Gamete development and embryo development

What is a stem cell?

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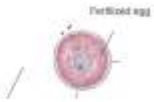

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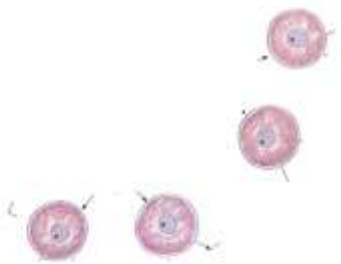

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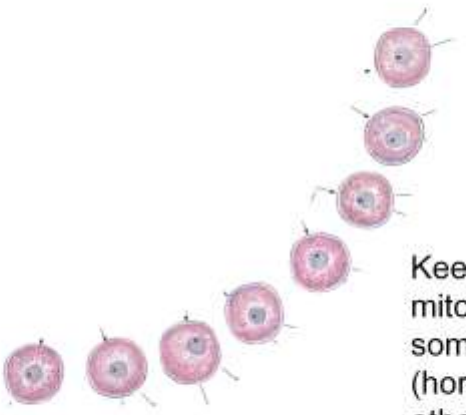
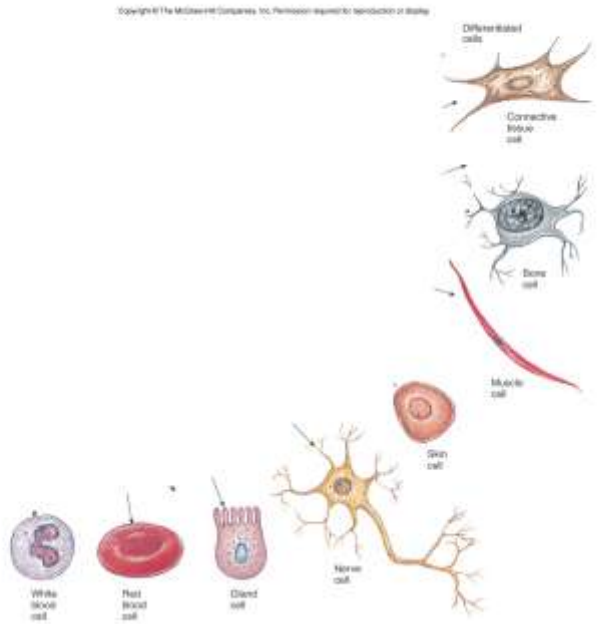


Keep undergoing mitosis until something (hormones or other chemical tells them)

What is a stem cell?



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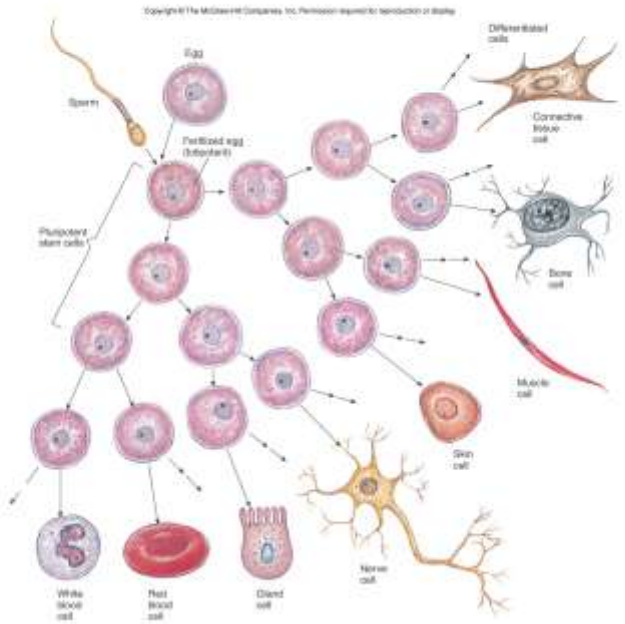


Stem Cells

Cells that contain all of our genetic information –

Not just in the umbilical cord

complete directions to build a person (or frog or…).

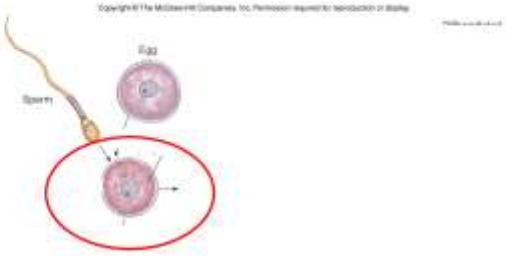
- Bone marrow (to make blood)
- Testes (to make sperm)
- Embryo (first two weeks)
- Umbilical cord
- Various other areas in body

Are eggs and sperm stem cells?

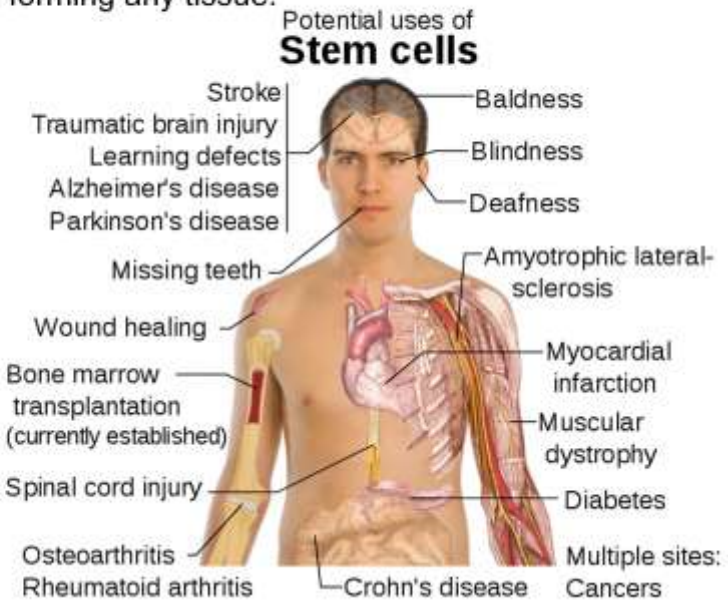
A. No
B. Yes

No Only the egg/sperm combination after fertilization. Then you have all the material needed to make a baby. Until then, each only has half.

What is a stem cell?

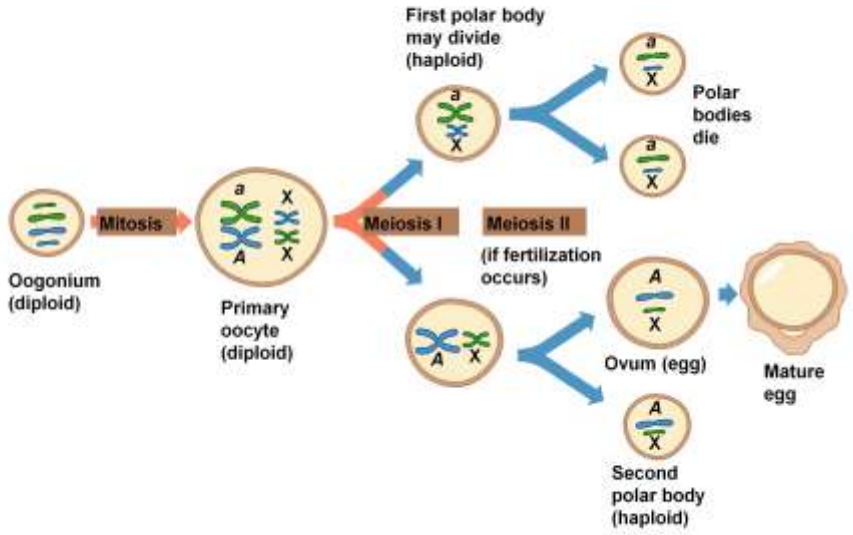


Stem cell "lines" can be maintained by taking cells from embryos and let them divide in a culture condition that allows them to keep dividing without forming any tissue.



At present, no new stem cell lines can be created using government money.

Oogenesis


First polar body
may divide
(haploid)
Polar
bodies
die
Mitosis
Meiosis I
Meiosis II
(if fertilization
occurs)
Oogonium
(diploid)
Primary
oocyte
(diploid)
Ovum (egg)
Mature
egg
Second
polar body
(haploid)

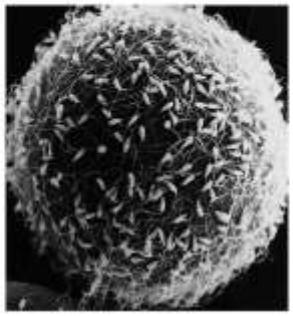
Oogenesis

- Eggs are created in the embryo, before birth
- These eggs begin meiosis (before birth) and stop just before the first division.
- Puberty: ovulation once a month, egg completes it's first division and is released from the ovary
- It begins the second division, but does not complete the process unless fertilized!
- On average, a woman will ovulate about 400 eggs between puberty and menopause.

Spermatogenesis

- Stem cells that will make sperm are present at birth
- Puberty: the stem cells undergo mitosis to make spermatocytes
- Proceed immediately into meiosis and produce spermatids that mature into sperm – 48 day cycle.
- Each orgasm produces about *400 million* sperm cells.

Fertilization



• As soon as one sperm gets into the egg, a chemical reaction occurs, preventing additional sperm from entering.

What would happen if two sperm fertilized the egg?

a. Embryo would have 3 copies of every chromosome
b. Embryo would have normal chromosomal content
c. Embryo would develop normally
d. Embryo would die
e. A and D

E Embryo would get 3 copies of every chromosome (2 from 2 sperm and 1 from the egg) and that would cause it to die.

Twins

- Fraternal
  - Two separate eggs ovulated.
  - Just like any other siblings.
- Identical
  - A fertilized egg splits into two.
  - Share *exact* genetic material

Reproductive problems and technology

Male infertility

About 1 in 25 men are infertile (4%) (usually a problem with Y chromosome genes)

Female infertility: more things can go wrong

- failure to ovulate
- cystic ovaries
- failure of uterine lining to thicken
- abnormal thickening of lining (endometriosis)
- blocked Falopian tube
- failure of implantation, etc.

Defects during development can be caused by

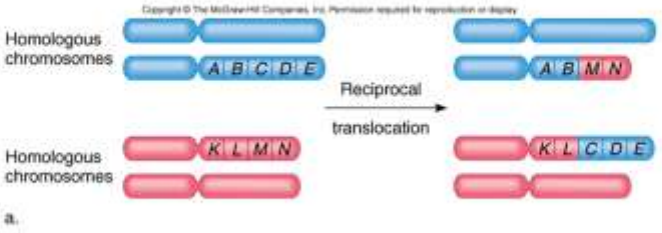
- recessive disease that both parents carry (Molly's case)
- complete loss or duplication of a chromosome
- can have pieces rearranged
- can trade material

Abnormal chromosome structure

Normal sequence of genes:

a.

Translocations



All parts of all chromosomes are present so person is usually normal.

Problems arise if a gene is interrupted

Next generation can be affected

Miscarriage

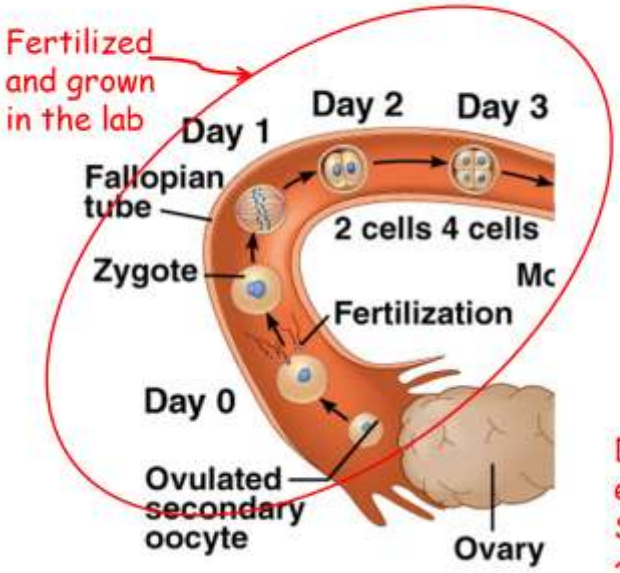
Our body's way of taking care of most chromosomal defects – "mistakes".

- 25 - 30% of all pregnancies - usually in first 6 weeks
- 60% of early miscarriages are genetic problems
- Rate of miscarriage increases with age of both men and women.
- 3 or more in a row considered a case for further investigation.

In Vitro Fertilization (IVF)

1. Super-ovulation is induced in mother to be
2. Multiple eggs removed
3. Combined with sperm in the lab

Early development



Drugs help lots of eggs mature
Surgically remove ~30

In Vitro Fertilization (IVF)

1. Super-ovulation is induced in mother to be
2. Multiple eggs removed
3. Combined with sperm
4. **Rate** the health of each embryo
5. Flash frozen while testing and waiting for mom

Pre-implantation Genetic Screening or Diagnosis (PGS or PGD)

Detection of genetic abnormalities prior to implantation.

PGS – checks for number of chromosomes

PGD – checks for specific diseases like cystic fibrosis (can also tell gender)

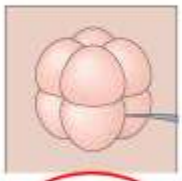
Since June 2008 can screen all 23 chromosomes

- Time consuming so flash freeze embryos
- Gives mom time to recover from egg harvesting.

Cell Removal

What do you think happens to the embryo that has only 7 instead of 8 cells now?

a. It will develop abnormally
b. It will not develop at all
c. It will develop normally
d. ~~They put the~~ 8th cell back after testing.



C The cells are still stem cells so the 7 have all the same information as the 8th that was removed. This means nothing goes wrong without it.

In Vitro Fertilization (IVF)

1. Super-ovulation is induced in mother to be
2. Multiple eggs removed
3. Combined with sperm
4. **Rate** the health of each embryo
5. Flash frozen while testing and waiting for mom
6. Fertilized embryos/blastocysts are implanted in uterus

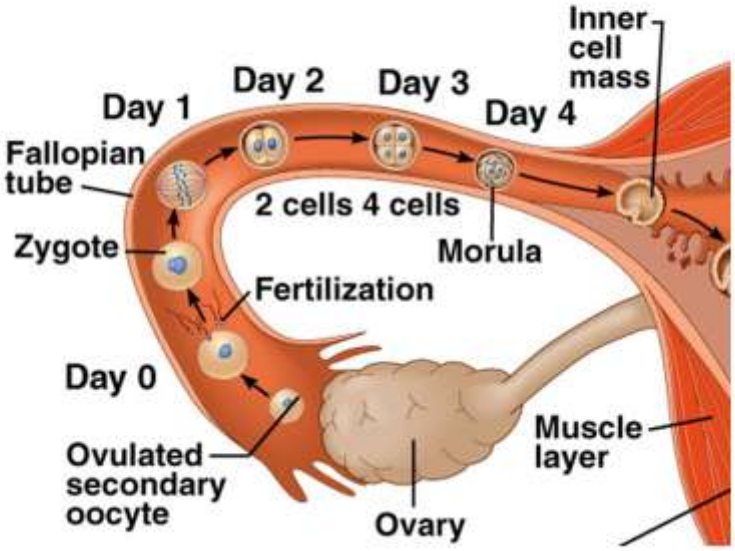
If 2 embryos implanted: have a 50-60% of 1 surviving and 30% that both will survive

7. Extra embryos remain frozen

Brecken and Kaiya
both had 8-1 =**7 cells while embryos**.
Flash frozen and stored for several weeks. *2 others*

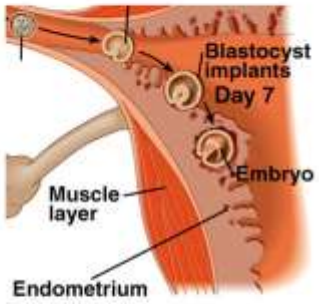
Kaiya and Brecken my IVF neice and nephew

Early development: ovulation to implantation



Blastocyst

The developing embryo becomes a hollow ball of cells and is called a blastocyst.



What was unusual (first of its kind) about the form of PGD (preimplantation genetic diagnosis) that was used with Molly's brother Adam?

A. He was the first embryo where PGD was used to remove unwanted genetic characteristics.
B. He was the first embryo selected in a lab for his immune system so he could help Molly.
C. He was the first embryo where PGD was used to give Adam the specific genes needed to help Molly

Molly Nash, suffering from Fanconia Anemia with brother Adam, whose stem cells saved her life, and Dr. Wagner.

What was unusual (first of its kind) about the form of PGD (preimplantation genetic diagnosis) that was used with Molly's brother Adam?

A. He was the first embryo where PGD was used to *remove* unwanted genetic characteristics.

B. He was the first embryo *selected* in a lab for his immune system so he could help Molly.

C. He was the first embryo where PGD was used to *give* Adam the specific genes needed to help Molly

B. Scientists at this point are not able to remove or give genetic characteristics to embryos of any time. They don't have the technology not to mention the ethical ramifications!!

I was doing some more research on the article about [Molly}]. I didn't know where I heard this before; it sounded so familiar. I looked up the family and it turns out that Adam, the family's son, was my camper at the resident camp I work at in the summer. What a small world. In the picture, he is the child on the far left of me on the log.

How can Molly inherit Fanconi's anemia even though neither of her parents suffer from the disease?

A. She didn't inherit it, it was a random mutation that caused her to get it.
B. It must be a dominant trait and each of her parents were a carrier.
C. It must be a recessive trait and each of her parents were a carrier.
D. It must be a recessive trait and only one of her parents was a carrier.
E. It must be a dominant trait and only one of her parents was a carrier.

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What are the odds that the Nash's next child would have the disease? Assuming a natural pregnancy – not IVF?

A. 100
B. 75
C. 50
D. 25
E. less than 1

1 in 4 or 25%

How much pain and suffering was involved for Adam when his cells were donated to Molly?

A. A substantial amount - bone marrow removal is very painful
B. Adam was only a baby so he was too young to suffer from the pain
C. A new technique was used that caused very little pain and suffering
D. None – his marrow was not used.

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Cells from Adam's umbilical-cord blood where used to seed Molly's bone marrow.

"Spare" Embryos: ethical concerns

Fertilized embryos that are not implanted can be donated for research purposes

Stem cell "lines" can be maintained to help cure all sorts of diseases and ailments.

Using IVF and PGS or PGD, a prospective child can be "screened" to see if they are healthy, or even if they are a match for donating stem cells to a sibling.