The Future of Developmental Biology: Biological Systems

Myung Chan Gye, PhD

Department of Life Science, Hanyang University

Developmental Biology

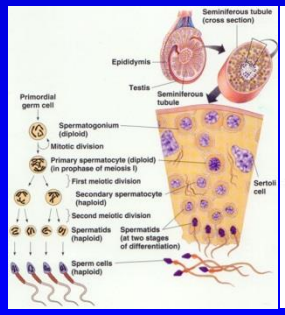
- Study of the process by which animals and plants grow and develop
- Most development occurs in embryonic life, but it is also found in regeneration, asexual reproduction and metamorphosis, and in the growth and differentiation of stem cells in the adult organism.

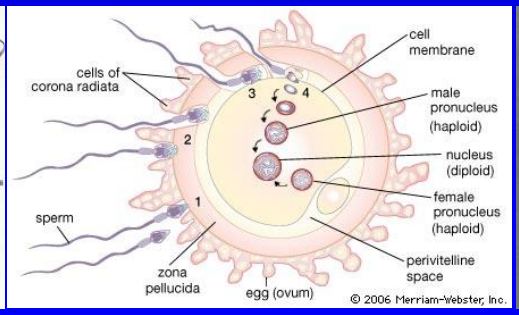
The main processes in the embryonic development

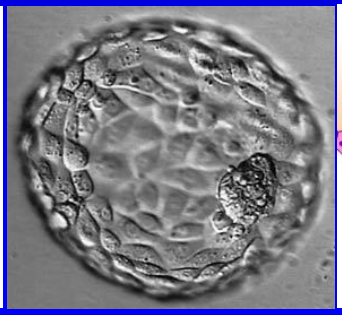
- Regional specification
- Morphogenesis
- Cell differentiation
- Growth
- Metamorphosis
- Overall control of timing

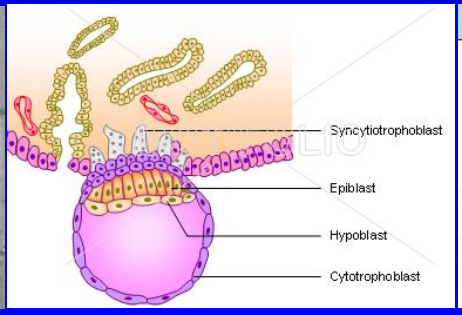
Classic topics: Gametogenesis and Early Development

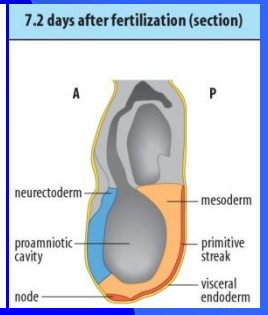
- Gametogenesis
- Fertilization
- Cleavage and Blastocyst Development
- Implantation
- Gastrulation





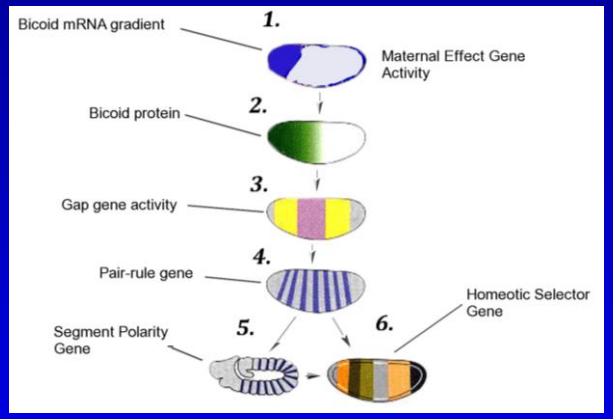


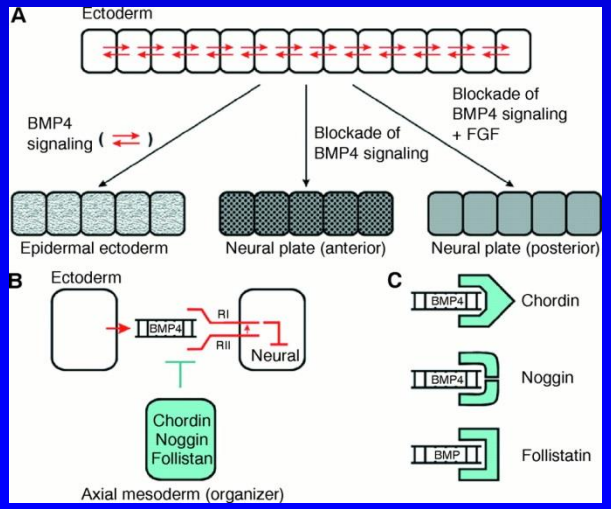


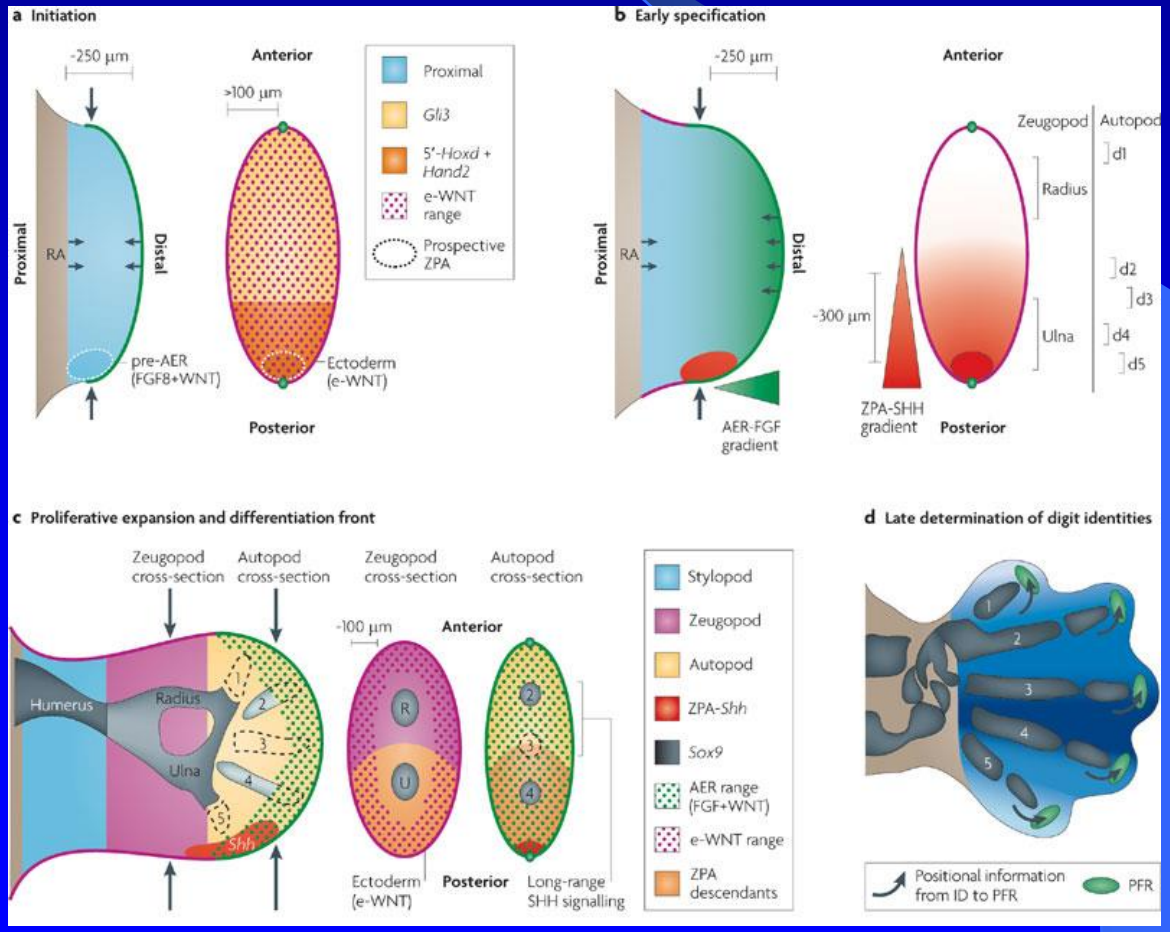


Classic topics: Cellular Mechanisms of Early Development

- **Body Axis and Morphogenesis**
- **Patterning and Cell Fate**





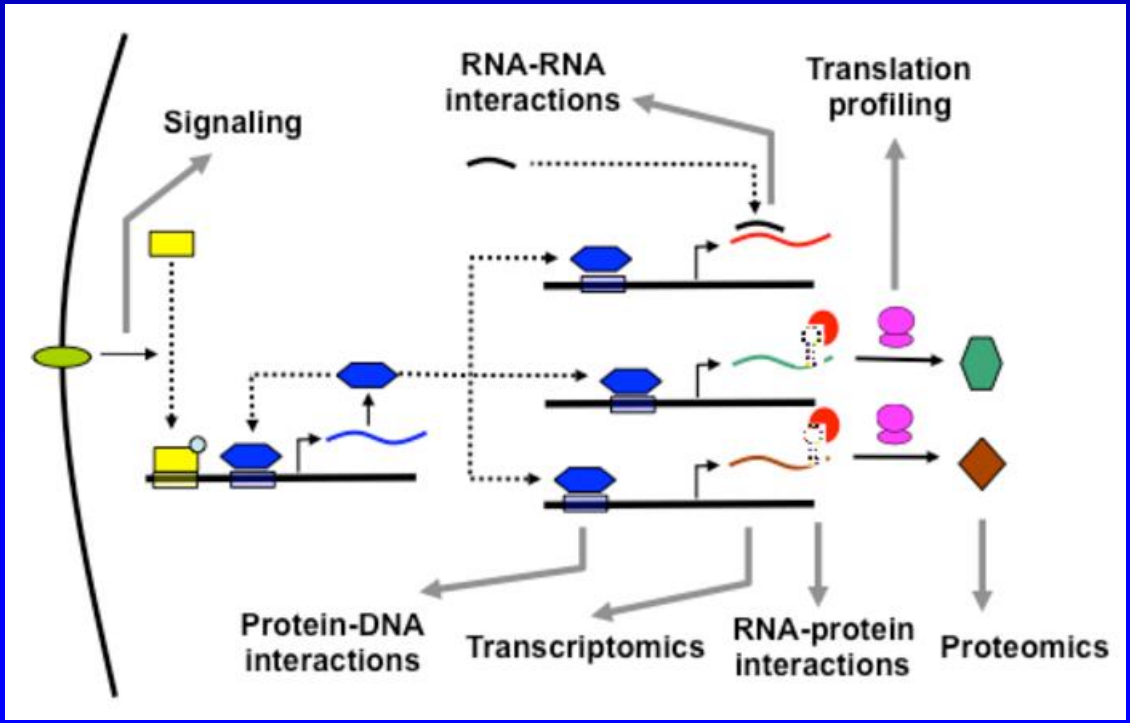


Classic topics: Regulatory Networks of Gene Expression

- Transcription factors

- Epigenetic modification

- Small non-coding RNAs

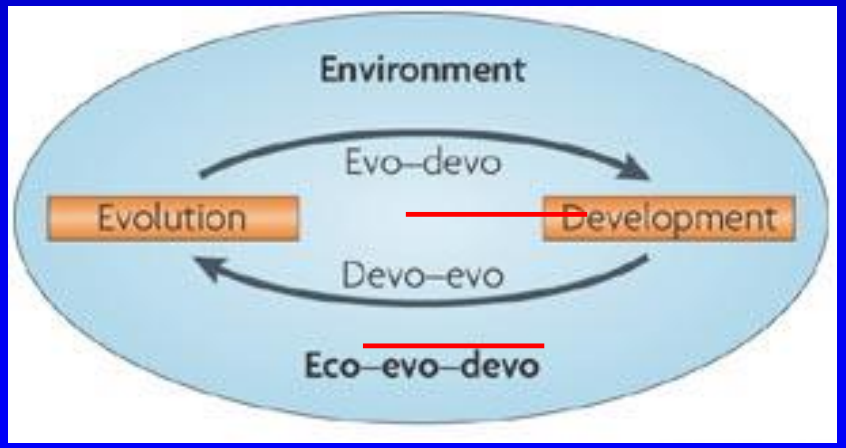


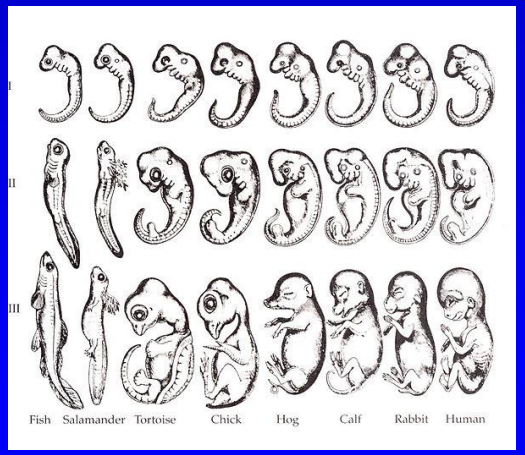
Classic topics: Evo Devo

Discovering and understanding the role of changes in developmental mechanisms in the evolutionary origin of aspects of the phenotype.

Questions

- **How did development originate?**
- **How did the developmental repertoire evolve?**
- **How are developmental processes modified in evolution?**



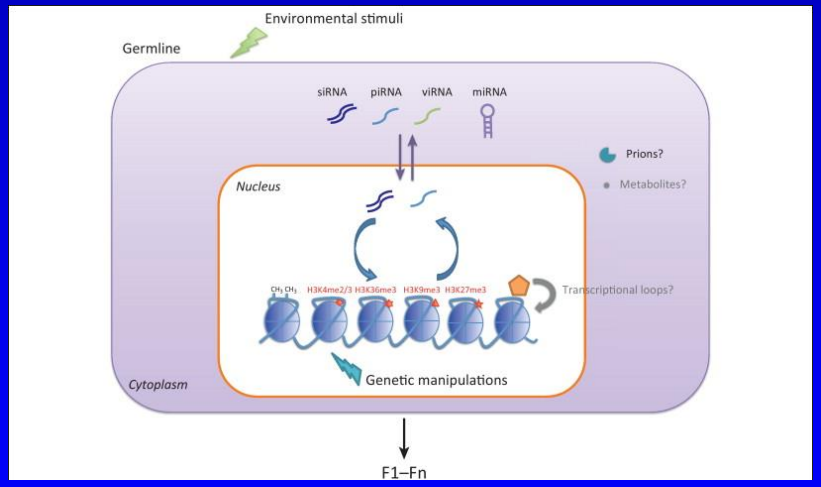


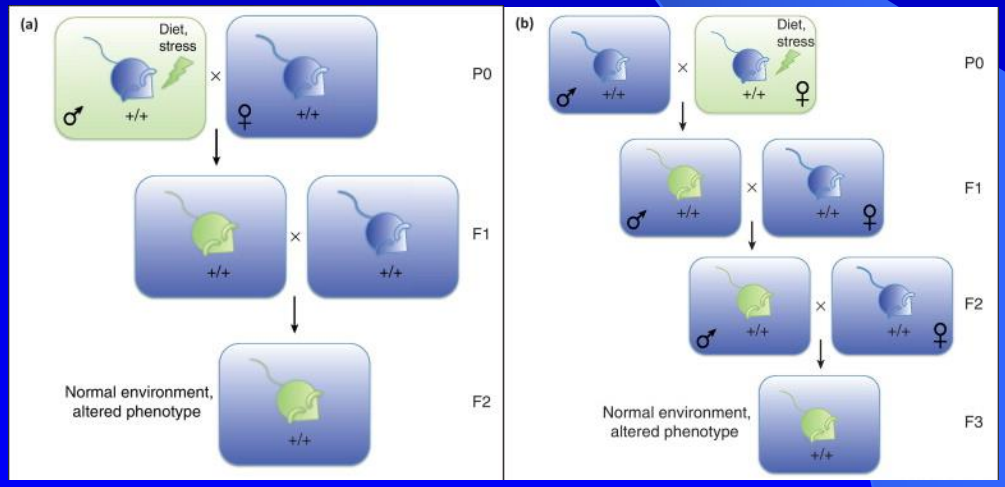
Emerging areas: Transgenerational Signaling

- Non-genetic inheritance of new phenotypes
- Phenotypes induced by a transient treatment or mutation that persist for multiple generations without mutations in DNA."

Chromatin modifications

RNA molecules

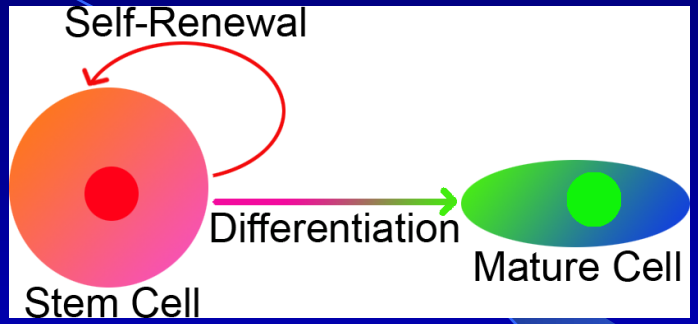




Emerging areas: Stem Cell Biology

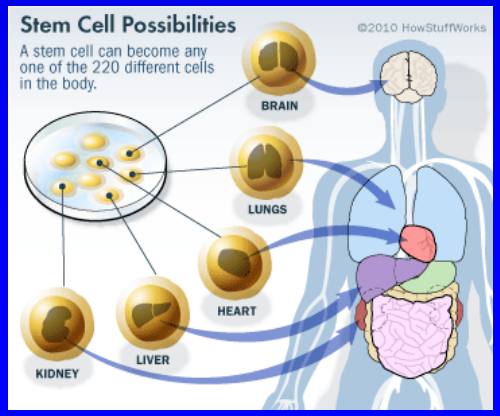
ES cells

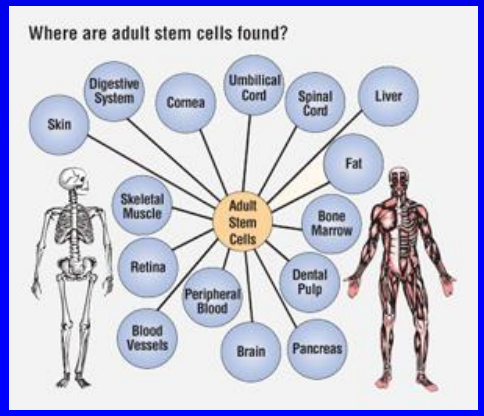
- The body of pluripotency
- Control of differentiation
- Prevention of cancergenesis

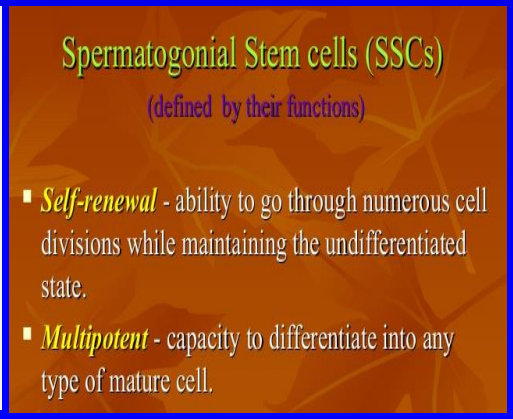


Adult stem cells

- Understanding the replenishment of adult tissue in the body
- Use of various ASC in regeneration medicine





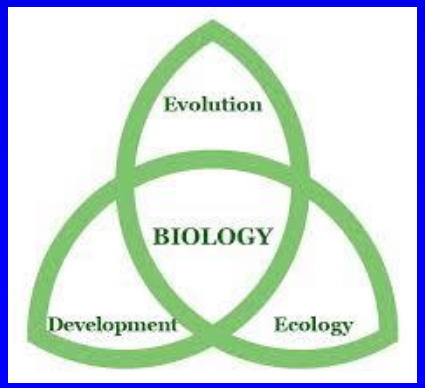


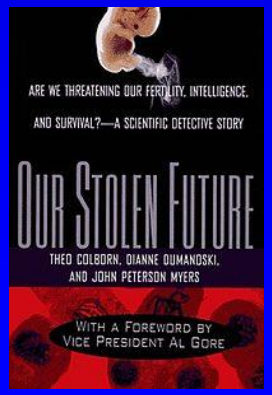
Emerging areas: *Eco-Devo*

- Animal development can be modified by external factors in such a way as to increase its efficiency in dealing with them
- The environment where the development occurs should be integrated as a part of control mechanism of development

Questions

- How does the environment interact with developmental processes?
- How does environmental change influence phenotypic evolution?
- How does developmental evolution affect the environment?

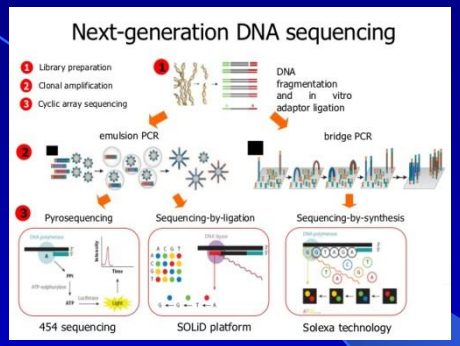




Recent technologies

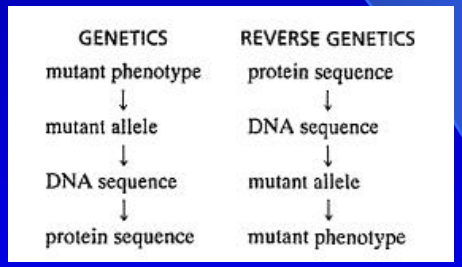
Next generation sequencing (NGS)

- Whole genome seq.
- RNA seq



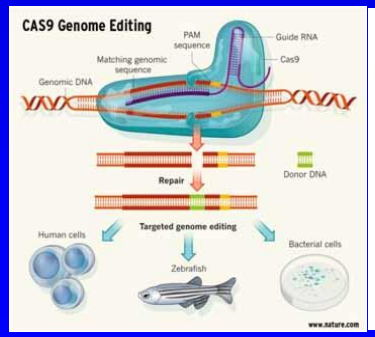
Proteomic approach

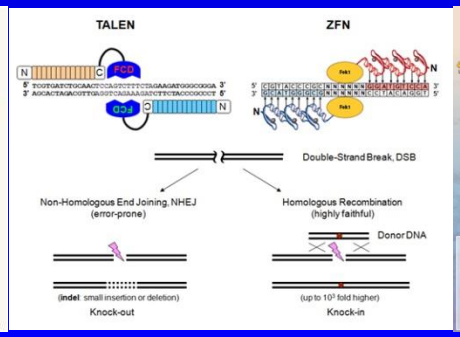
- Reverse genetics

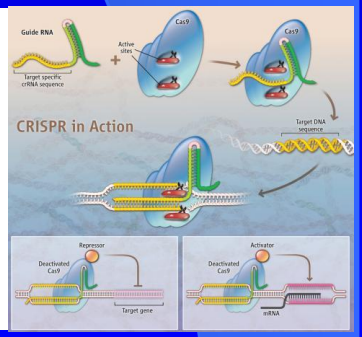


Transgenesis

- Genome editing enzymes







Practical outcomes from the study of developmental biology

- *In vitro* fertilization
- Identification of risks from teratogens
- Creation of animal models for human disease
- Stem cell therapy

Way to go

- Developmental Biology lies at the crossroads of all the Life Sciences
- Integration of investigations at molecular, cellular, tissue and organism levels
- Cross-fertilization of ideas from complementary organisms such as *Drosophila*, *C. elegans*, zebrafish, *Xenopus* and the mouse, as well as plants, non-standard animals and humans.
- Focus on the overcome of disease

감사합니다.