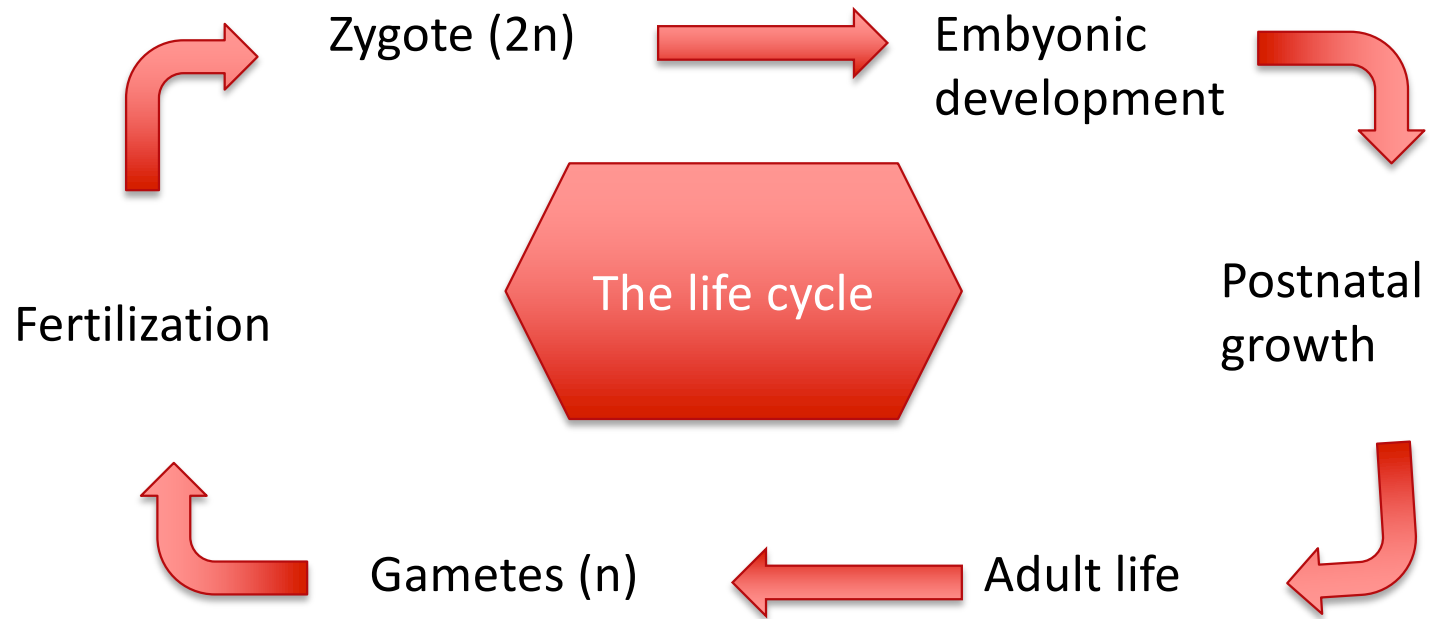


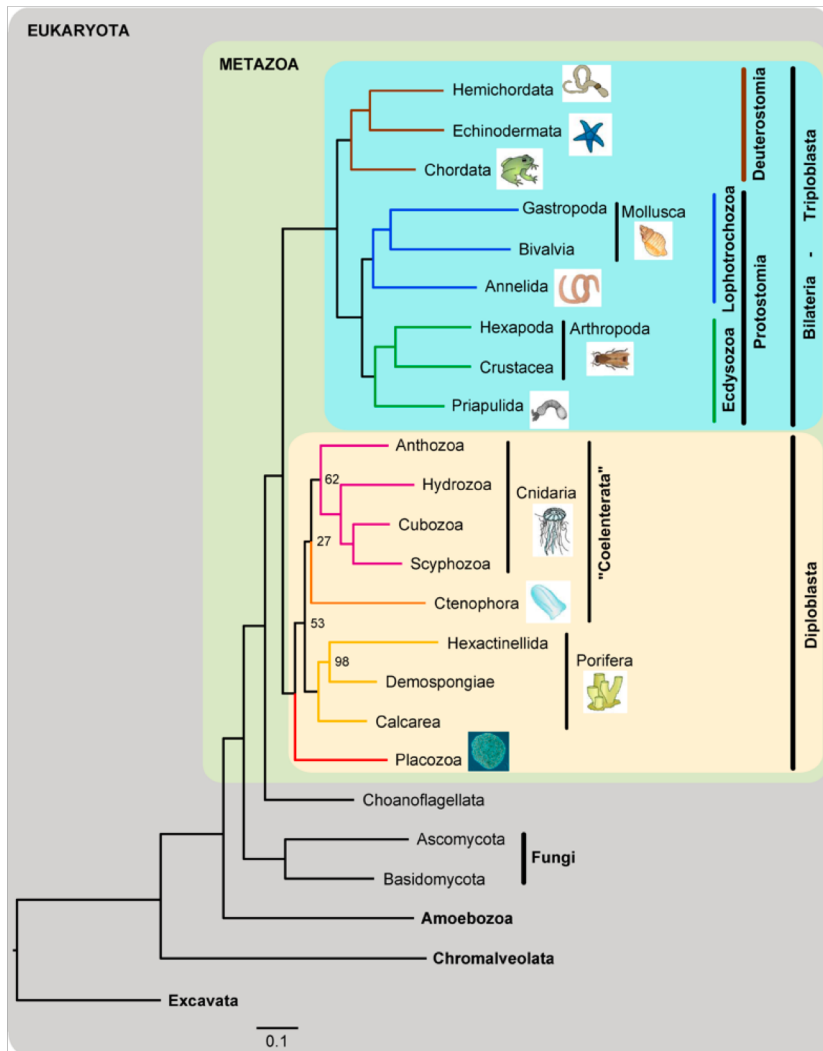
UNIT 1

Concepts and Signaling Pathways in Developmental Biology

Key Concepts in Developmental Biology

Animal development

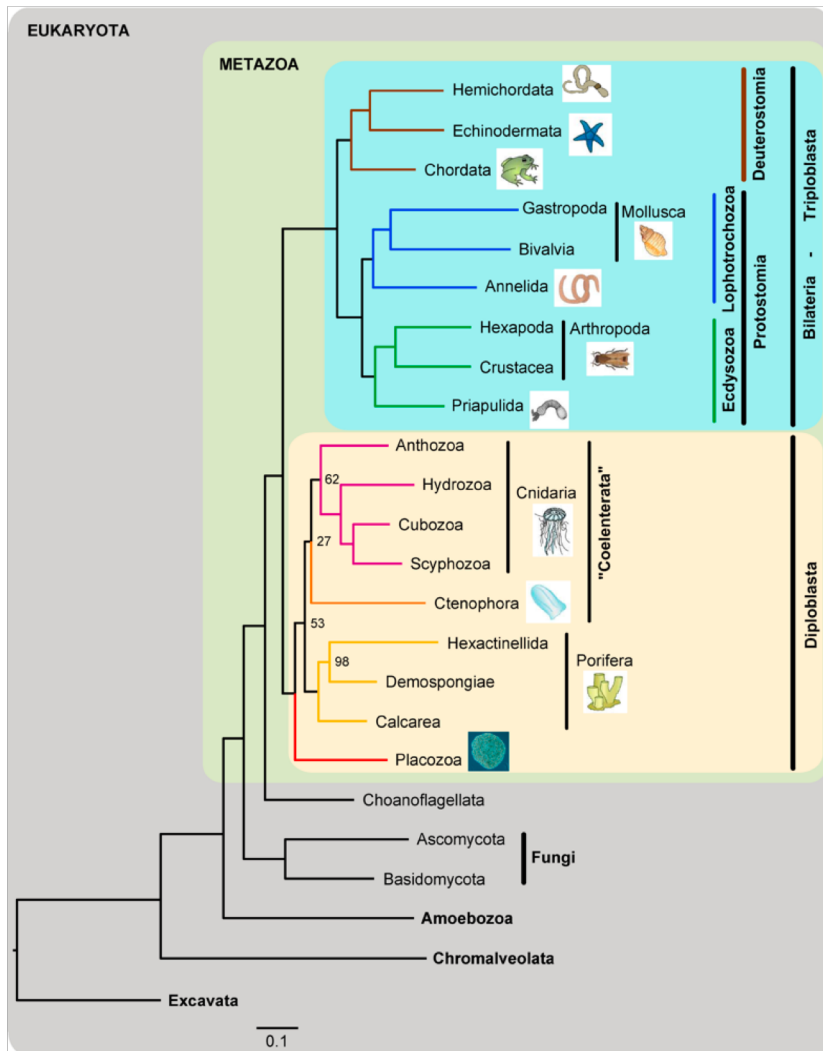




Early development is generalizable

Each animal passes through similar stages of early development

What are the main steps in animal development ?



Early development is generalizable

Each animal passes through similar stages of early development

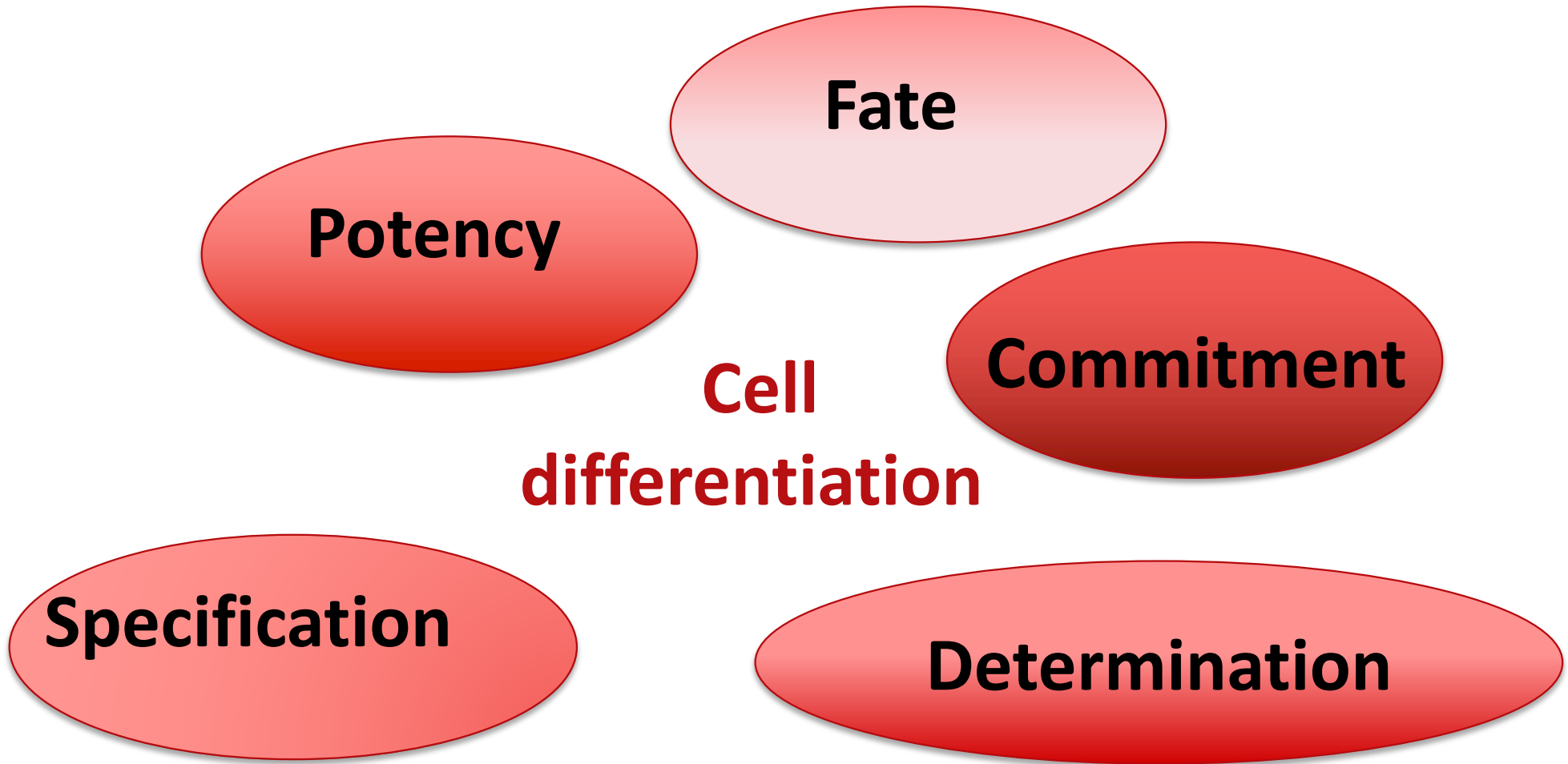
Embryogenesis

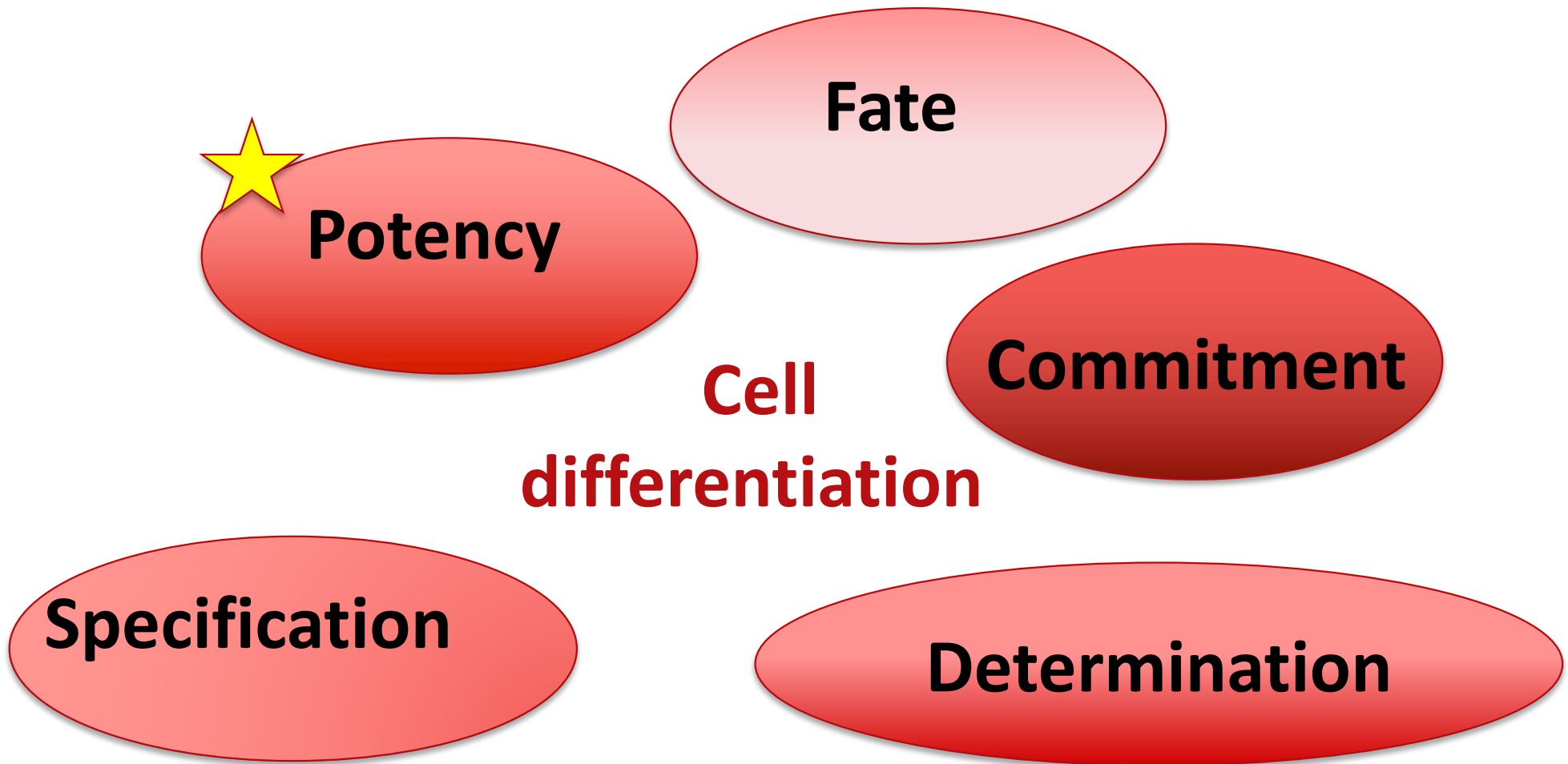
- fertilization
- cleavage
- gastrulation
- organogenesis

Developmental Biology

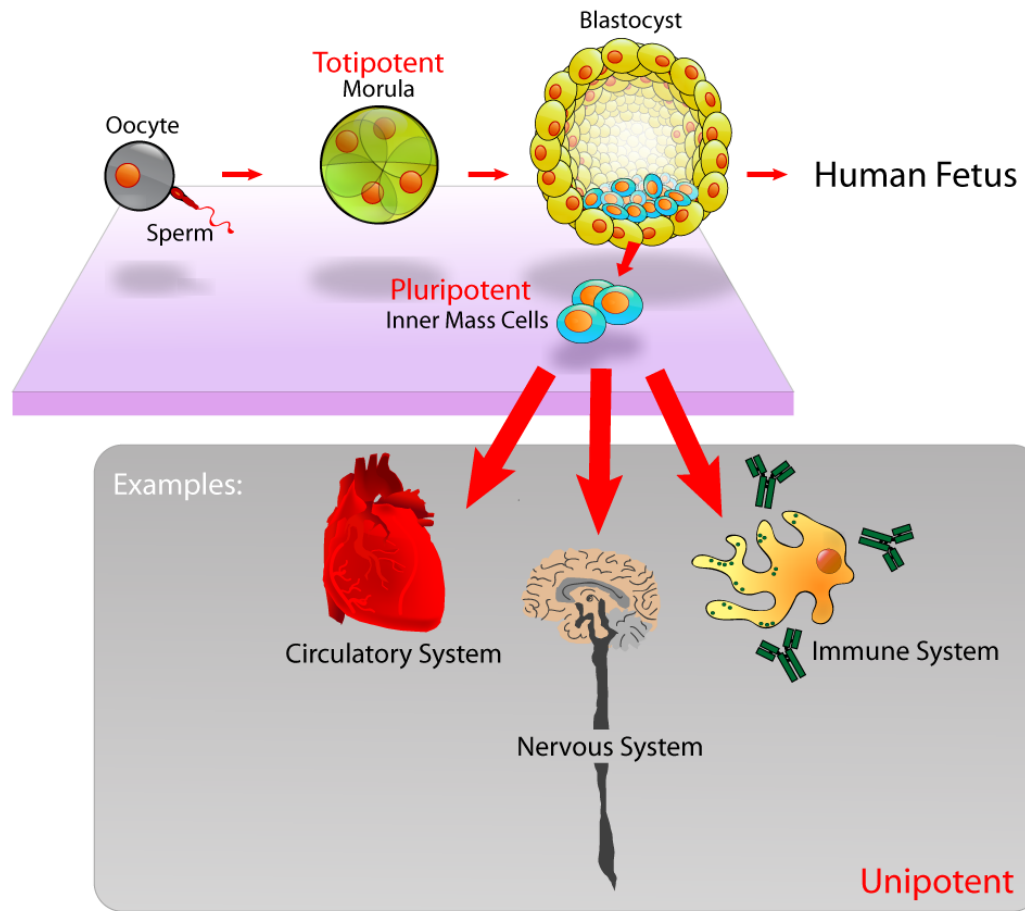
“the study of the **cellular and molecular mechanisms** which control the different stages of embryo development and the **differentiation of cells**, tissues and organs of the body”

...but also regeneration and aging





Cell potency



Original work by Mike Jones for Wikipedia (2006)

Cell potency

Cell Potency

Repertoire of cell types a particular cell can give rise in all possible environments

Cell potency & fate

Cell Potency

Repertoire of cell types a particular cell can give rise in all possible environments

Cell Fate

The range of cell types a particular cell can give rise to during development

What is the main difference and the relationship between the two?

Cell potency & fate

Cell Potency

Repertoire of cell types a particular cell can give rise in all possible environments

Cell Fate

The range of cell types a particular cell can give rise to during development

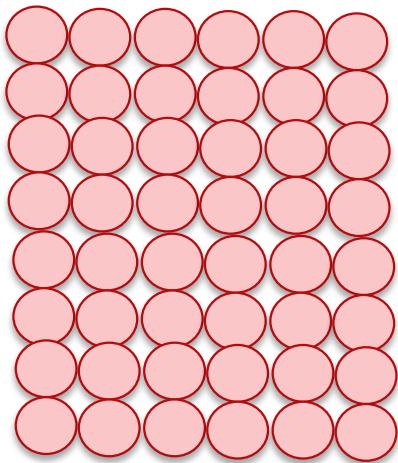
The **potency of a cell** is an **intrinsic property**
and is **greater than or equal** to its **fate**
(fate=potency + environment)

Cell commitment

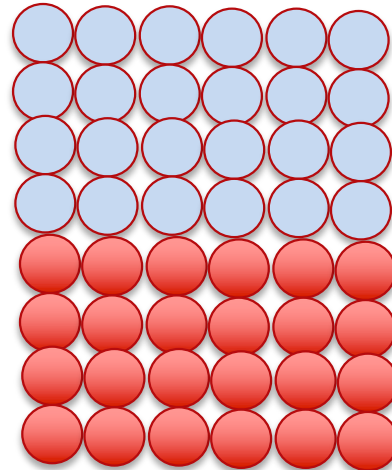
As cell fate becomes restricted following each decision in the developmental hierarchy, cells become **committed** to a certain fate or developmental pathway

Cell commitment in developing tissues

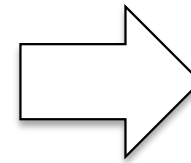
UNCOMMITTED



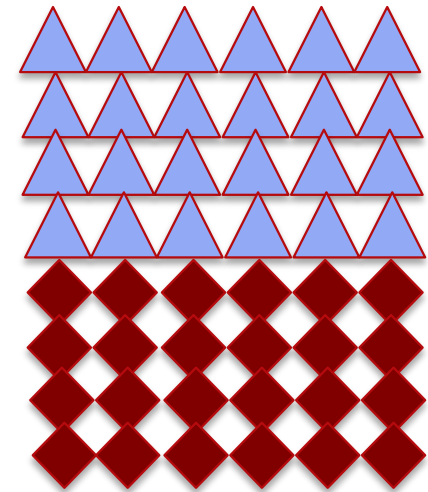
COMMITTED



cell fate

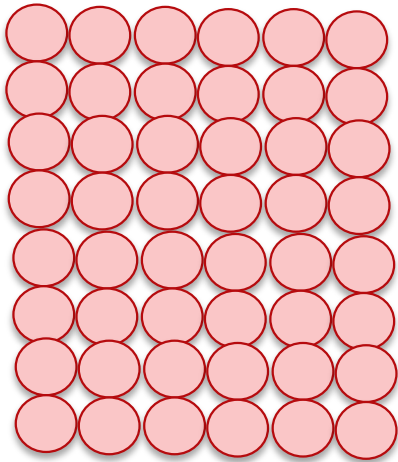


DIFFERENTIATED

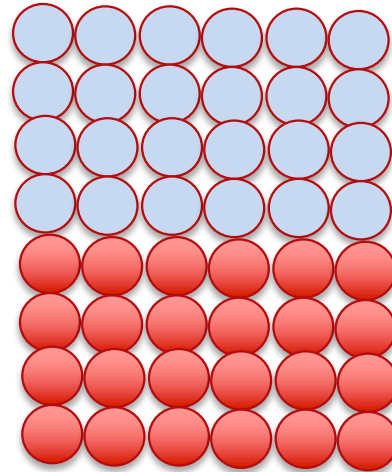


Cell commitment in developing tissues

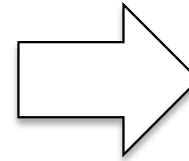
UNCOMMITTED



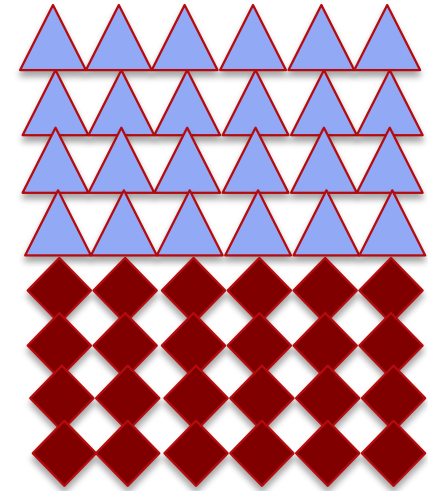
COMMITTED



cell fate



DIFFERENTIATED



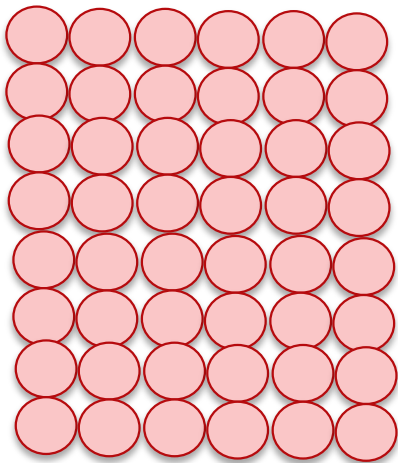
COMMITMENT



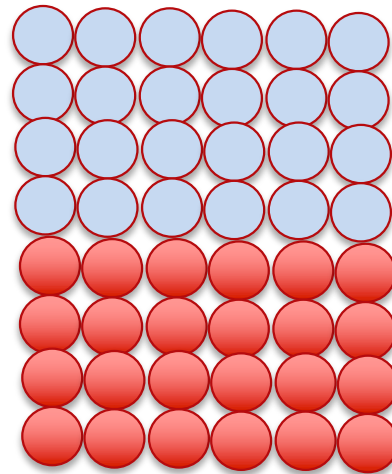
Specification - Determination

Cell Specification

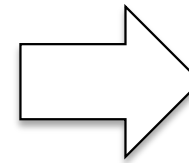
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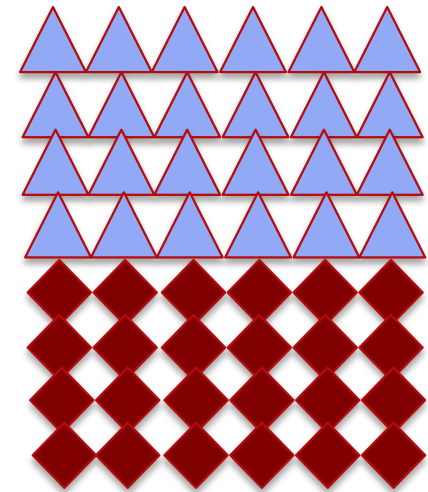
COMMITTED



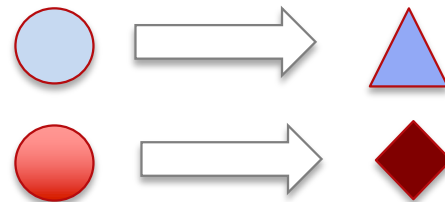
cell fate



DIFFERENTIATED

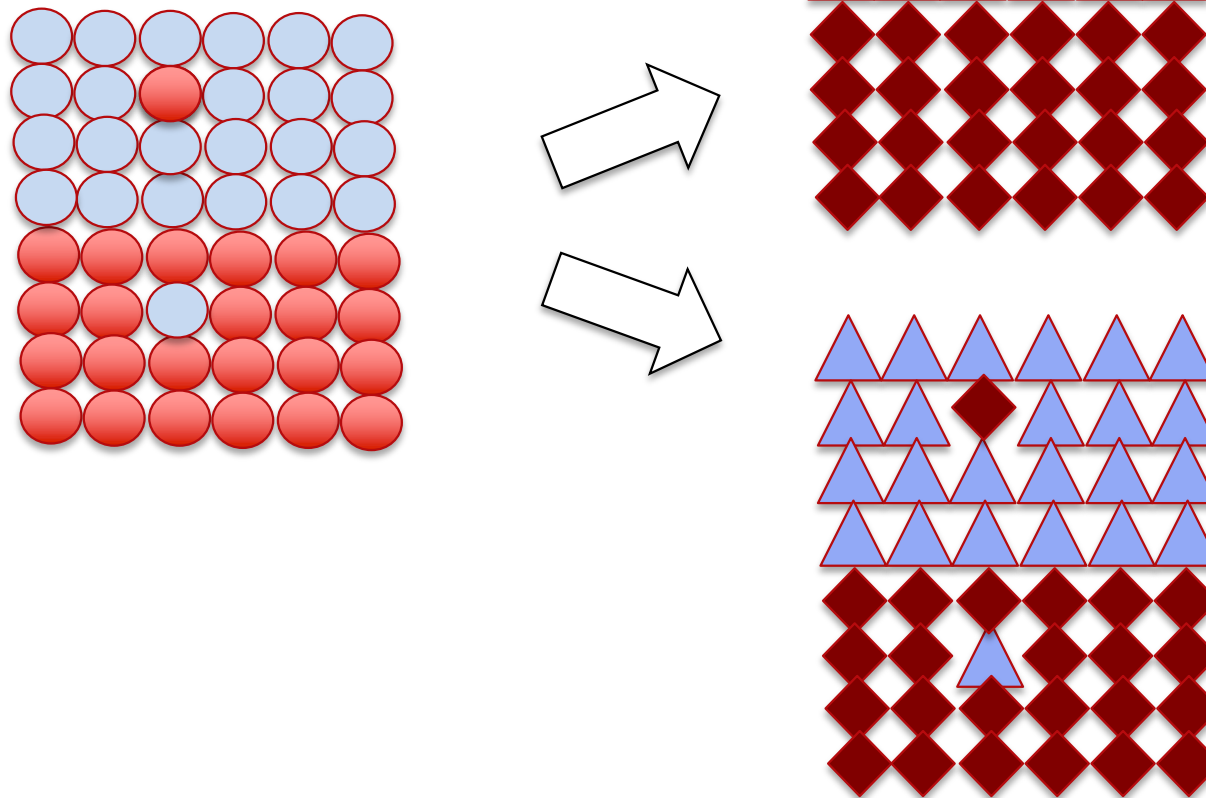


SPECIFICATION

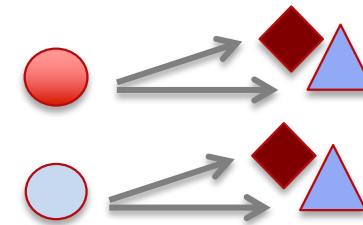


Cells are **specified** if they follow their fate even when placed in a **neutral environment** or **isolation**

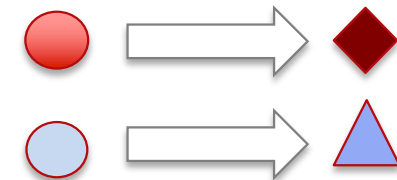
Cell determination



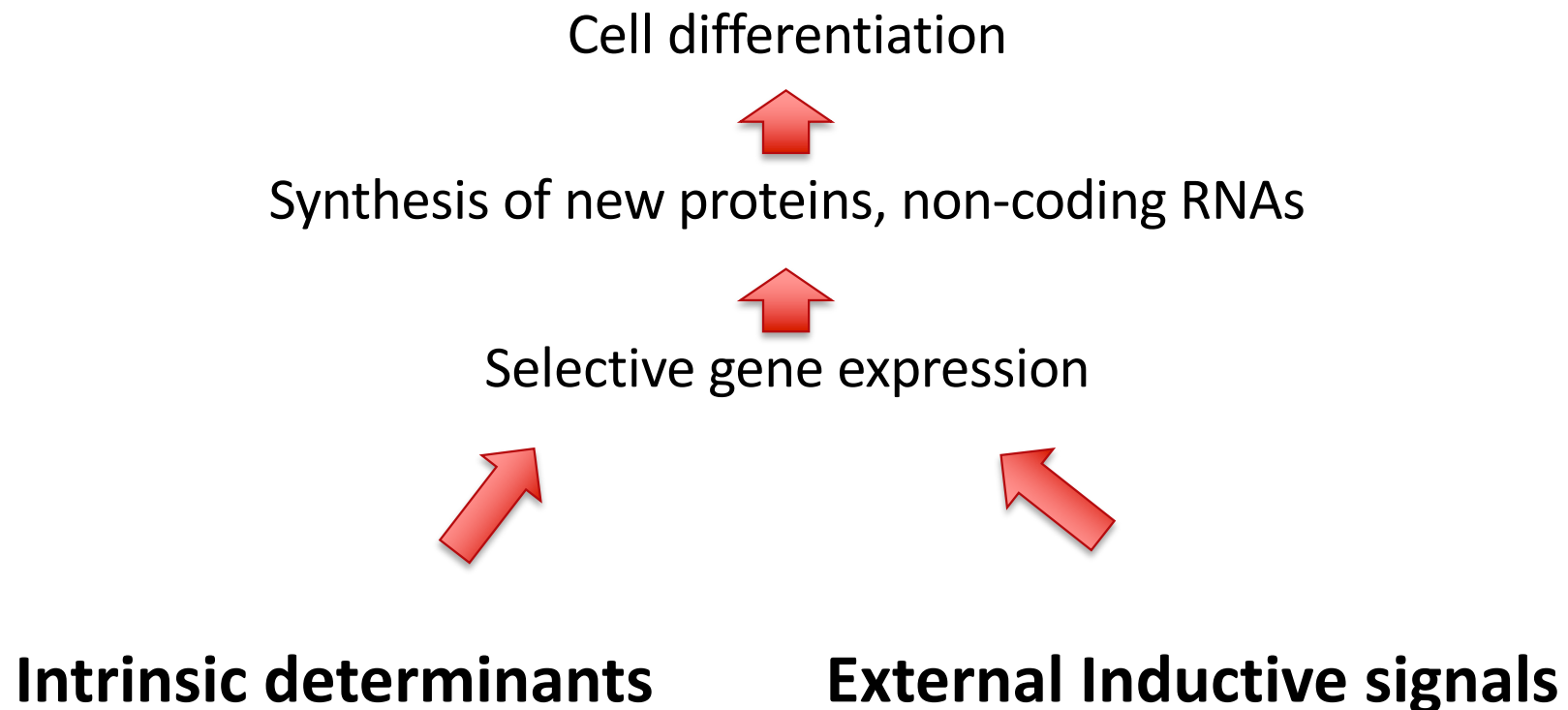
Committed cells are **not determined** if they can change their fate depending on the environment



Committed cells are **determined** if they maintain their fate regardless of the environment

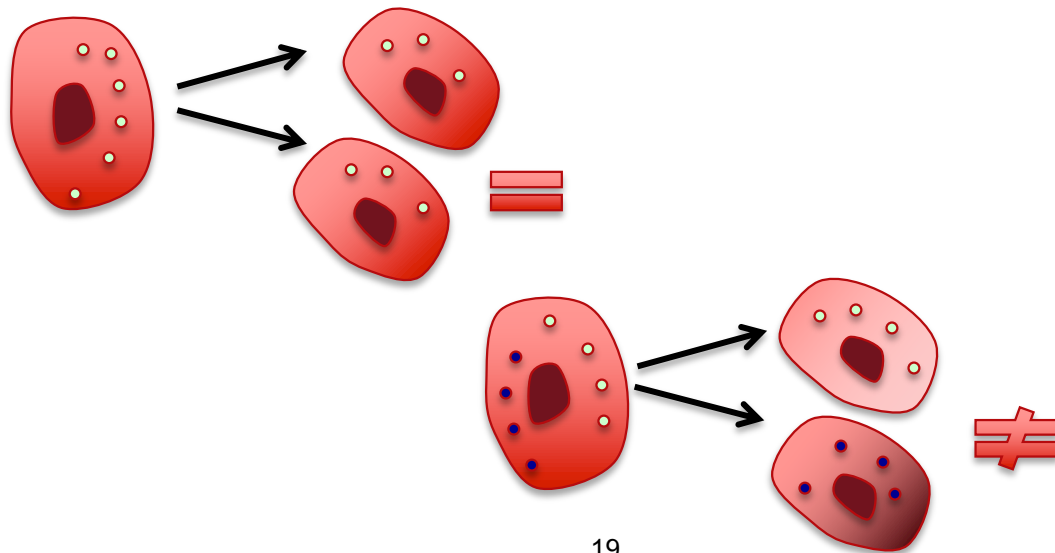


Mechanisms of developmental commitment

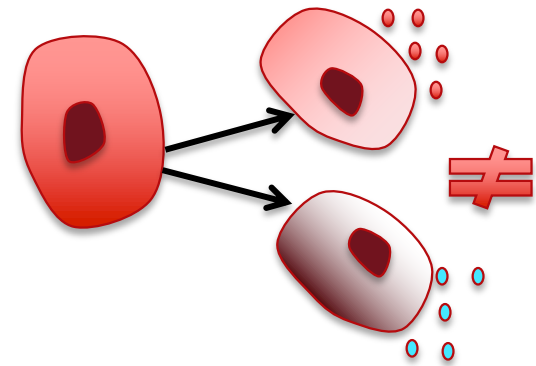


Intrinsic versus Extrinsic factors

Intrinsic determinants



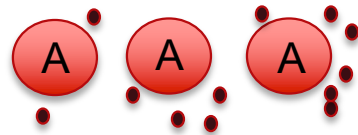
External Inductive signals



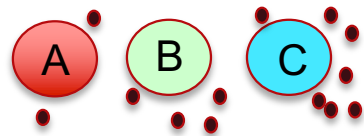
Inductive signals

The response of a cell to inductive signals can be:

1) Stereotyped



2) Different depending on the signal concentration



Morphogens

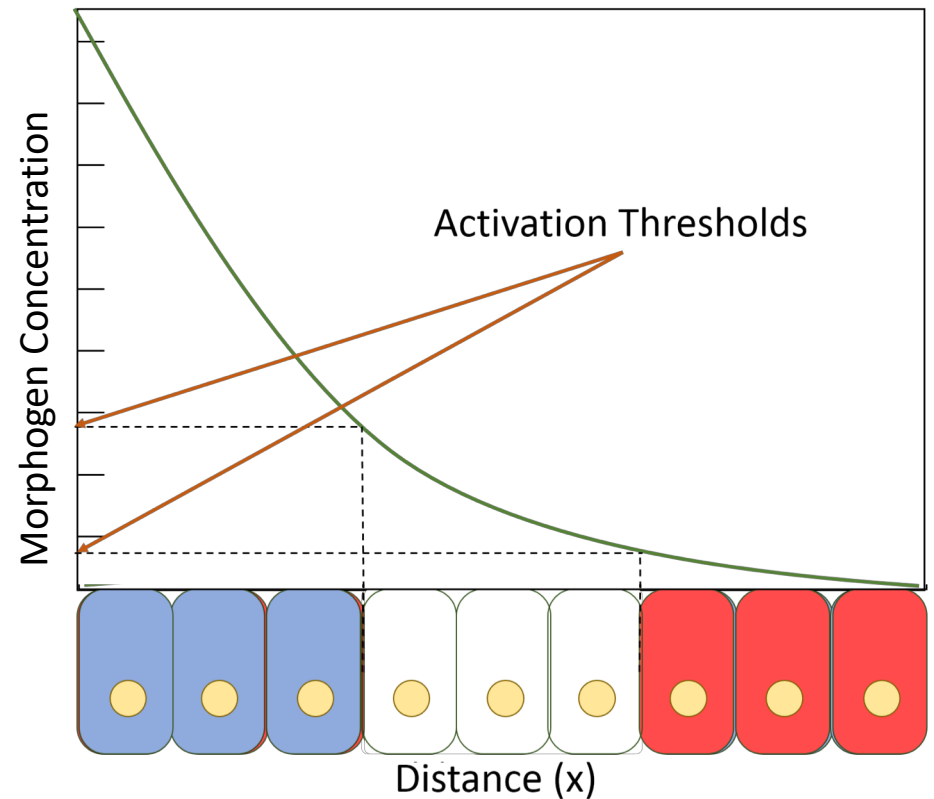
Soluble secreted molecules form a **morphogen gradient**

A morphogen can specify more than one cell type depending on its concentration

The response of receiving cells to the signal is dependent on their distance from the source of the signal

What are the factors influencing morphogen distribution ?

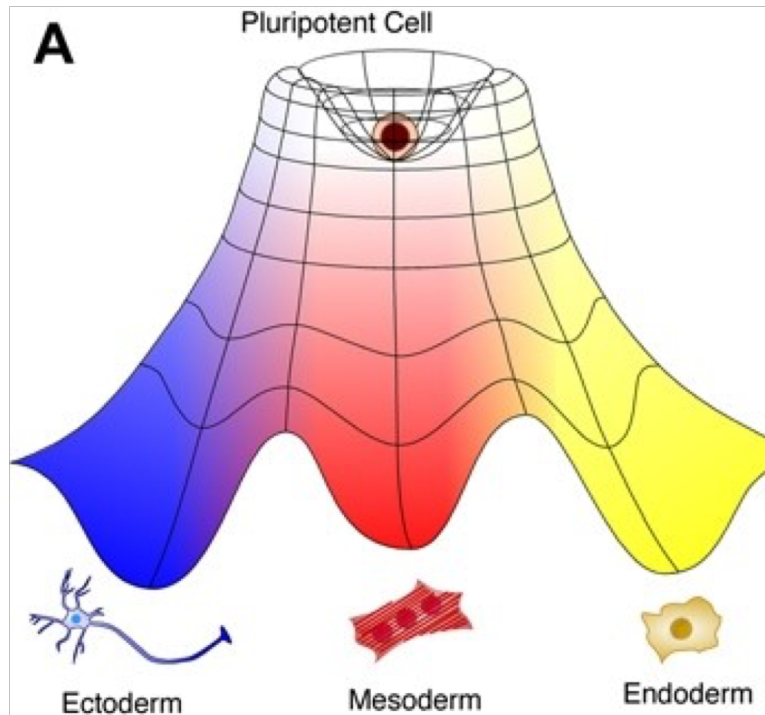
The French flag model



Modified from original work by Daniel Alber (2018)

Cell differentiation and the epigenetic landscape model

Conrad Hal Waddington



....interaction between GENES and the ENVIRONMENT models the developmental pathways a cell can take during DIFFERENTIATION

Rodolfa, K.T., Inducing pluripotency, StemBook, ed. The Stem Cell Research Community, StemBook, 2008doi/10.3824/stembook.1.22.1

Cell differentiation, an irreversible process?

The reversal of cell differentiation

The Nobel Prize in Physiology or Medicine 2012

Sir John B. Gurdon and Shinya Yamanaka

Cloning in frog
1962

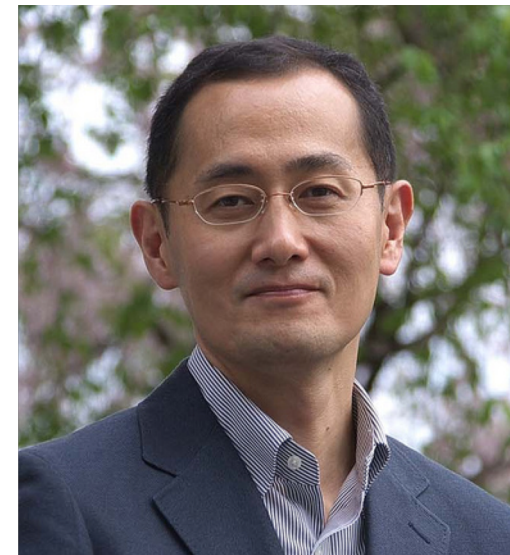
Principle
of genome
conservation

From nuclear
transfer
to nuclear
reprogramming



Original work by Deryck Chan,
courtesy to cameraman Sien Yi Tan (2012)

“for the discovery
that mature cells
can be
reprogrammed to
become pluripotent”



Original work by Rubenstein on flickr (2009)

iPSCs
Oct4
Sox2
Klf4
c-Myc