Evolution of Animal Form & Function

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Lecture 5

1) First Exam: TBD
2) Exam questions will be posted in advance
3) No office hours next Tuesday – we have EEB’s grad interviews.

But there is one organ where initial cell differentiation is delayed and directly influenced by life experiences...

- Somatic mosaicism: cells within organism have different genetic sequences
  - In the brain, mobile DNA/RNA sequences are the main source of somatic mosaicism.
  - >17% of genome, > 3,000 in mice

- Mosaicism in adult brain: low control, high anxiety, low coordination of activities, major obsessions (= amplified “teenage” brain...)

- Higher parental neglect, lesser cuddling → greater accumulation of non-silenced (non-methylated) mobile elements in neuron precursors
- Giving rise to brain’s somatic mosaicism... and high anxiety / greater obsessiveness / lower control in adulthood...

Early life experience drives structural variation of neural genomes in mice

Tracey A. Relyewicz, Carolina Quaglio, Nicole Neveu, Fred H. Gage*

The brain is a genomic mosaic owing to somatic mutations that arise throughout development. Mobile genetic elements, including retrotransposons, are one source of somatic mosaicism in the brain. Retrotranspositions may represent a form of plasticity in response to experience. Here, we use droplet digital polymerase chain reaction to show that natural variation in parental care modulates the mobilization of long interspersed nuclear element-1 (LINE-1) retrotransposons in the hippocampus of the mouse brain. Increasing the amount of maternal care blocks the accumulation of LINE-1 retrotransposons in the hippocampus. This observation above DNA methylation at YY1 binding sites implicated in L1 activation and affects expression of the de novo methyltransferase DNMT3a. Our observations indicate that early life experience drives somatic variation in the genome via L1 retrotransposons.

Life

Faithful self-replication
How to reconcile?

Faithful self-replication vs uninterrupted unstoppable evolutionary change

How to reconcile?

Faithful self-replication vs uninterrupted unstoppable evolutionary change

How to test?

Evolution Development Inheritance

Generation 1

Generation 2

How to test?

Two questions:
Fertilized Egg —> Adult phenotype; Adult Phenotype —> Adult Phenotype

Environment 1

Environment 2

Genes 1

Genes 2

Generation 1

Generation 2

Seven general questions in evolution and development:

1) The question of differentiation
2) The question of morphogenesis
3) The question of growth
4) The question of reproduction
5) The question of regeneration
6) The question of evolution
7) The question of environmental integration

THE SEVEN questions in evolution and development:

1) The question of differentiation
2) The question of morphogenesis
3) The question of growth
4) The question of reproduction
5) The question of regeneration
6) The question of evolution
7) The question of environmental integration

https://youtu.be/3mCgHK-X6lE
Seven general questions in evolution and development:

2) The question of morphogenesis

Differentiated cells are not randomly distributed: the organs and tissues formed and arranged in a particular way.

The production of ordered form is called morphogenesis. Coordination of cell growth, cell migration, cell death

— How can the cells form such ordered structures?

https://vimeo.com/293618382

3) The question of growth

Just one more cell division on each side of a body will produce horrible malformations

— How is cell division so tightly regulated?

4) The question of reproduction

The sperm and egg are very specialized cells. They transmit the instructions for making the organism to the next generation.

— How are these cells set apart? Why apart? Why so early?
— How is age reset during fertilization?

5) The question of regeneration

Some organisms can regenerate their entire bodies, some -- parts. Stem cells...

7 October 2012 Nobel Prize follows 11 September 2012 ECOL330 lecture

"New you":

By ECOL 330 finals (early May) you will have completely replaced your:
1) Skin: 8 times
2) Blood (RBC): once
3) Intestine surface: 30 times
4) Liver: 1/2
5) All sperm cells: 40 times (2 full cell lineages, ~27 billion)
6) Skeleton: ~5% completely
7) Only 2-3 of your tissues will have ALL cells that witnessed today’s lecture.

— How do stem cells retain their capacity to form new structures?