Cell Division The Cell Cycle Cloning

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.

- causes a cells 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

- 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.



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

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



- 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.



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



- 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.



- 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/w iki/Dolly_(sheep)

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 mechine; 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 Femility; 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; Theriopenology

Cell Division The Cell Cycle CellAging

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.
 - embyronic stem cells have a high level of telomerase.
 - □ telomere length acts as a biological clock.

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

- □ 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.

DEVELOPMENT OF S AND S GAMETES

- Formation of sex cells during meiosis is gametogenesis
- Cytoplasm of female gametes does not divide equally after each division- <u>oogenesis</u>.
 - 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

- 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

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

- 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.

29

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

Copyright @ Pearson Education, Inc., publishing as Benjamin Cummings.

How About Plants?

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

Plants vs. Fungi Reproduction

- Generalized Plant Life
 Cycle
- Alternation of Generations

