
Cell Division

The Cell Cycle

Cloning

Cell Division

The Cell Cycle

Cloning 411

- cellular differentiation
 - is the process by which a less specialized cell becomes a more specialized cell type.
 - occurs numerous times as the organism changes from a single zygote to a complex system of tissues and cell types.
 - a common process in adults as well: adult stem cells divide and create fully-differentiated daughter cells during tissue repair and during normal cell turnover.
-

Cell Division

The Cell Cycle

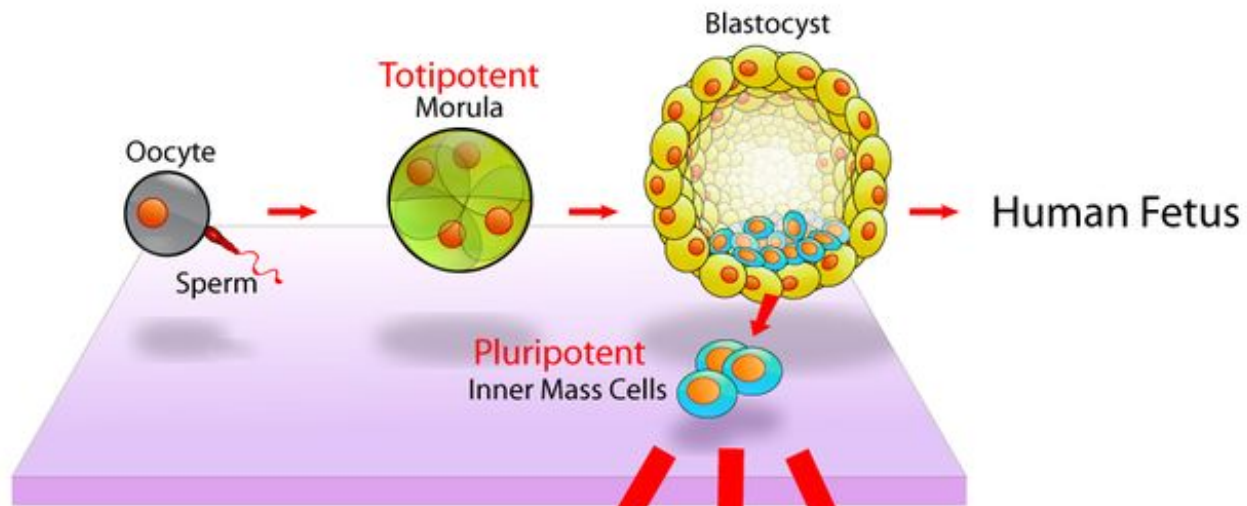
- causes a cell's size, shape, polarity, metabolic activity, and responsiveness to signals to change dramatically.
 - these changes are largely due to highly-controlled modifications in gene expression.
 - different cells can have very different physical characteristics despite having the same genome.
 - a cell that is able to differentiate into many cell types is known as pluripotent.
 - called stem cells in animals
 - called meristematic cells in higher plants
-

Cell Division

The Cell Cycle

- a cell that is able to differentiate into all cell types is known as totipotent.
 - in mammals, only the zygote and early embryonic cells are totipotent, while in plants (and in animals), many differentiated cells can become totipotent with simple laboratory techniques.





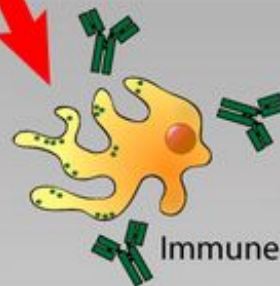
Examples:



Circulatory System



Nervous System



Immune System

Unipotent

Cell Division

The Cell Cycle

What is Cloning?

- ❑ cloning is the process of forming identical offspring from a single cell or tissue of a parent organism.
 - both the clone and the parent have identical or near identical DNA (random mutations occur)
 - does not result in variation of traits
 - ❑ considered a form of asexual reproduction
 - clones occur naturally
example)
 - ❑ Hydra undergoing mitosis during the process of budding
-

Cell Division

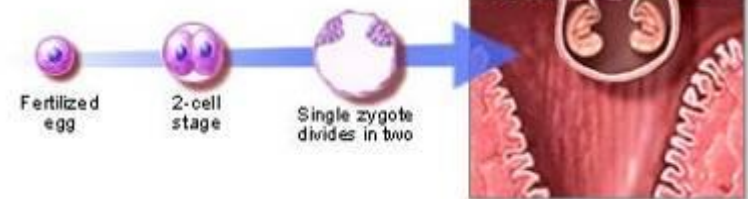
The Cell Cycle

example:

- Hydra undergoing mitosis during the process of budding
- Runner of a strawberry plant
- Monozygotic twins (zygote undergoes mitosis and splits into two)



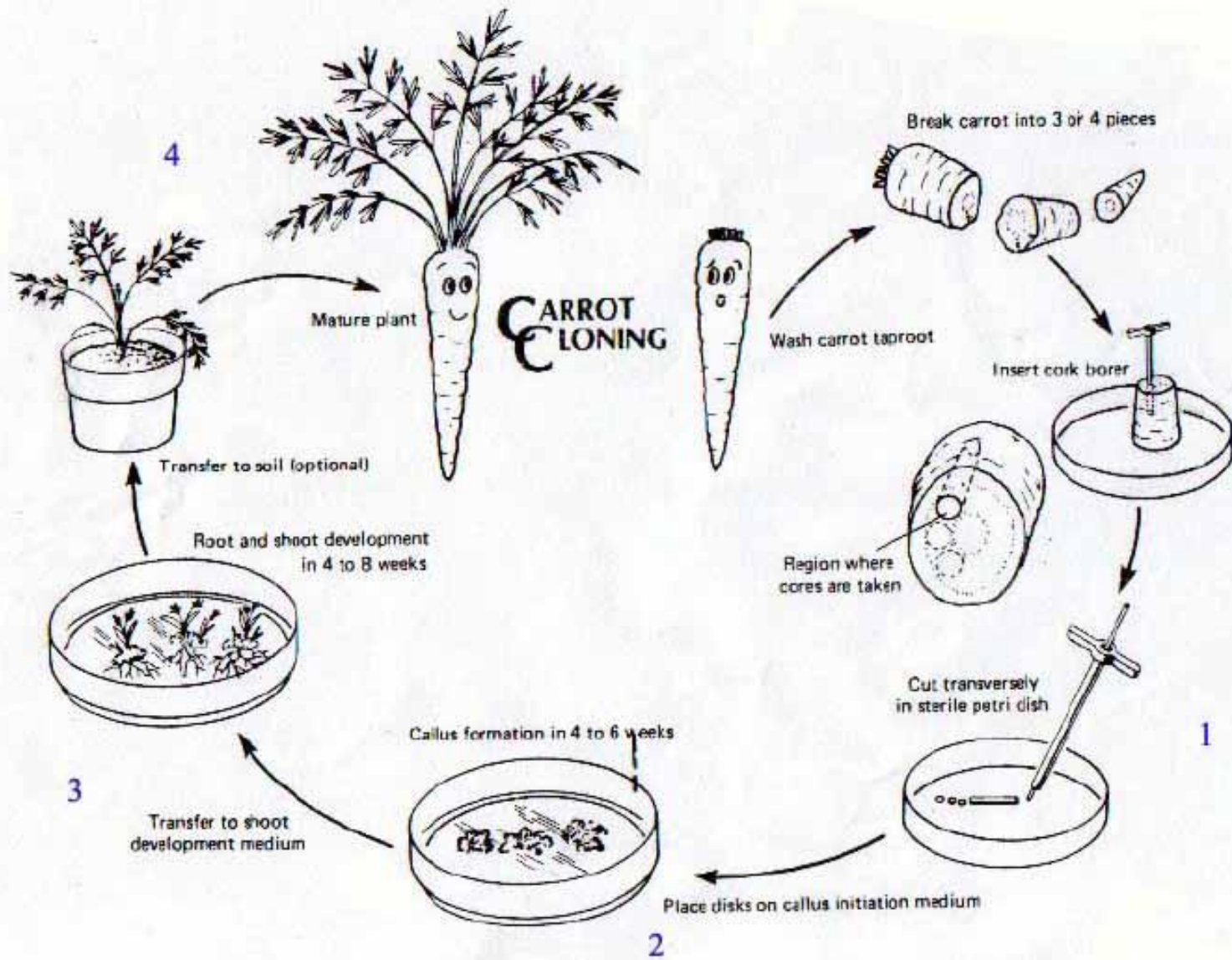
Identical (monozygotic) twins



Cell Division

The Cell Cycle

- Plant Cloning
 - In 1958 Fredrick Stewart produced a carrot plant from a single carrot cell
 - now cloning is widespread in the agriculture/horticulture industries.
 - it is desirable (profitable) to have plants of predictable characteristics
 - Easy to clone plants: carrots, tobacco, lettuce
 - Hard to clone plants: grasses, legumes.
-



source: Carolina Biological

Cell Division

The Cell Cycle

- Animal Cloning
 - Robert Biggs and Thomas King
 - investigated nuclear transplants in frogs.
 - first to clone a frog.



Cell Division

The Cell Cycle

- the cloning of the sheep “Dolly” by Dr. Ian Wilmut’s team was the first to clone an animal using adult cells.
 - the nucleus of an udder cell of an adult sheep was placed in the enucleated egg cell from another sheep.
 - the egg developed in a Petri dish until an early embryo stage.
 - then the egg was placed into the womb of another sheep.



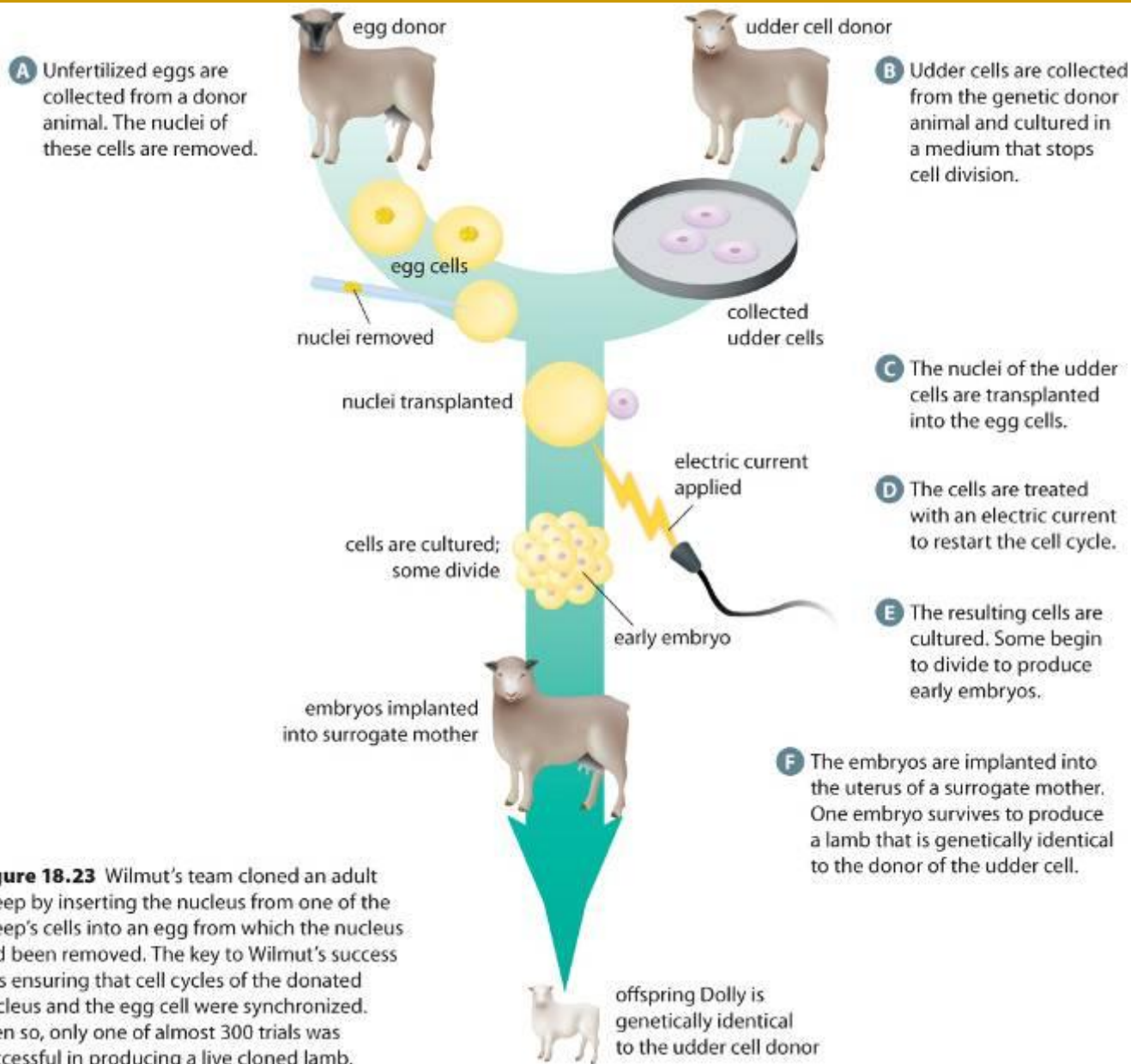


Figure 18.23 Wilmut's team cloned an adult sheep by inserting the nucleus from one of the sheep's cells into an egg from which the nucleus had been removed. The key to Wilmut's success was ensuring that cell cycles of the donated nucleus and the egg cell were synchronized. Even so, only one of almost 300 trials was successful in producing a live cloned lamb.

Cell Division

The Cell Cycle

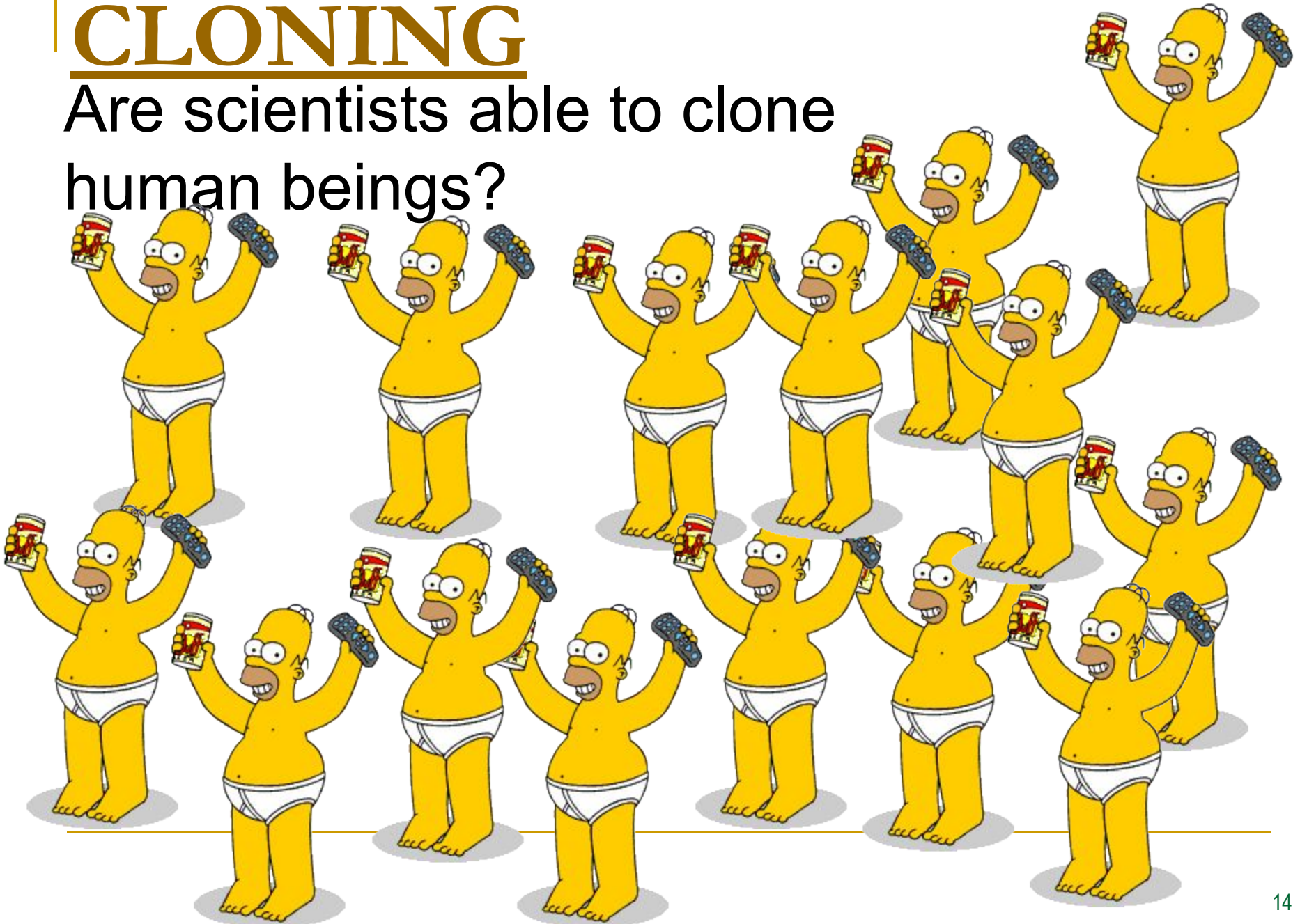
- ❑ DNA donor: adult Finn Dorsett Sheep
- ❑ Egg donor: Poll Dorsett Sheep
- ❑ Womb provider: a third sheep
- ❑ Clone: Dolly was a clone of the adult Finn Dorsett Sheep

[http://en.wikipedia.org/wiki/Dolly_\(sheep\)](http://en.wikipedia.org/wiki/Dolly_(sheep))



CLONING

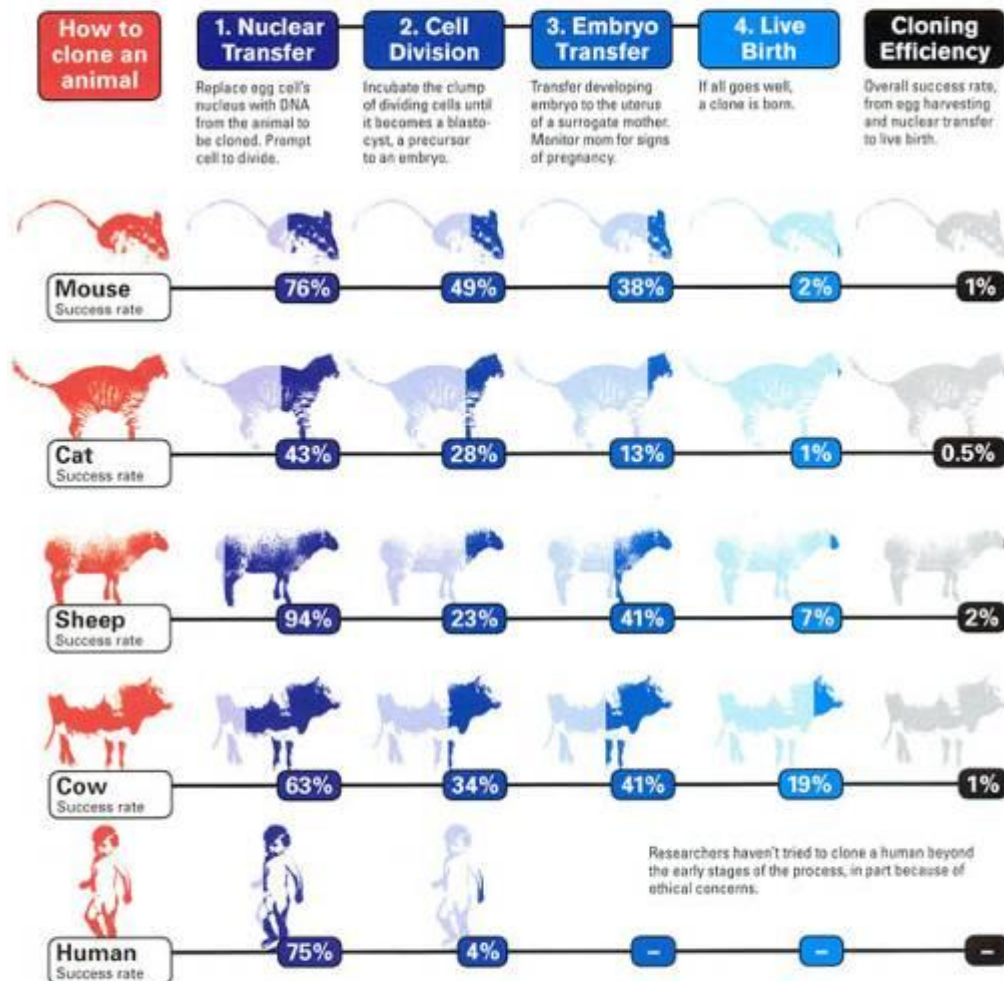
Are scientists able to clone human beings?



The Killer Task of Cloning

Copying mammals fails 98 percent of the time.

Fears surrounding cloning are based more in hysteria than in science. After all, producing a genetic duplicate isn't exactly a trip to the Xerox machine; cloning is really hard. Researchers face significant drop-offs in success rates at each step of the process, and less than 2 percent of their efforts produce a live animal. Dolly the sheep arrived after some 250 attempts, and she lived only half as long as the average ewe. Until the science improves, there's not much to be afraid of. — **Greta Lorge**



Sources: *Biology of Reproduction; Cloning and Stem Cells; Genetics and Molecular Research; Journal of Reproduction and Development; Journal of Reproduction and Fertility; Lancet; Molecular Reproduction and Development; Nature; Nature Biotechnology; Nature Genetics; Proceedings of the National Academy of Sciences; Reproduction; Reproduction, Fertility and Development; Reproductive Biomedicine; Science; Theriogenology*

MOUSE: C. SURVIVAL; SHEEP: STEELMAN/ANIMALS; ANIMALS: CAT: RENEZ; SHEEP: STODOL/ANIMALS; ANIMALS: CAT: RENEZ; SHEEP: STODOL/ANIMALS; ANIMALS: SHEEP: MARIAM SILVERSTEIN/ANIMALS; ANIMALS: COW: PETER WYMAN/ANIMALS; ANIMALS: HUMAN: ROBERT DODDNEY

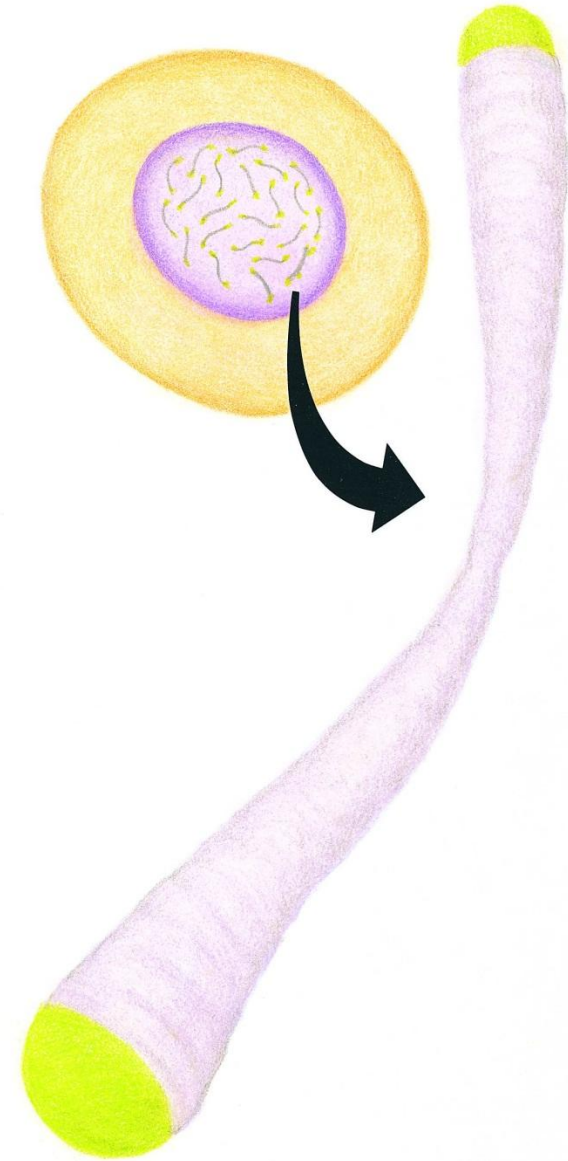
Cell Division
The Cell Cycle
Cell Aging

Cell Division

The Cell Cycle

Cell Aging

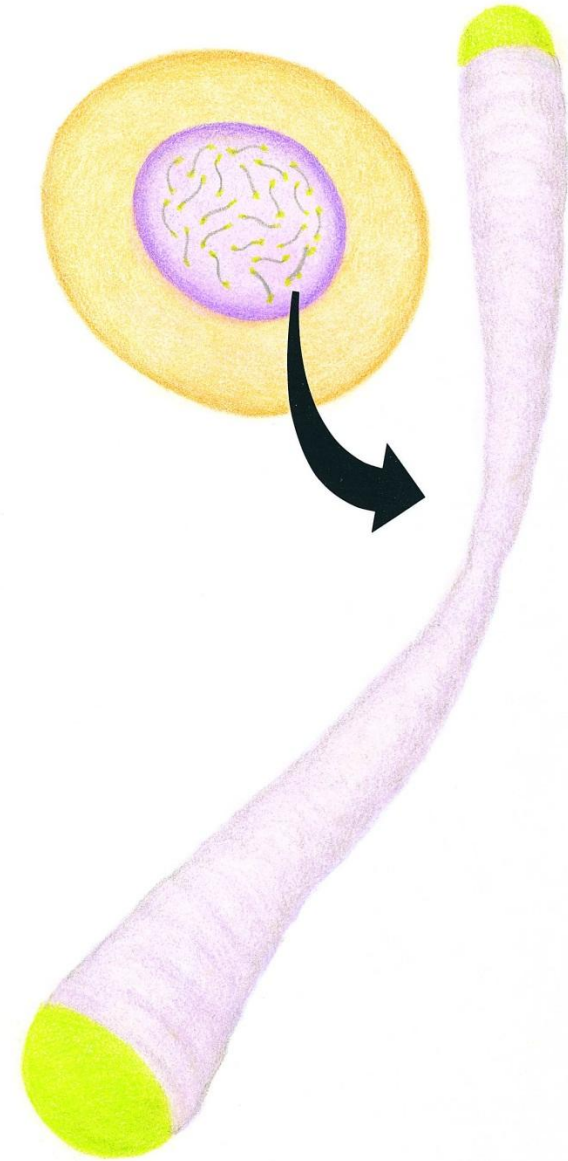
- Telomeres
 - are caps at the ends of chromosomes.
 - they reduce in length each time a cell undergoes the cell cycle
 - have a role in cell aging and cancer cells.
 - the length of telomeres is affected by the enzyme telomerase.



Cell Division

The Cell Cycle

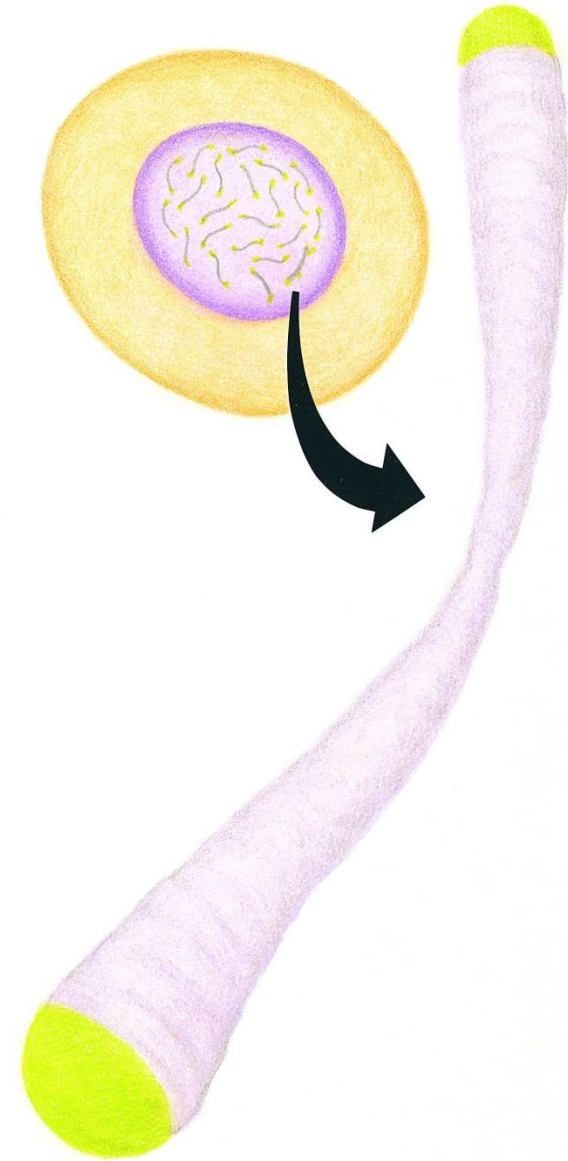
- as cells go through the cell cycle their telomeres become shorter.
 - eventually the telomeres become very short and the cell stops going through the cell cycle and dies.
- telomerase is an enzyme that keeps the telomeres long but is only found at limited levels in somatic cells.
 - embryonic stem cells have a high level of telomerase.
- telomere length acts as a biological clock.



Cell Division

The Cell Cycle

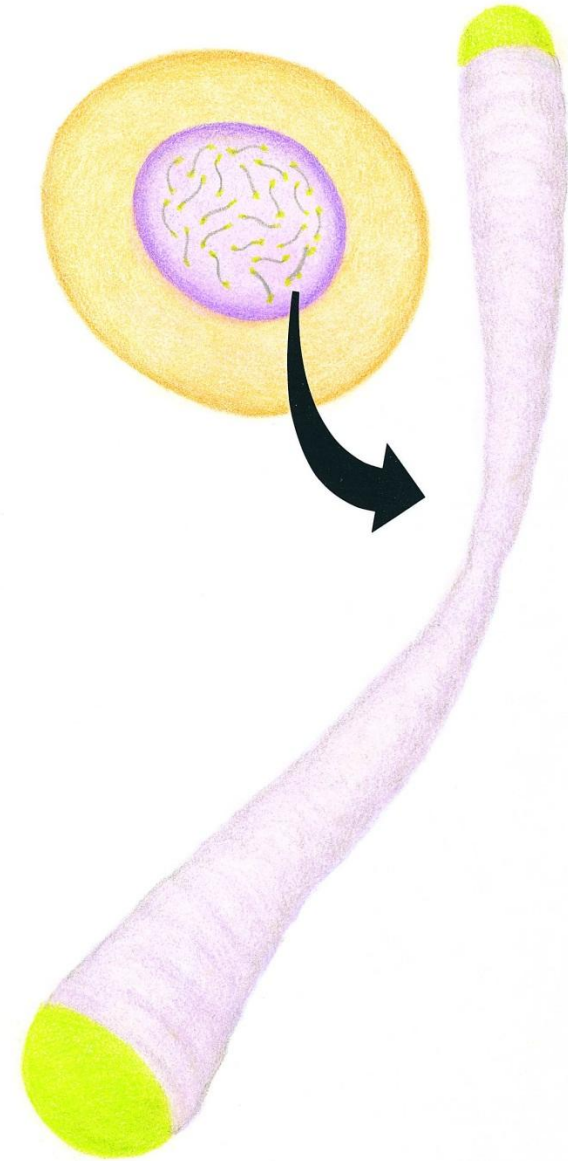
- the case of “Dolly” the prematurely aging sheep.
 - Dolly was cloned using an adult nucleus with telomeres that had already begun to shorten.
 - Dolly developed arthritis and died of a lung disease at only half her life expectancy. (controversy)



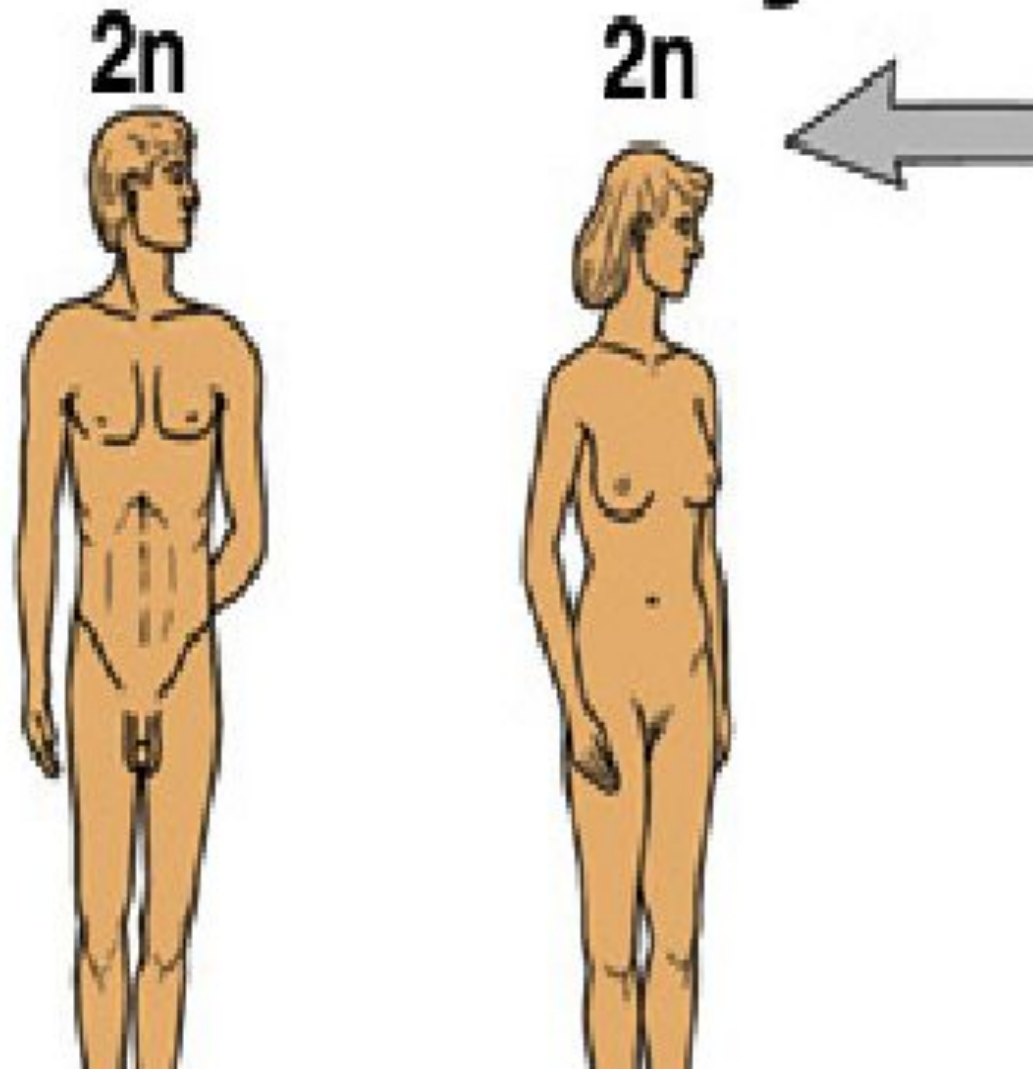
Cell Division

The Cell Cycle

- ❑ the case of Cancer
 - cancer cells never seem to lose their ability to divide.
 - ❑ the telomeres of cancer cells do not shorten.
 - ❑ telomerase is reactivated in cancer cells allowing the cancer cells to maintain telomere length and keep on dividing.



Life cycle



DEVELOPMENT OF ♂ AND ♀ GAMETES

- Formation of sex cells during meiosis is gametogenesis
- Cytoplasm of female gametes does **not** divide equally after each division- oogenesis.
 - One of daughter cells, **ootid**, receives most of cytoplasm
 - Other cells, **polar bodies**, die, and nutrients are absorbed
 - Only **one egg** cell is produced from meiosis

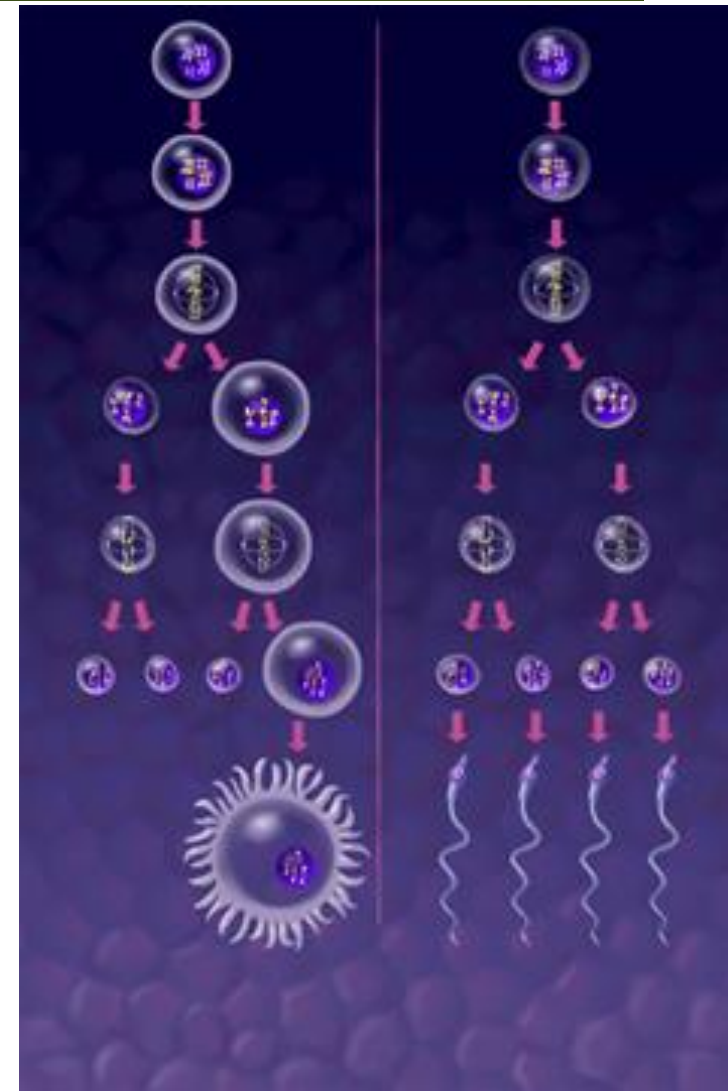
Meiosis II- splits 1st polar body and forms 3rd polar body- all disintegrate.

Sperm fuses with **ovum** (egg cell)

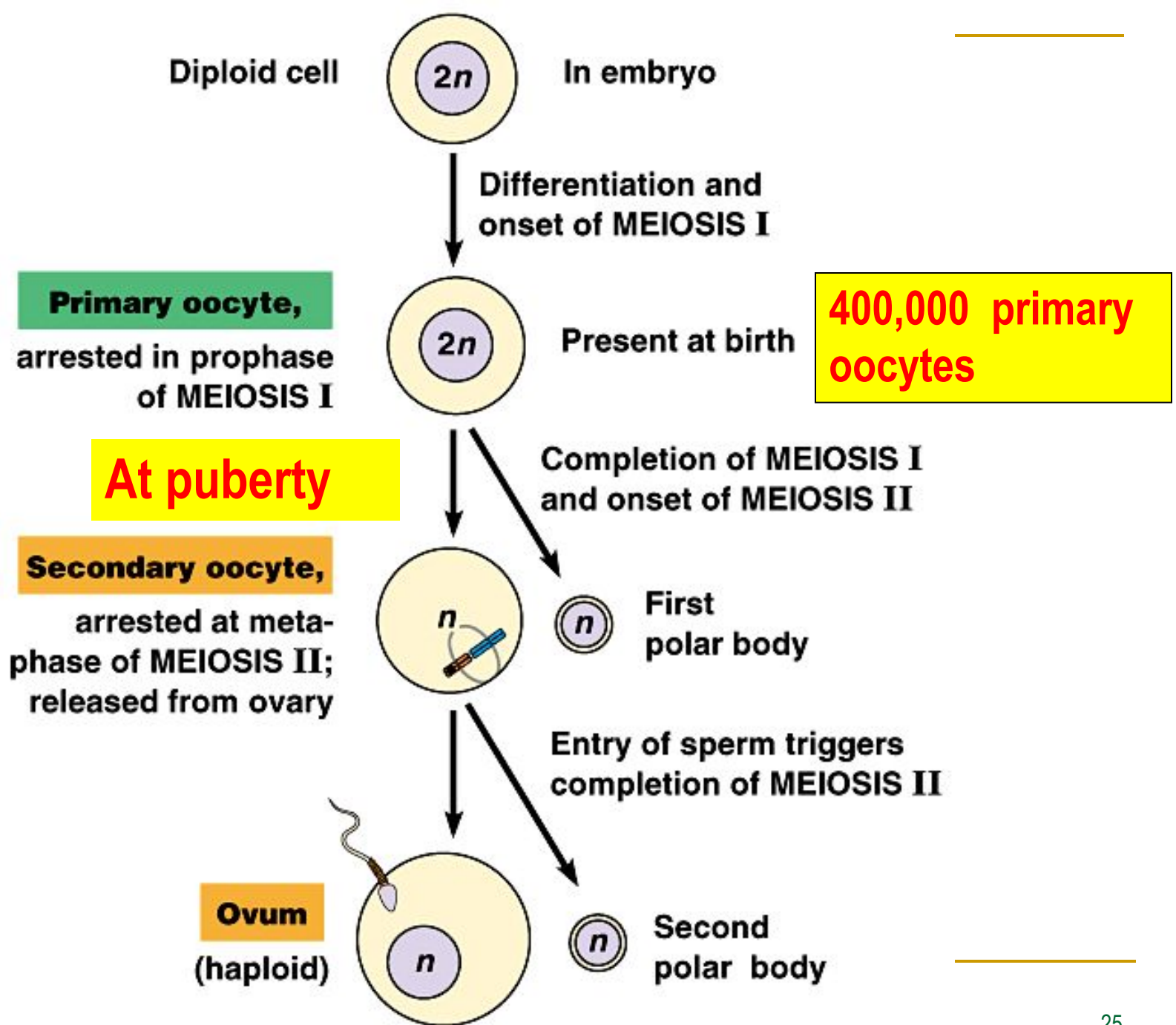
Egg does not move

Egg cells require nutrients

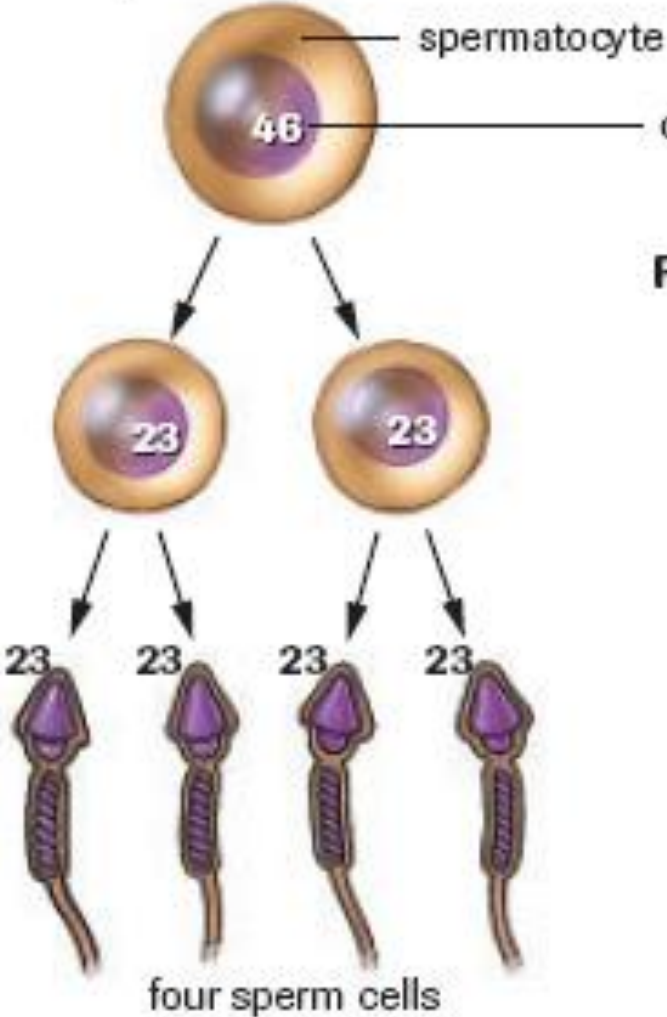
Fuel future cell divisions in event that egg cell becomes **fertilized**



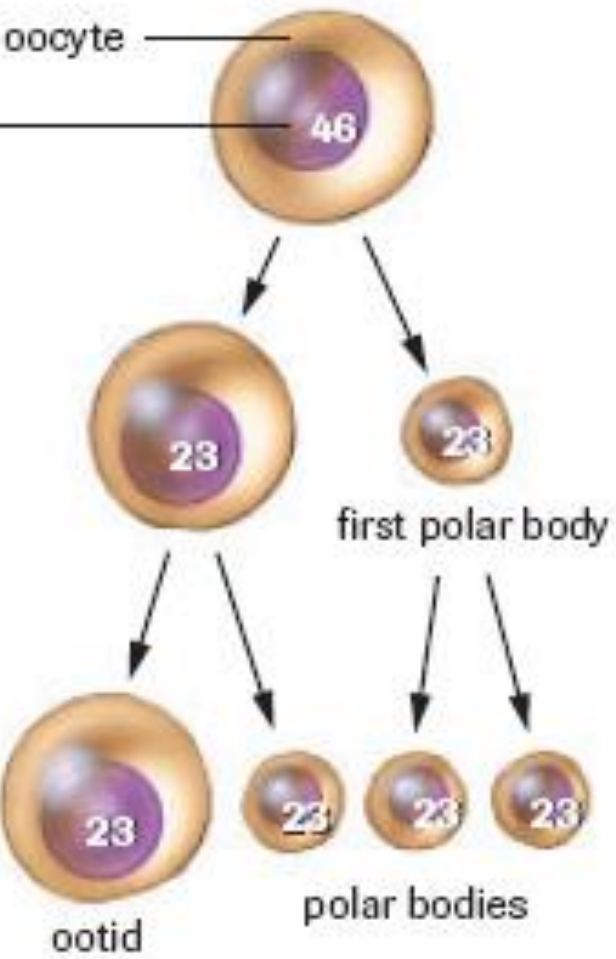
-
- ♀ born with 400 000 egg cells (only 400 mature)
 - 1000 egg cells **mature** within ovary every 28 days
 - Only 1 egg cell leaves ovary, the rest break down and are absorbed by body
 - **Oocyte** - cell that produces egg cells
 - Does not continue to divide after a woman reaches puberty
 - As a ♀ ages:
 - # of egg cells in ovary declines until about age 50 or 60
 - No eggs remain in ovary = **Menopause**
-



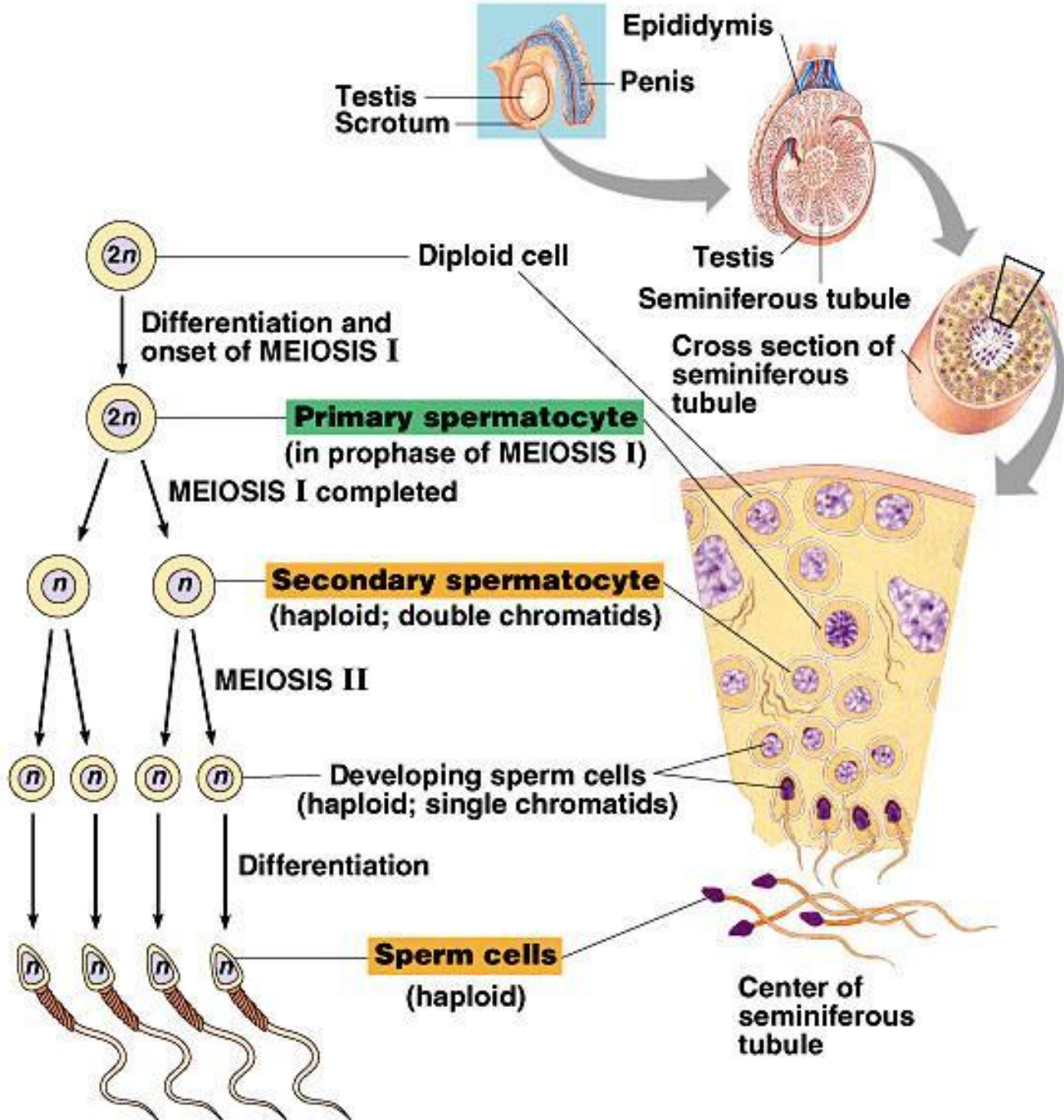
Spermatogenesis



Oogenesis

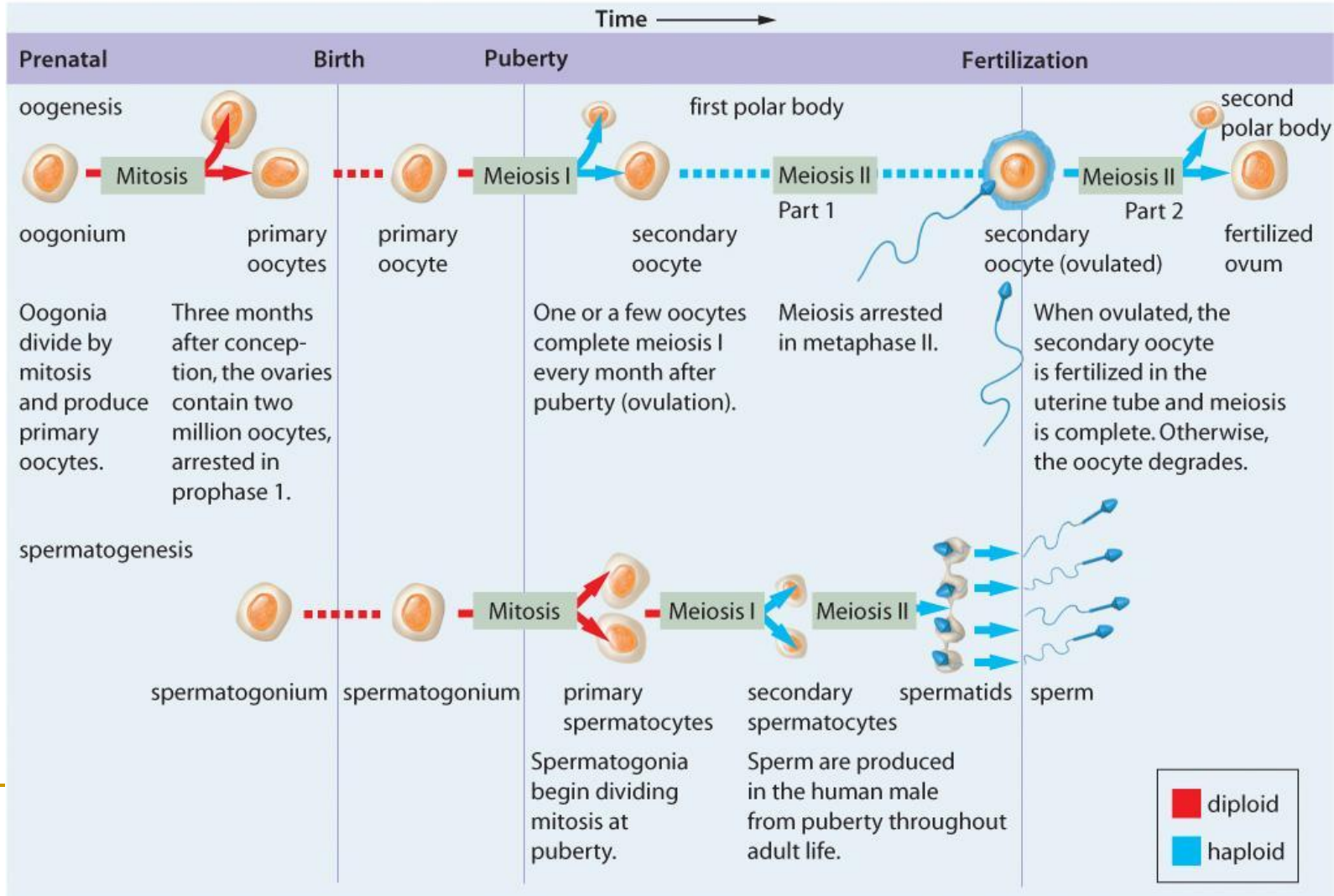


-
- Diploid **spermatocytes**
 - Cells that give rise to **sperm cells**
 - Are capable of many mitotic divisions before meiosis ever begins
 - Males can produce **1 billion** sperm cells every day
 - **Spermatogenesis**
 - Sperm cells show equal division of cytoplasm
 - Because of their function, sperm cells have much **less** cytoplasm than egg cells



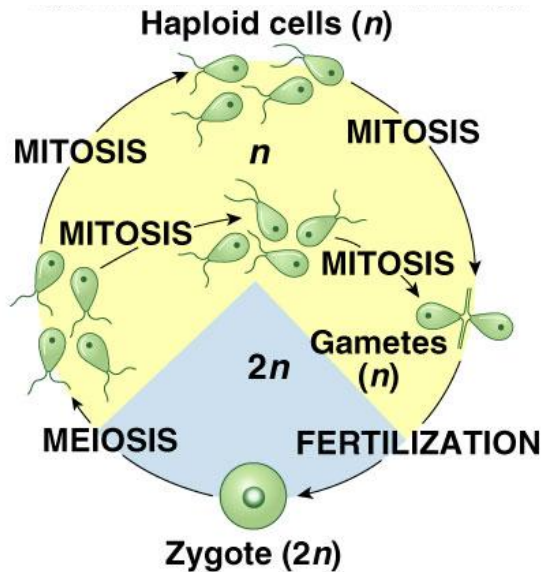
SUMMARY OF GAMETOGENESIS

Figure 16.16 The processes of spermatogenesis and oogenesis in mammals. This illustration is not drawn to scale. In reality, the diameter of the egg is about 20 times greater than the length of the sperm head.

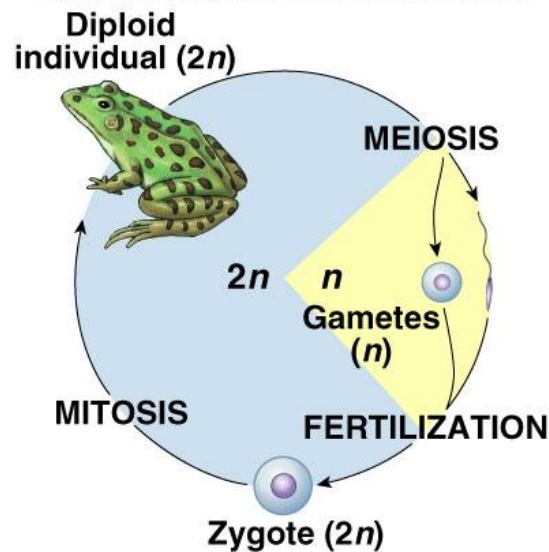


Differences across kingdoms

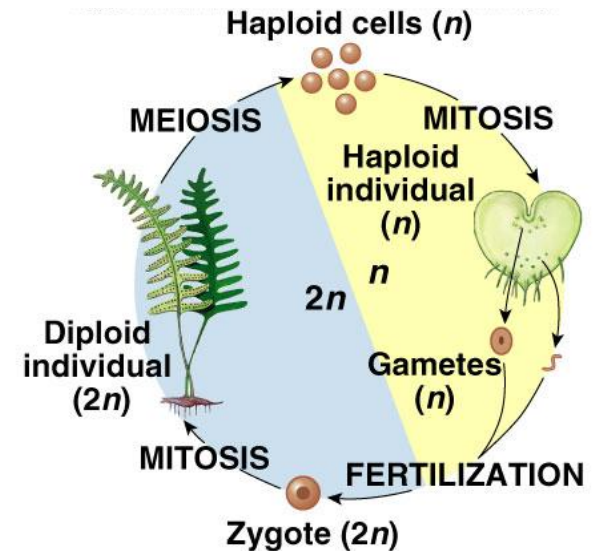
- **Not** all organisms use haploid & diploid stages in same way
 - which one is dominant ($2n$ or n) differs
 - but still **alternate** between haploid & diploid
 - have to for sexual reproduction



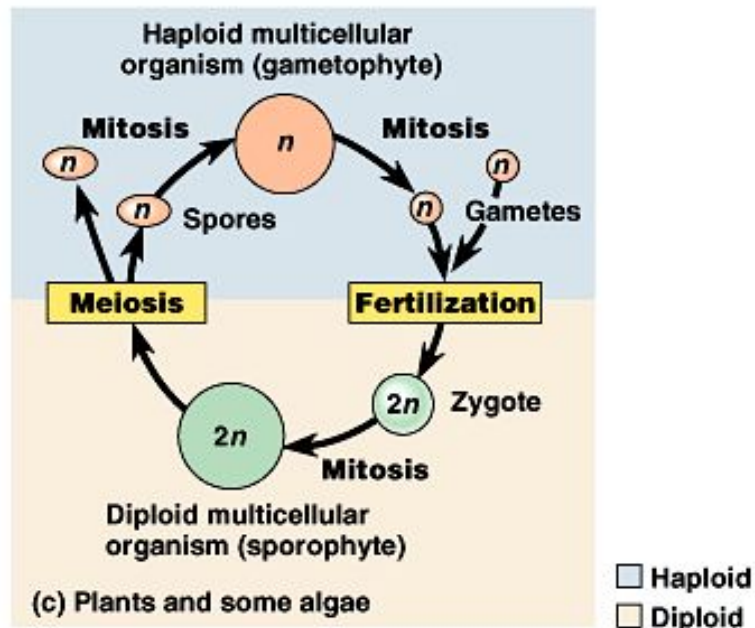
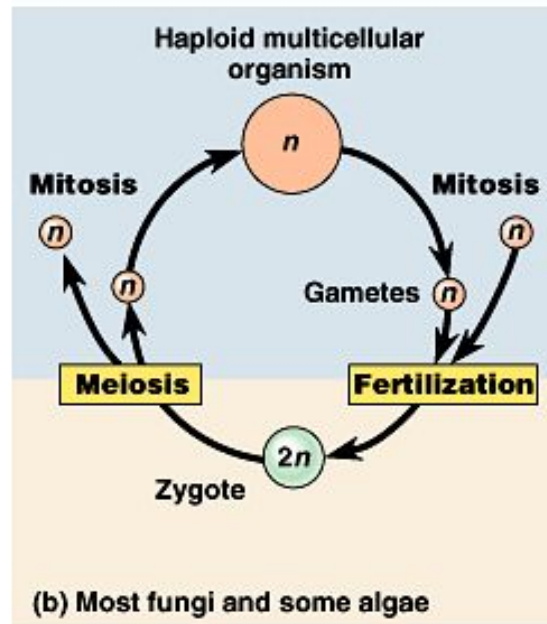
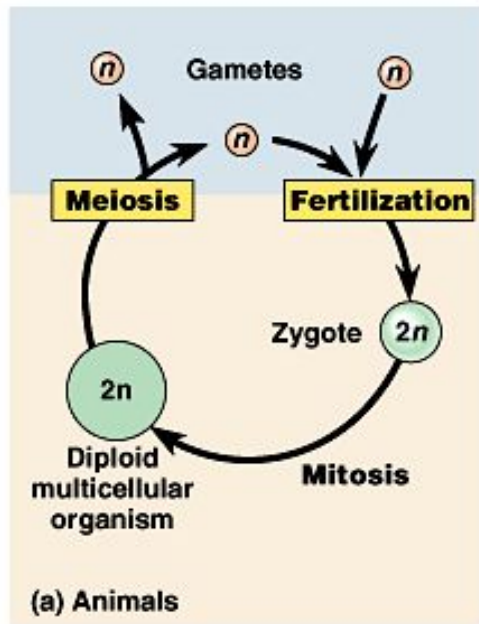
(a) Some types of algae



(b) Most animals



(c) Some plants and some algae

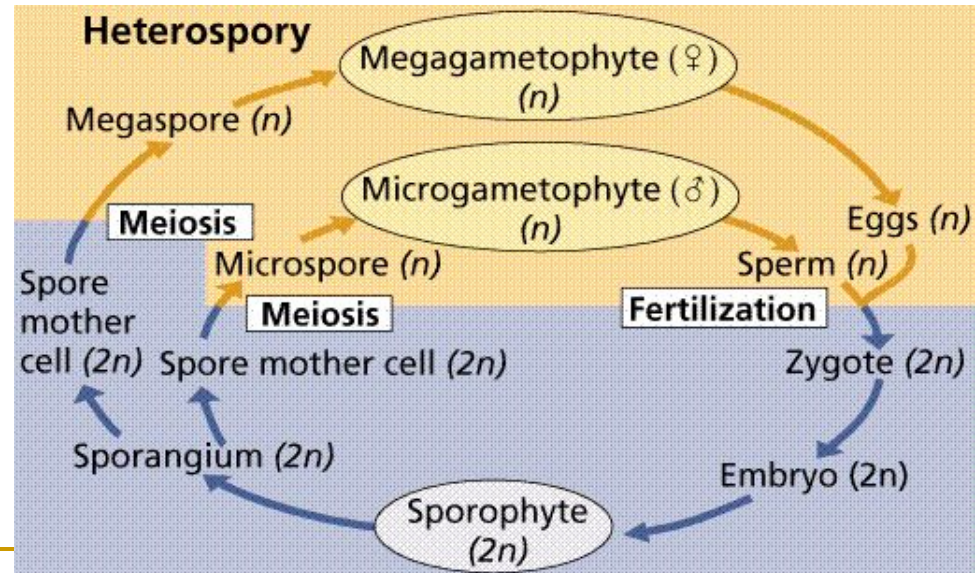
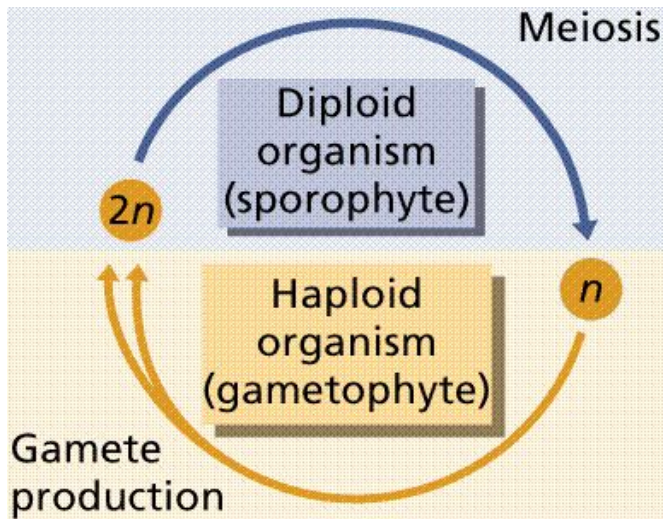


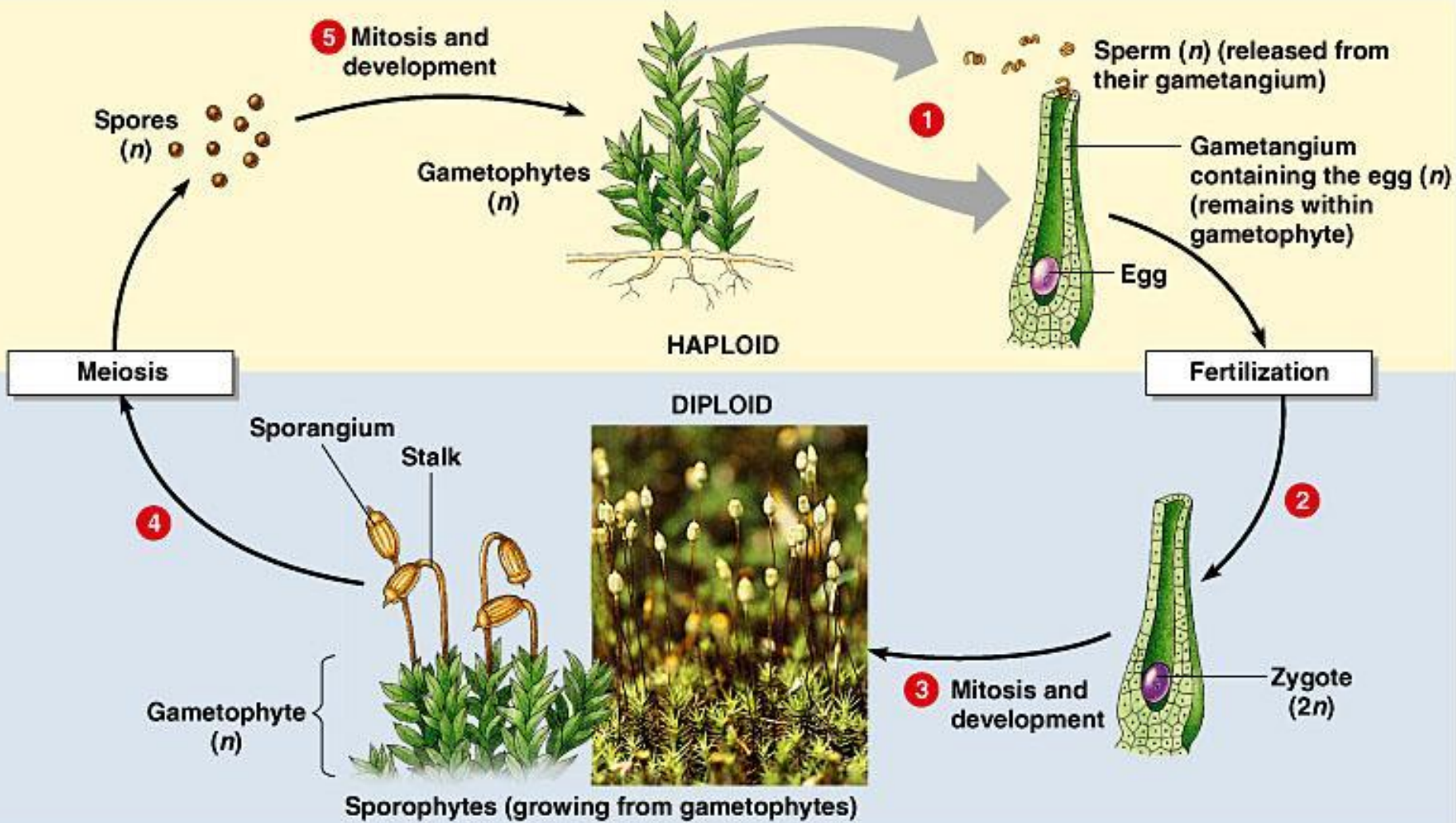
How About Plants?

- Plants also form gametes, by meiosis
 - Pollen cells are ♂ sex cells
 - Egg cells are stored in a variety of structures
 - Contain a **haploid** chromosome number
 - Fusion of ♂ and ♀ gametes restores **diploid** chromosome number

Plants vs. Fungi Reproduction

- Generalized Plant Life Cycle
- **Alternation of Generations**
- **Sporophyte** and **gametophyte** take turns reproducing each other





Copyright © 2003 Pearson Education, Inc., publishing as Benjamin Cummings.

