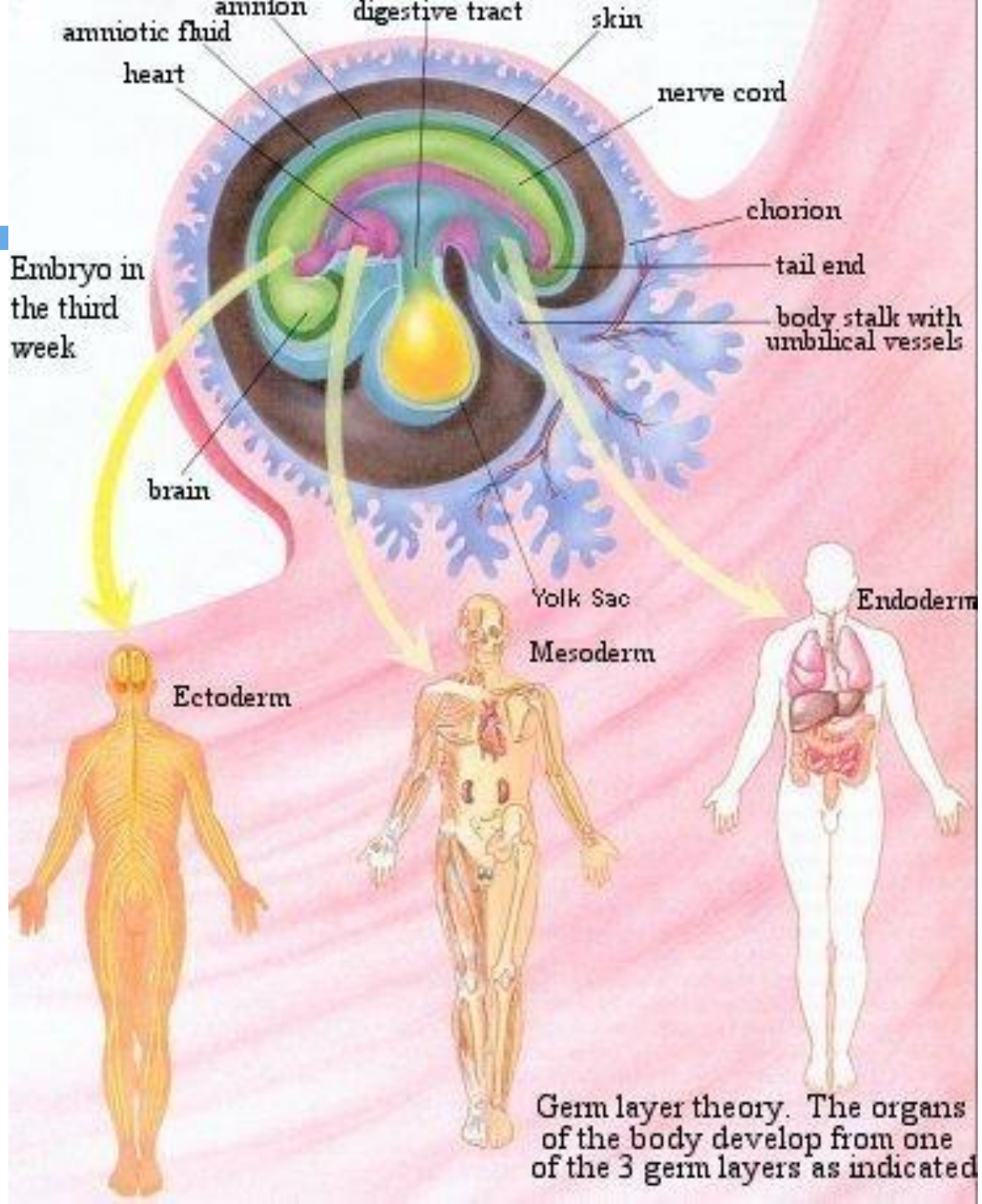
Early transformation in the embryo

Development of germ layers





scienceblogs.com



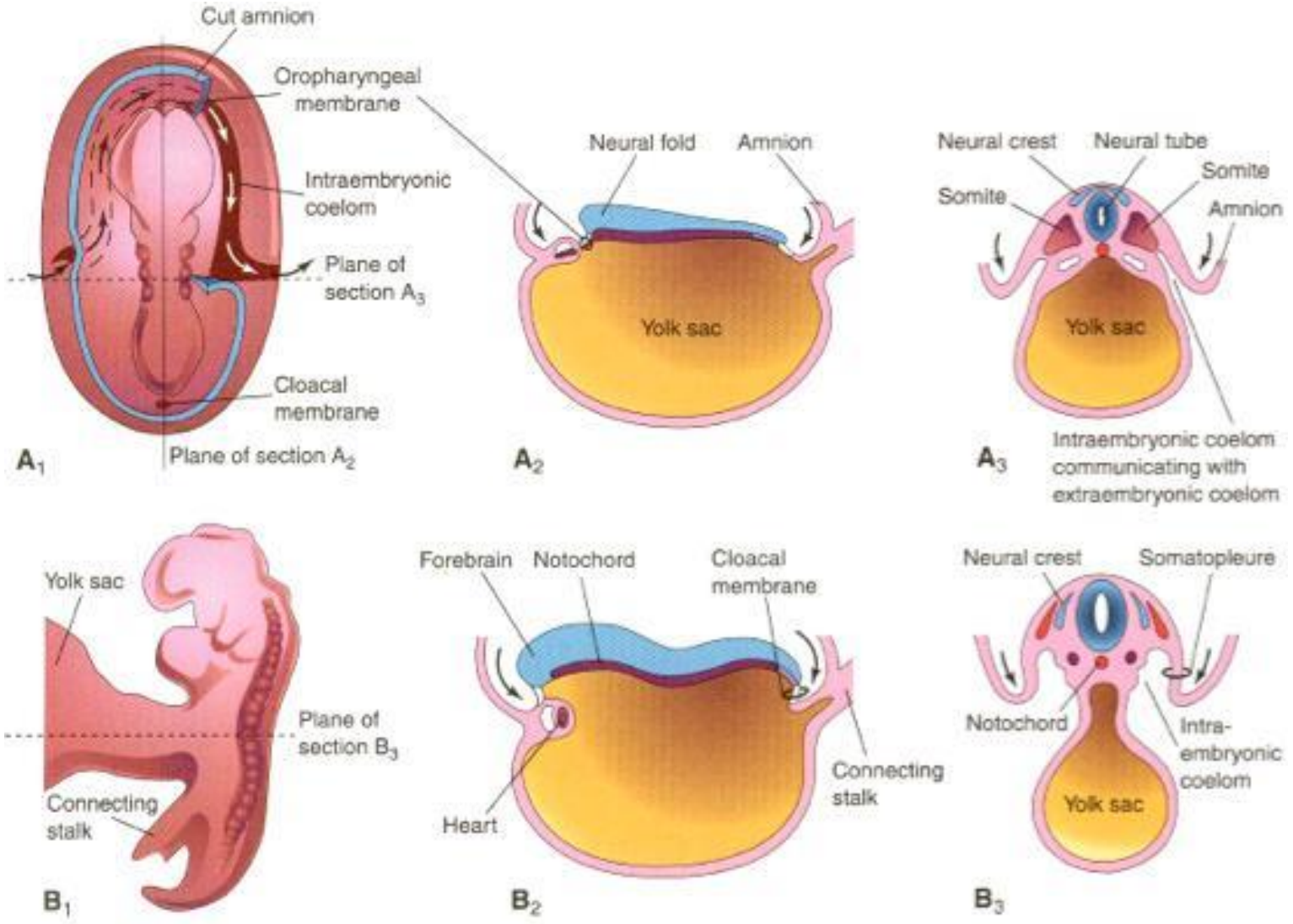
Ectoderm (outer layers)
skin, nervous system, pigment cells

Mesoderm (middle layer)
skeleton, muscle, kidney, heart, blood

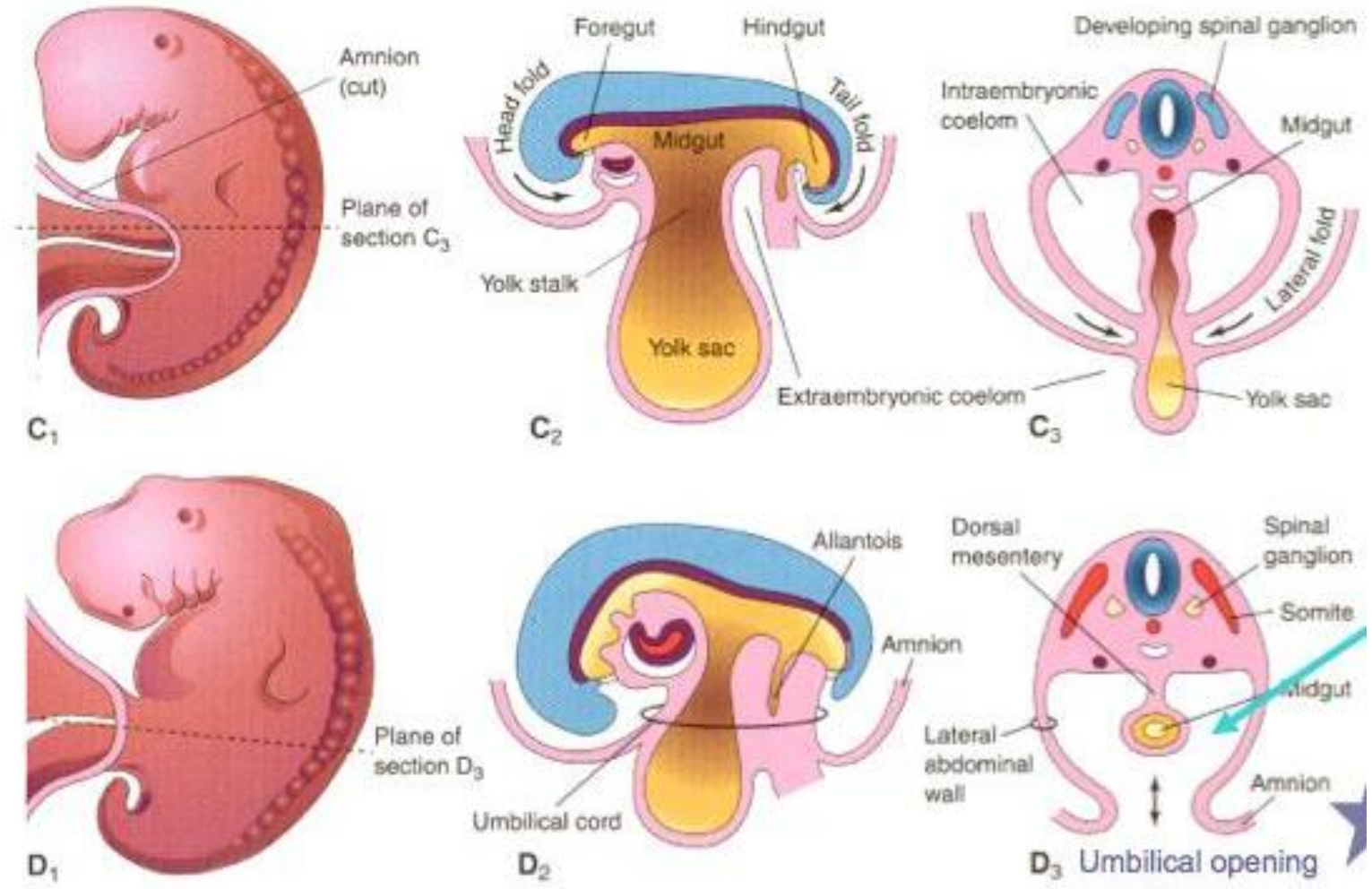
Endoderm (inner layer)
gut, liver, lungs, thyroid

http://www.stmary.ws/highschool/science/humanbio/q1/CellandTissueNotes.htm

Early transformation in the embryo



Control of Development



Stages of development in vertebrates (1)

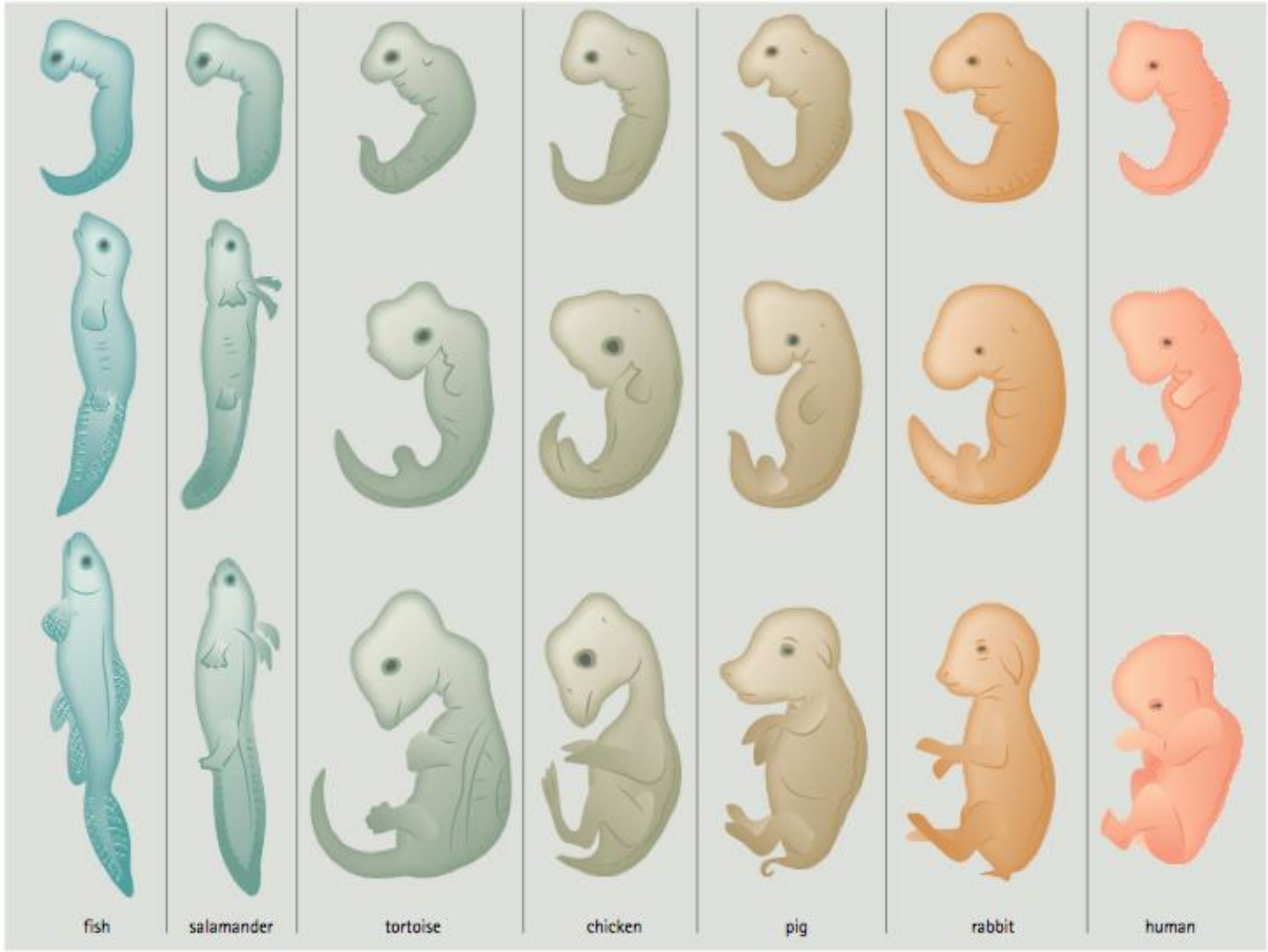
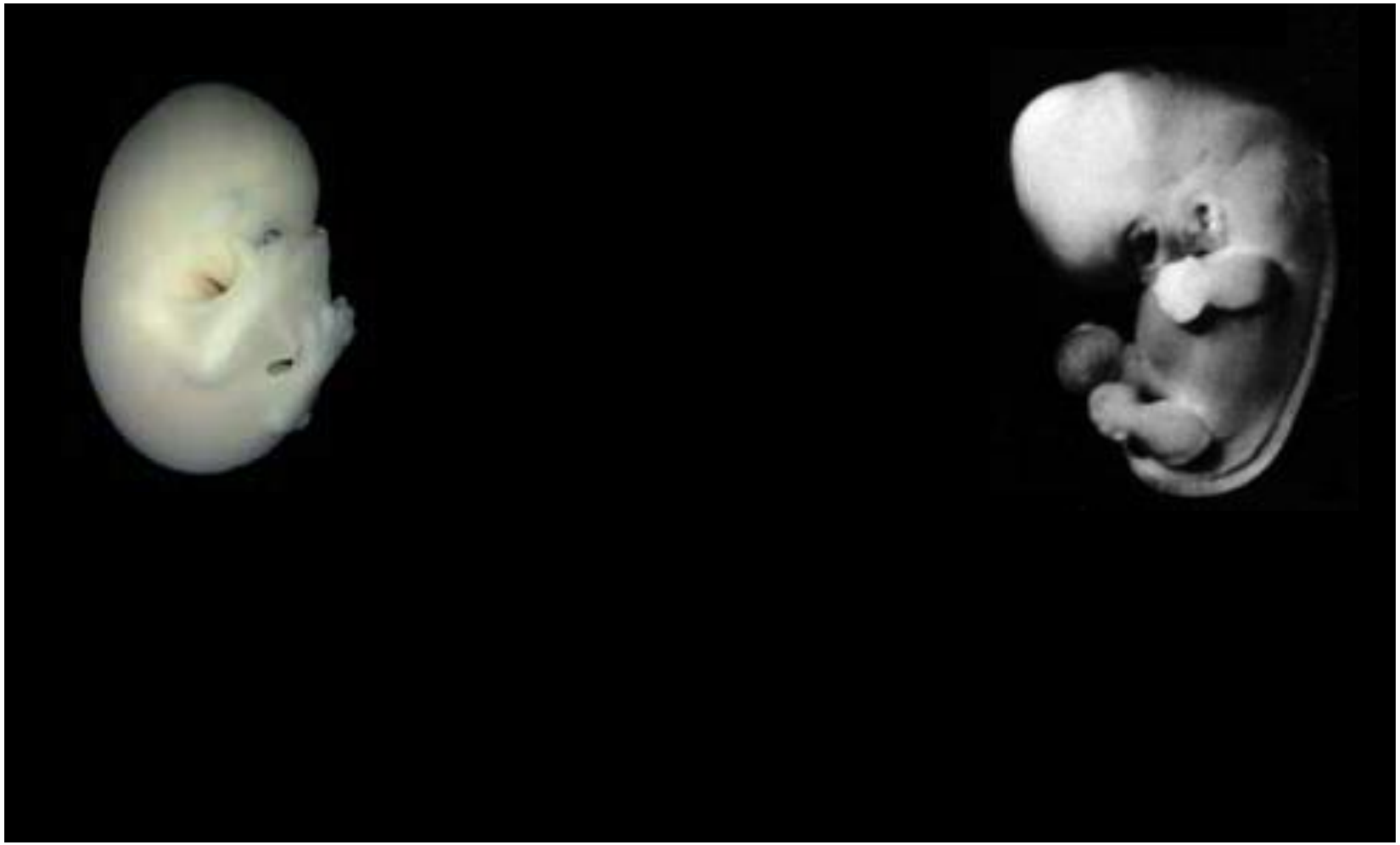


Figure 6.2.6 Stages in the embryonic development of vertebrates

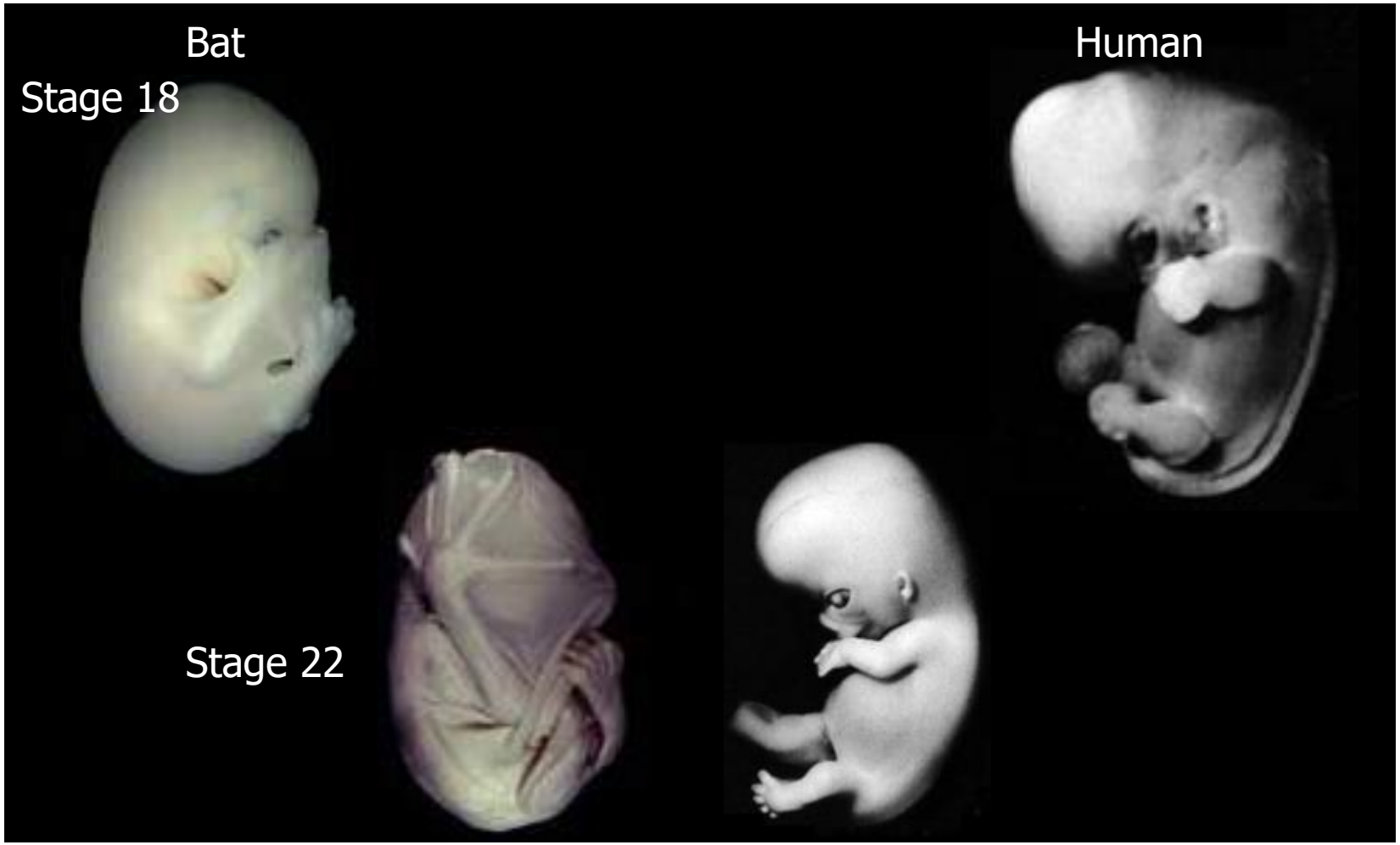
https://wikis.engrade.com/hscbiology/bpl

Stages of development in vertebrates (2)



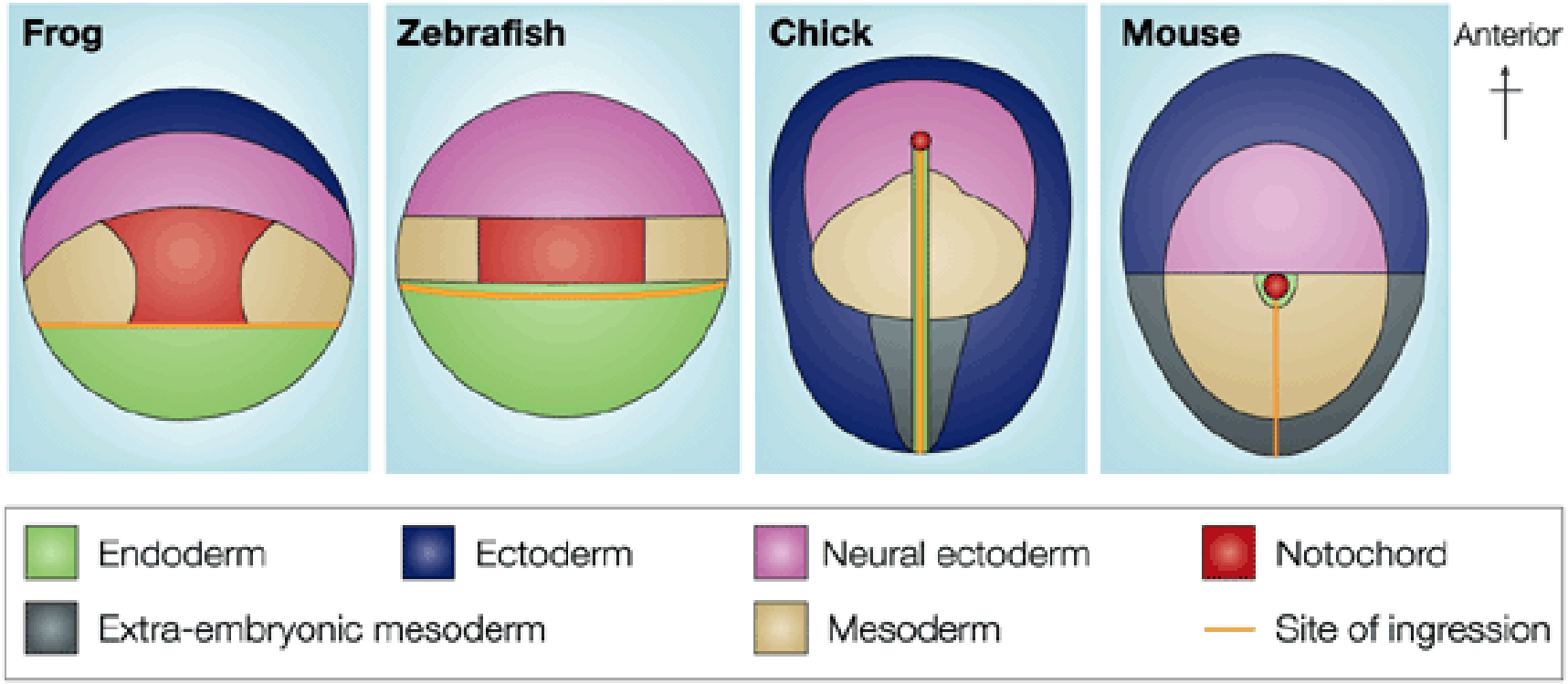
http://php.med.unsw.edu.au/embryology/index.php?title=File:Bat_embryo_stage_18-24.jpg
http://php.med.unsw.edu.au/embryology/index.php?title=Carnegie_Stages

Stages of development in vertebrates (3)



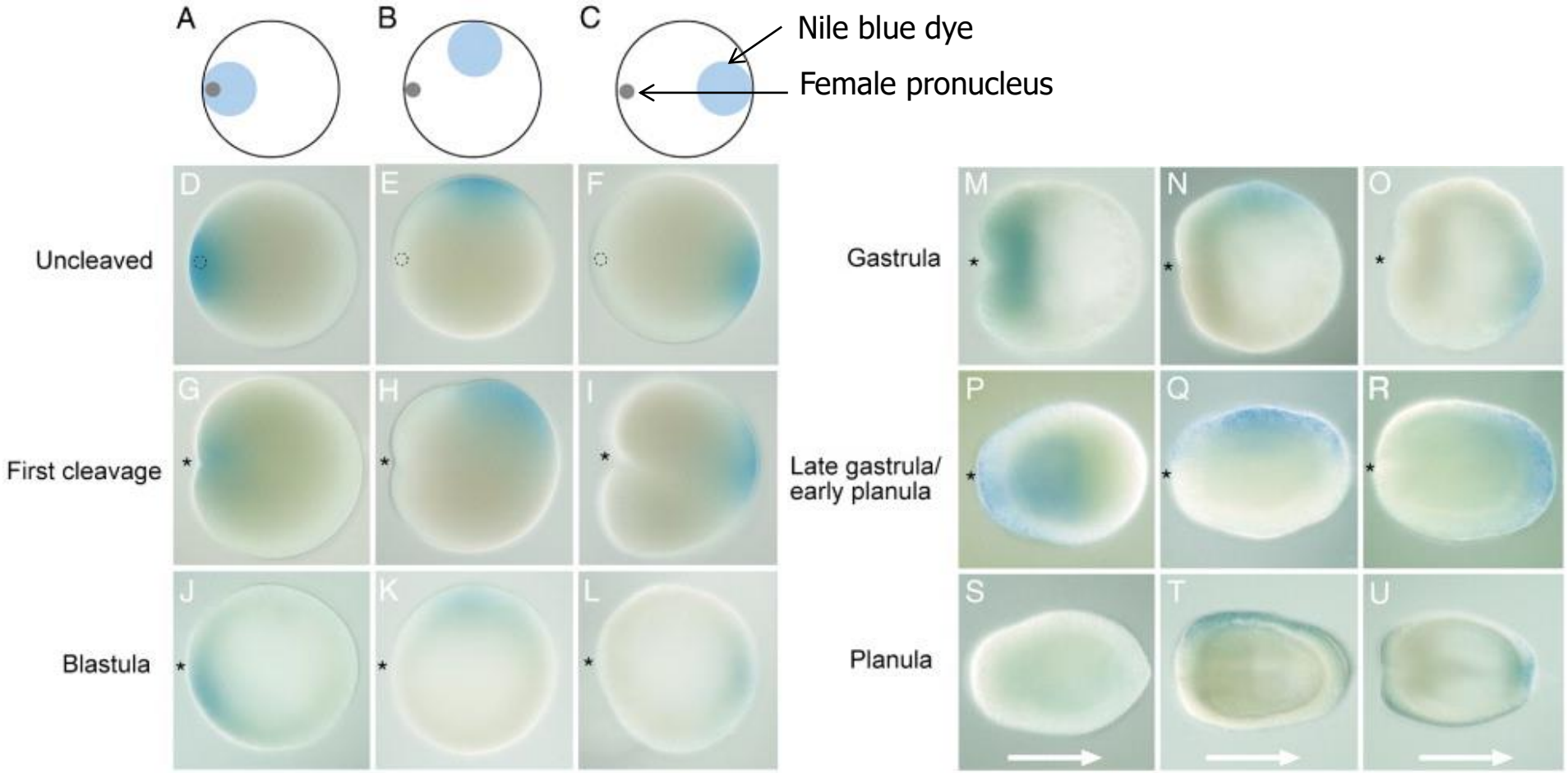
http://php.med.unsw.edu.au/embryology/index.php?title=File:Bat_embryo_stage_18-24.jpg
http://php.med.unsw.edu.au/embryology/index.php?title=Carnegie_Stages

Fate Mapping (1)



Nature Reviews | Neuroscience

Fate Mapping (2)

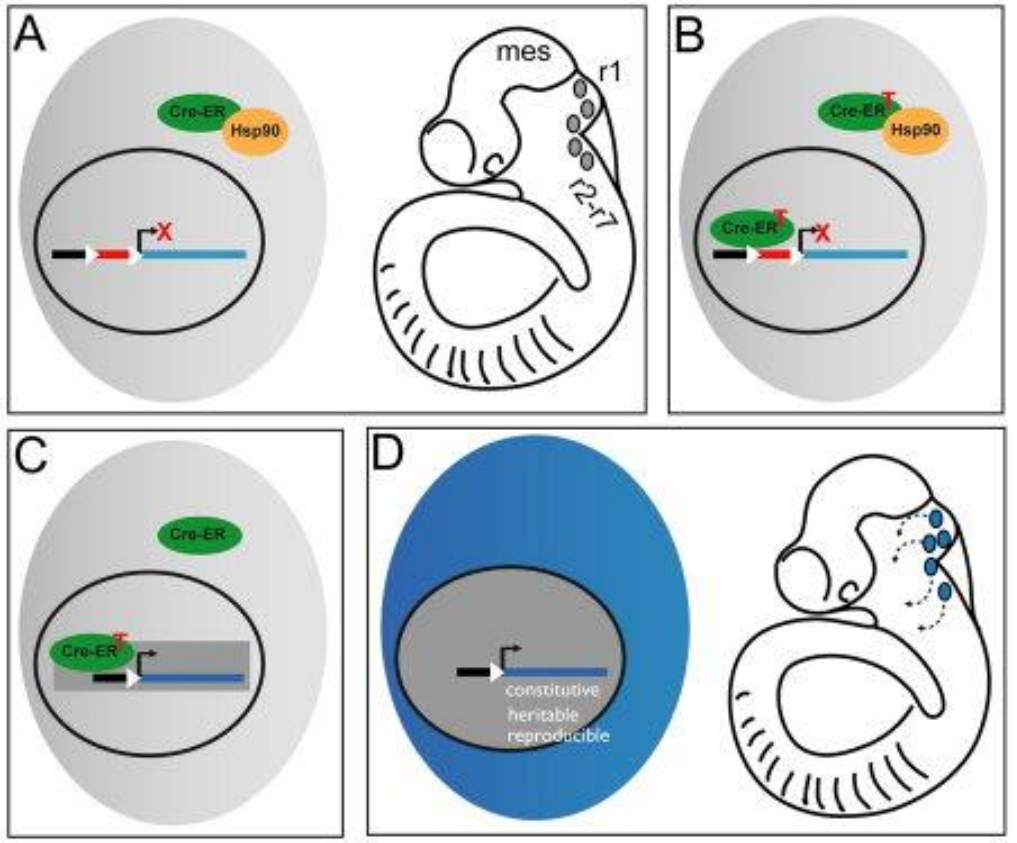


Lee et al. 2007

Fate Mapping (3)

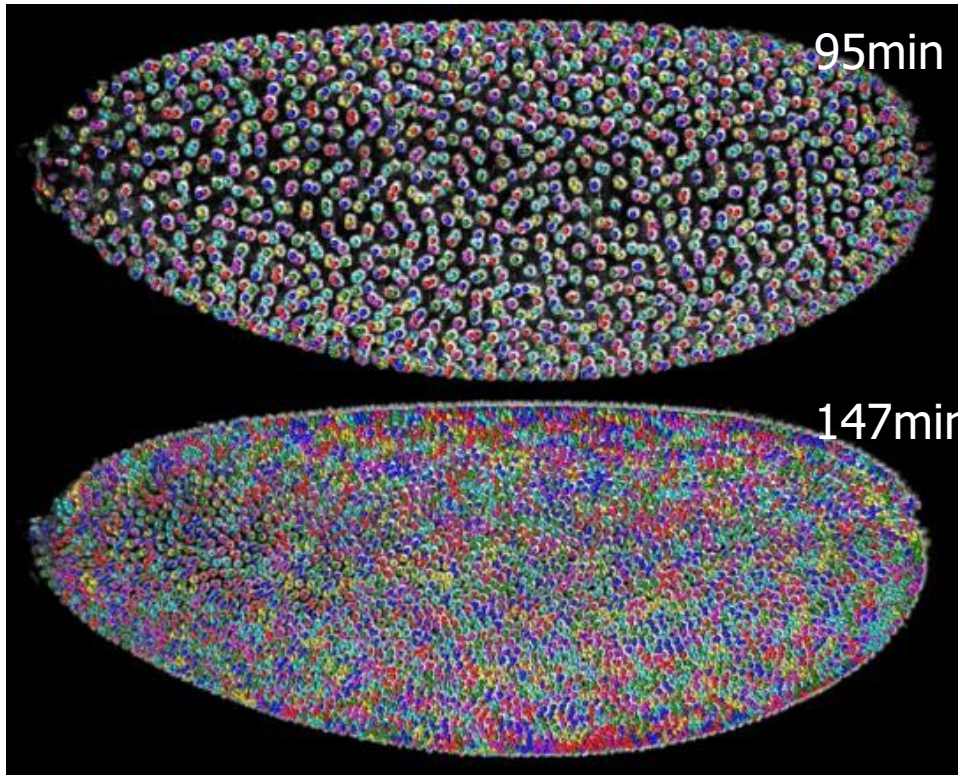
Cre-lox system

Genetic inducible fate mapping (GIFM)



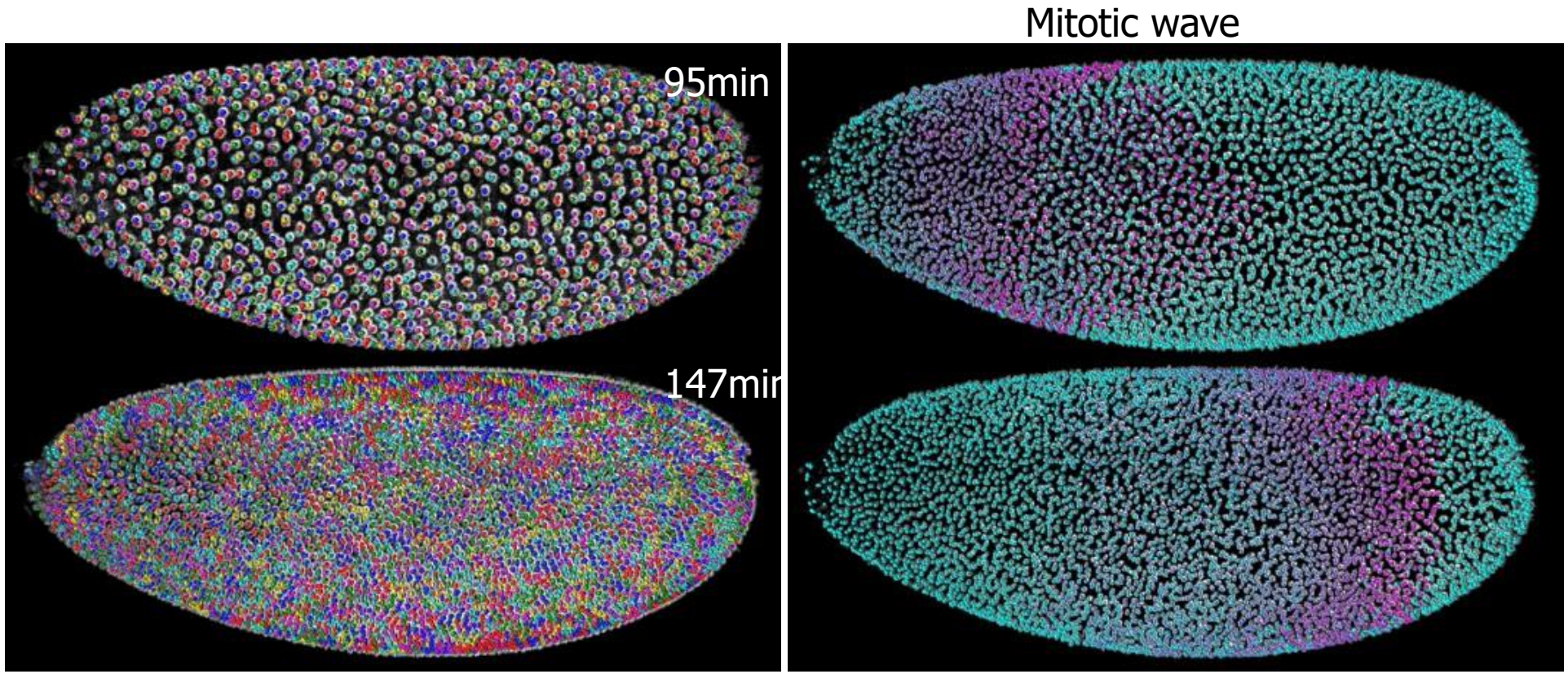
Joyner and Zervas, 2006
https://research.brown.edu/myresearch/Mark_Zervas

Fate Mapping (4)



http://janelia.org/lab/keller-lab

Fate Mapping (5)



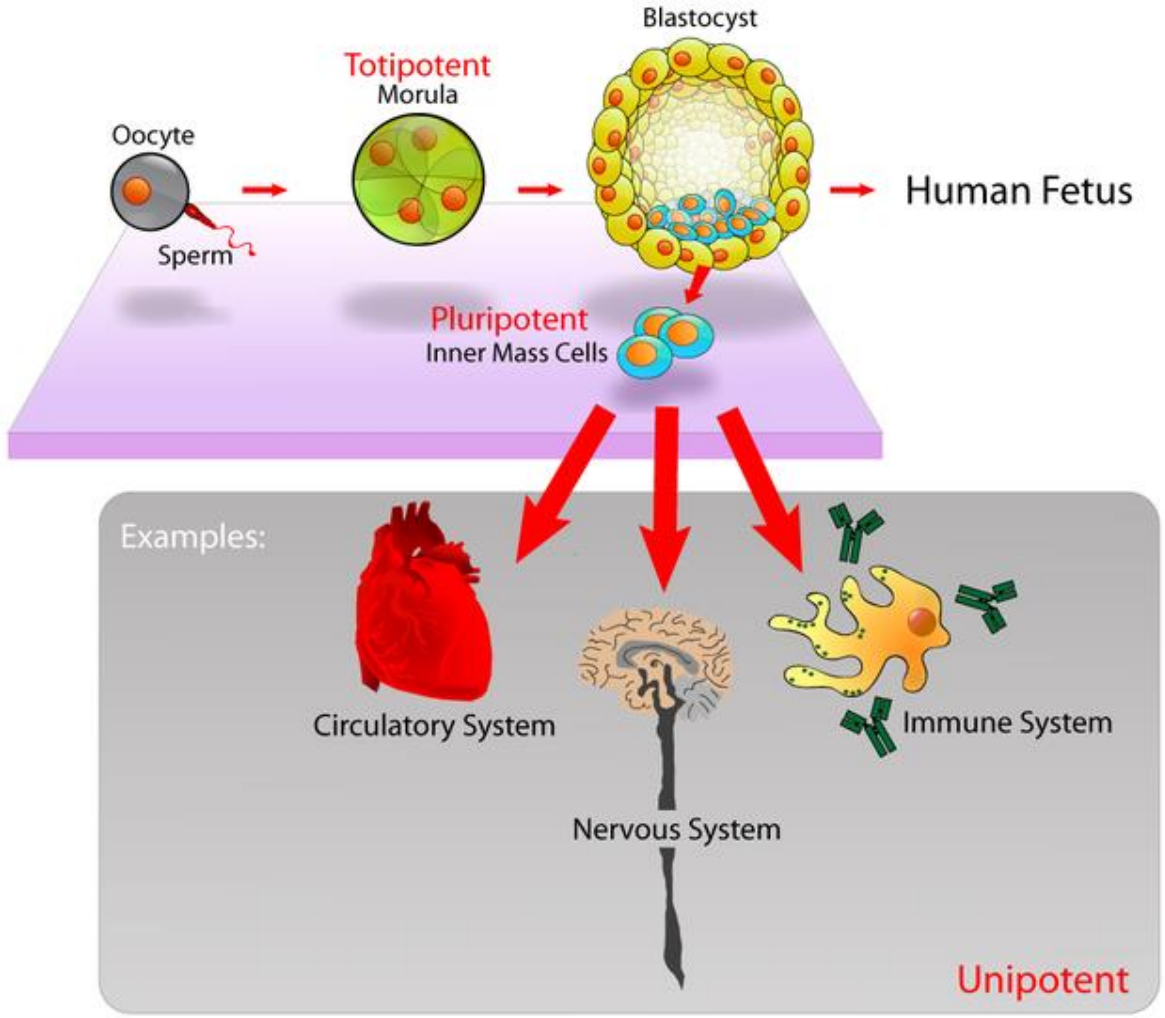
http://janelia.org/lab/keller-lab

Cell Potency

TOTIPOTENT
A cell that can produce a whole organism

PLURIPOTENT
A cell that can have more than one fate

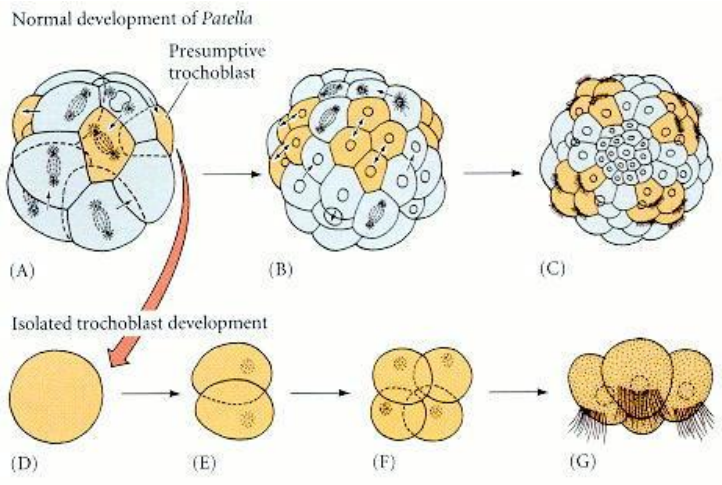
UNIPOTENT
A cell that has only one fate



http://en.wikipedia.org/wiki/File:Stem_cells_diagram.png

Cell Specification

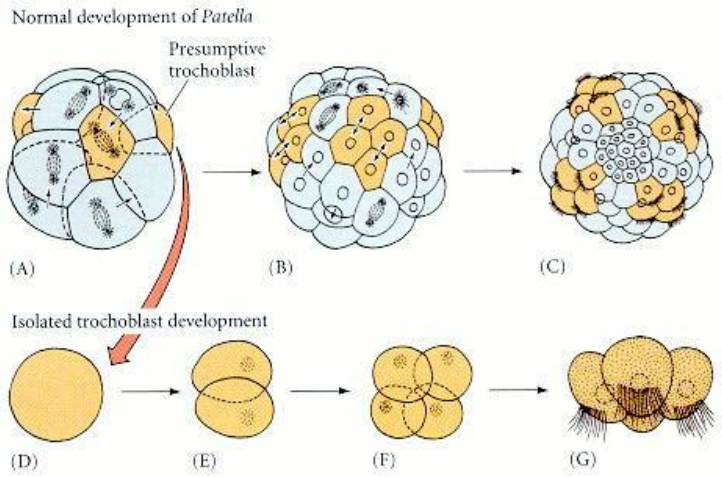
- Autonomous Specification – all specification signals are contained within the cells cytoplasm

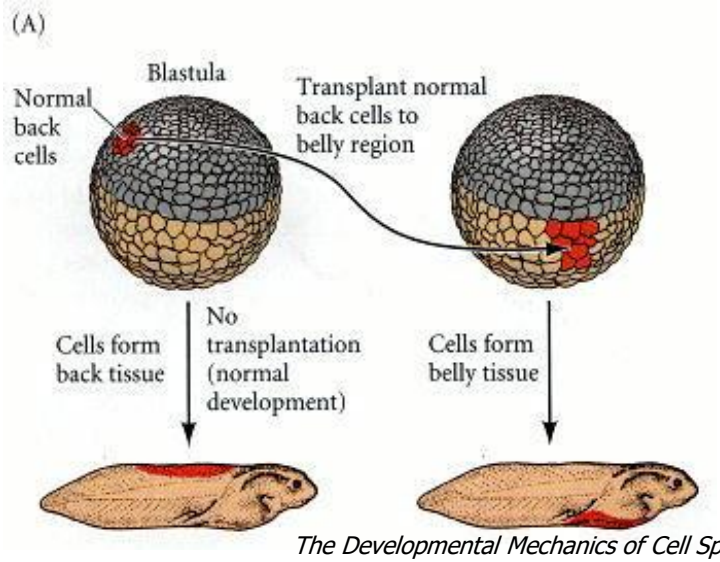


The Developmental Mechanics of Cell Specification, Gilbert 2000

Cell Specification (cont)

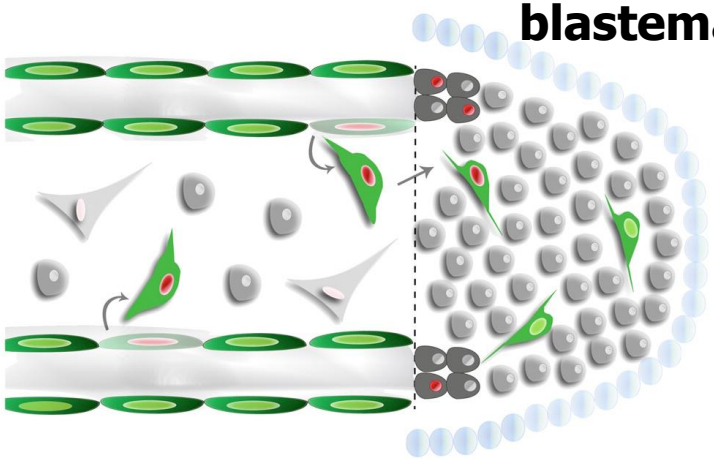
- Autonomous Specification – all specification signals are contained within the cells cytoplasm
- Conditional Specification – specification depends on interactions with the environment and other cells





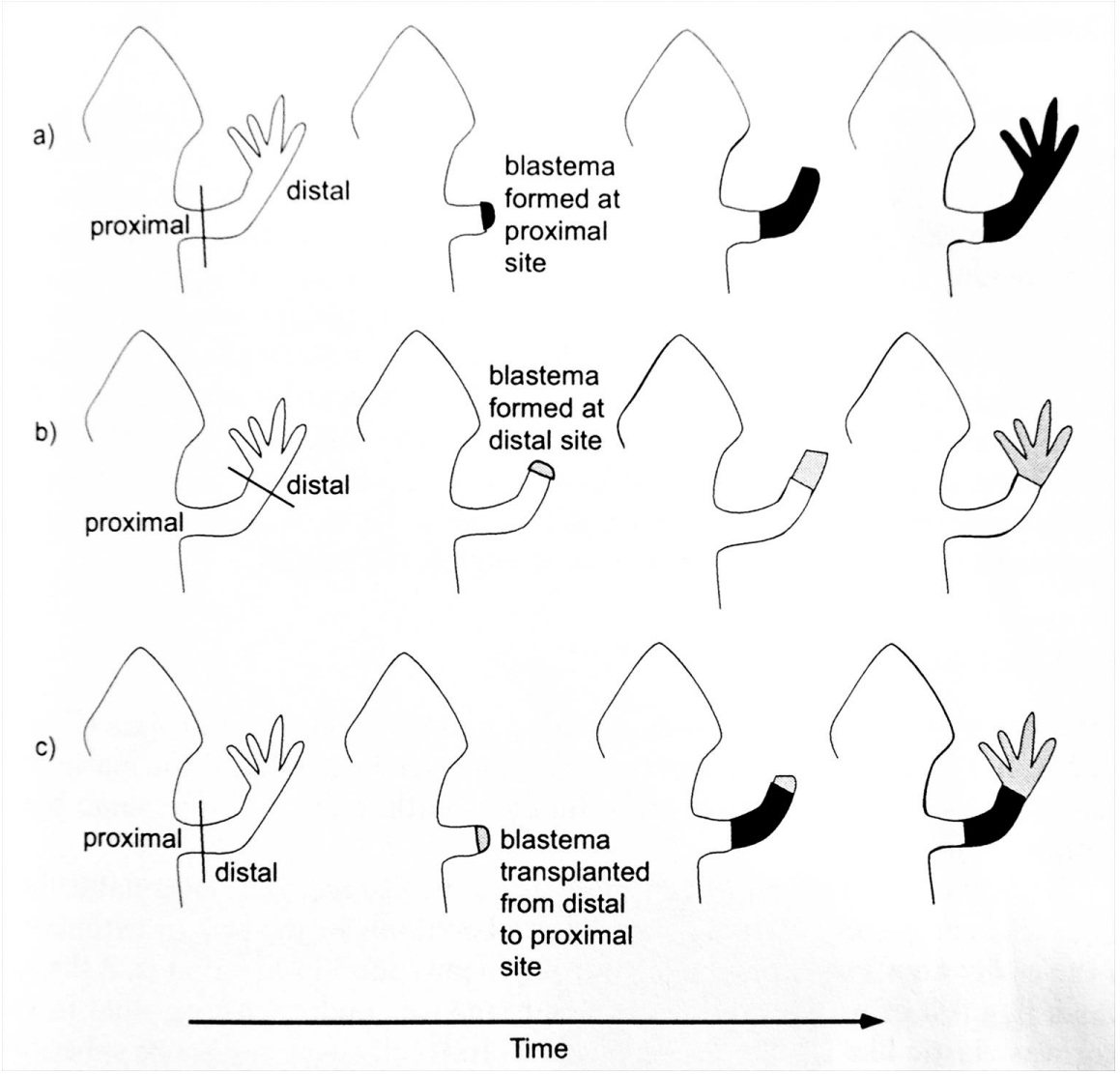
The Developmental Mechanics of Cell Specification, Gilbert 2000

Positional cell fate control and limb regeneration



dev.biologists.org
http://www.united-academics.org/magazine/earth-environment/unlocking-the-secret-of-regeneration/
http://www.newscientist.com/gallery/regeneration/2

Positional cell fate control and limb regeneration (cont)



http://www.newscientist.com/gallery/regeneration/2

Tissue Engineering, Saltzman

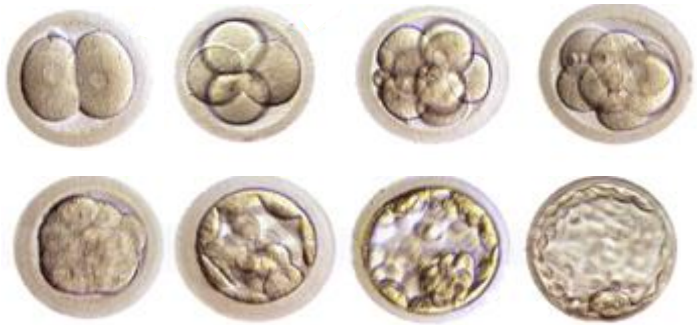
Genomic Equivalence

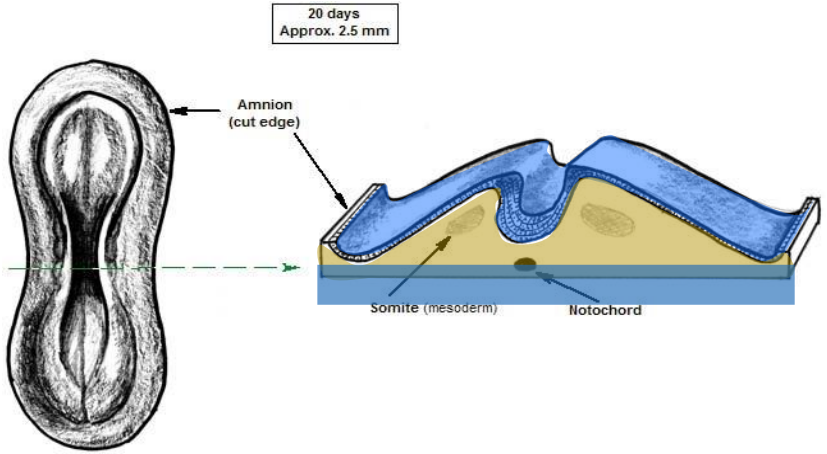
every cell has the same genes

http://www.aaas.org/news/releases/2008/1218breakthrough.shtml

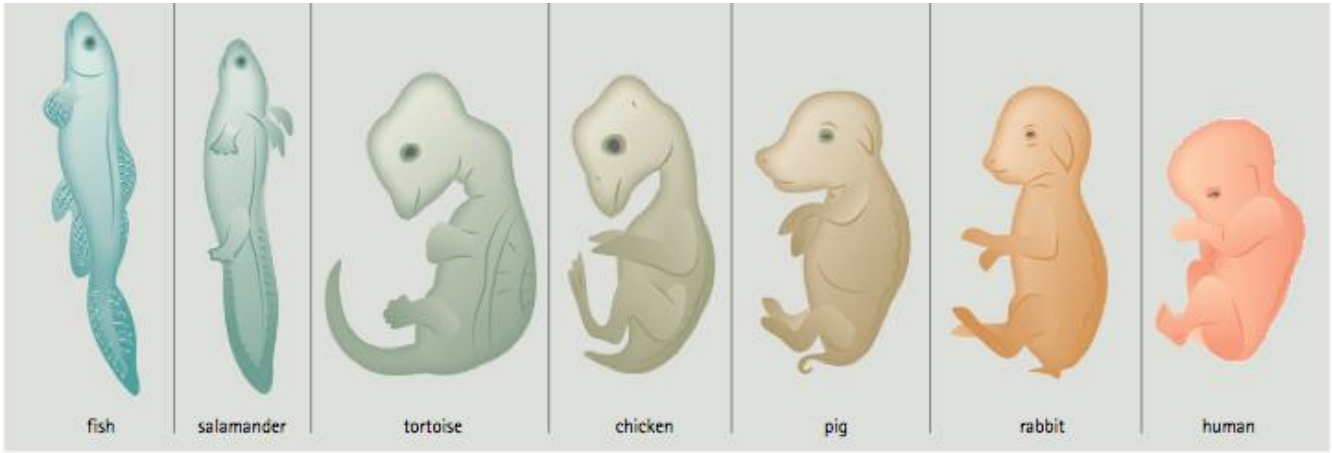
Review of Part 1

Early transformation in the embryo
Cleavage and Folding
Germ layers





Cell Fate Mapping
Cell Potency
Cell Specification



Next Lecture

- Morphogenesis Part 2: Mechanisms of Development