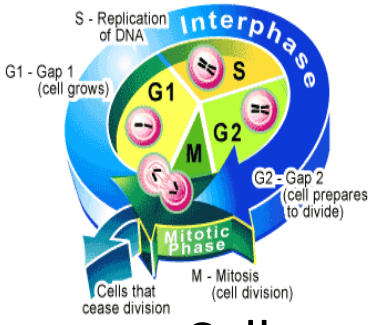
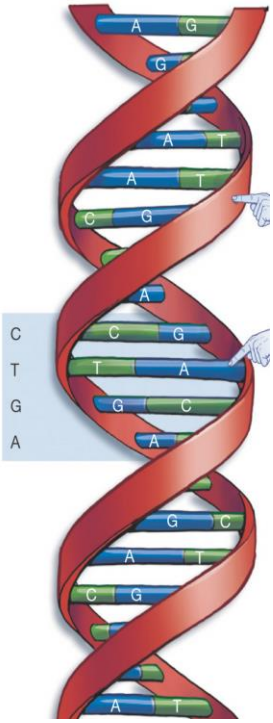


Cell reproduction and cycle

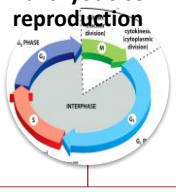


- How cells replace or "clone" themse

Because DNA stores genetic information and is faithfully replicated, information is passed largely unaltered from cell-to-cell, generation-to- generation.

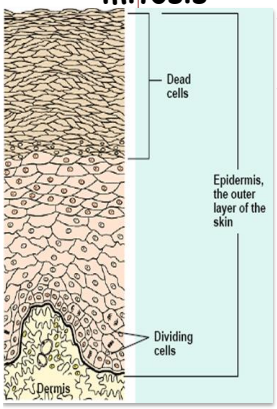
Eukaryotic cells divide in one of two ways

Eukaryotic cell reproduction



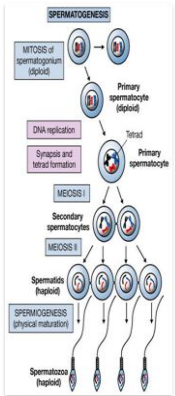
In eukaryotes, nuclei divide by either: mitosis or meiosis.

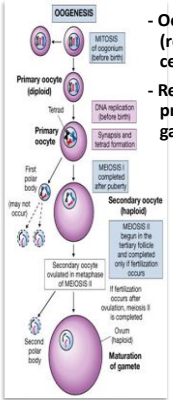
mitosis



- Occurs in somatic (nonreproductive) cells
- Asexual reproduction, development, growth and cell replacement are mitotic divisions

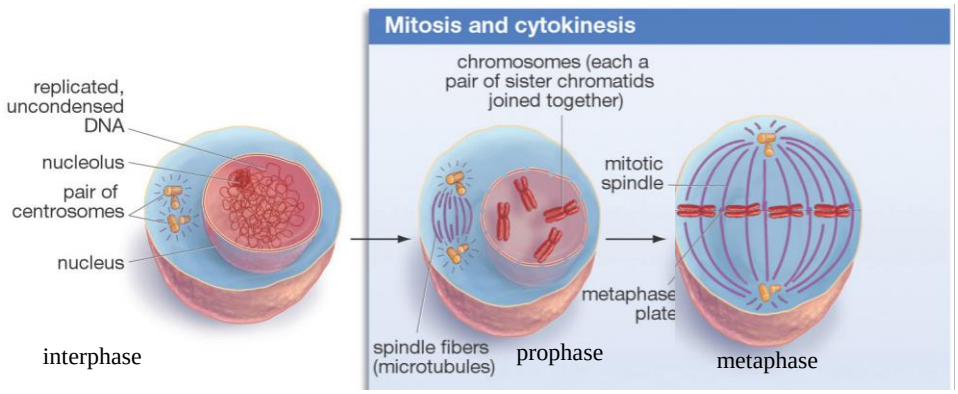
meiosis





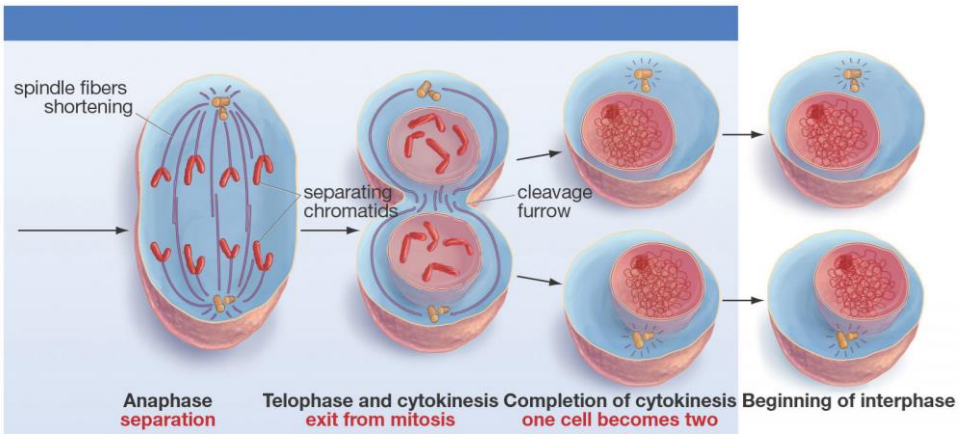
- Occurs in germ (reproductive) cells
- Results in the production of gametes

The Knit of Identity - Mitosis Precisely and Evenly Divides Duplicated Chromosomes

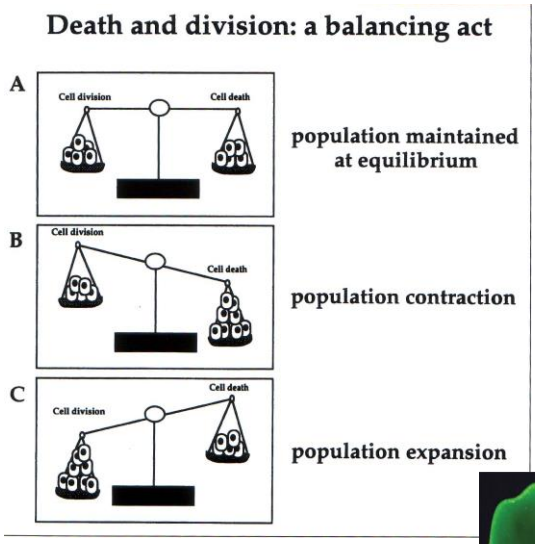


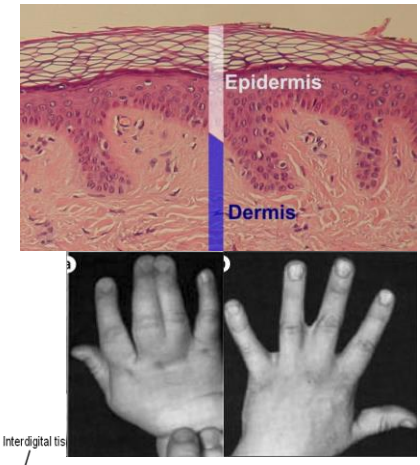
Precisely dividing the duplicated chromosomes has the consequence of providing each new cell with an identical and complete set of genetic instructions.

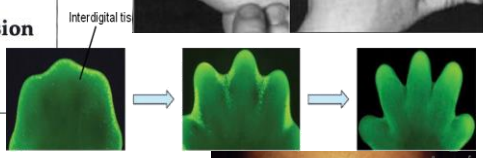
Mitosis Precisely and Evenly Divides Duplicated Chromosomes

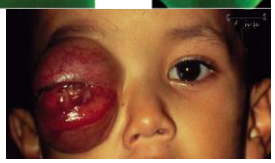


Cytokinesis is the process of cell division and it is distinct and separable from mitosis. Cell division is necessary for reproduction, growth, and repair of an organism.





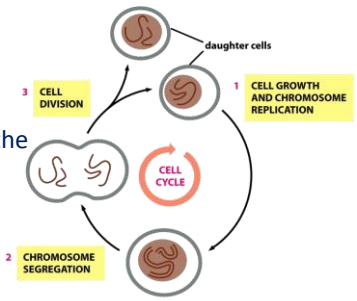


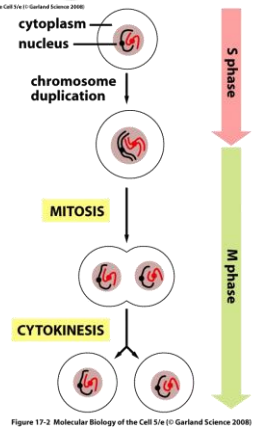


Programmed Cell death – apoptosis

Cell cycle

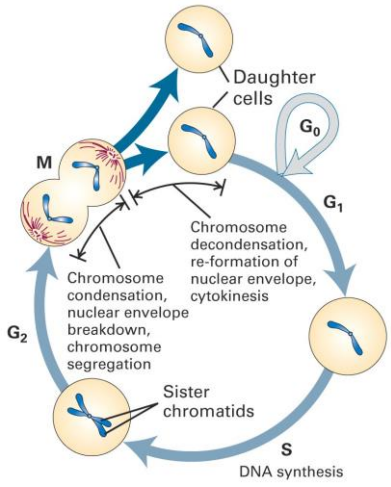
- The most basic function of the cell cycle is to **duplicate** accurately the vast amount of DNA in the chromosomes and then **segregate** the copies precisely into two genetically identical daughter cells.
- The eucaryotic cell cycle is divided into four sequential phases: G_1, **S**, G_2, and **M**.
- During most of the cell cycle, the cell is in interphase, which is divided into three subphases : S, G1, and G2.
- **two major** *phases* of the cell cycle: S and M
  1) **DNA duplication occurs during *S phase*** (S for synthesis)→ 10–12 hours (about half of the cell-cycle time in a typical mammalian cell).
  2) After S phase, **chromosome segregation and cell division occur in *M phase*** (M for *m*itosis)→less time (less than an hour in a mammalian cell). M phase involves a series of dramatic events that begin with nuclear division, or mitosis.

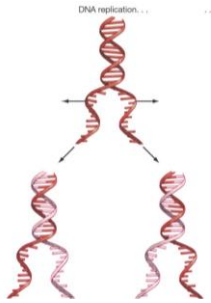




Chromosome during cell cycle

Mitosis → every cell : 2C
Synthesis→ DNA replication → 4C





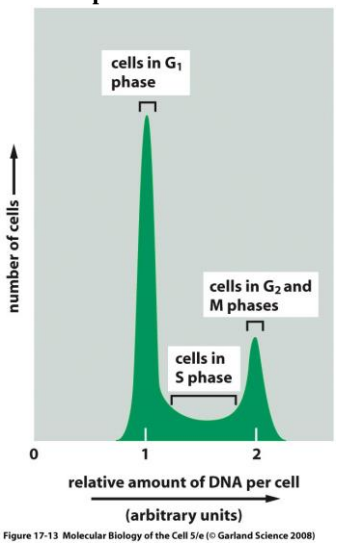


Figure 17-13 Molecular Biology of the Cell 5/e (© Garland Science 2008)

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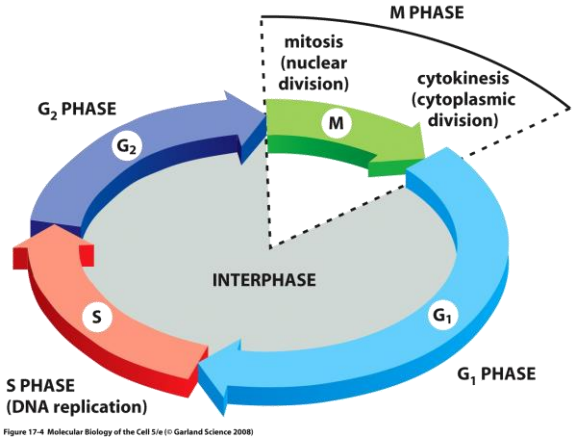

Figure 17-4 Molecular Biology of the Cell 5/e (© Garland Science 2008)

- Most cells require much more time to grow and double their mass of proteins and organelles than they require to replicate their DNA and divide.
- More time for growth → extra *gap phases* are inserted in cell cycles →a **G_1 phase** between M phase and S phase →a **G_2 phase** between S phase and mitosis.

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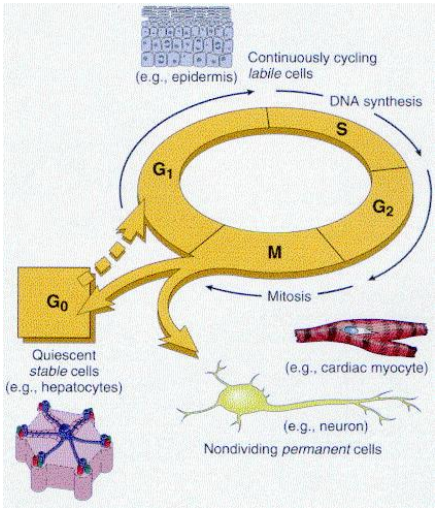
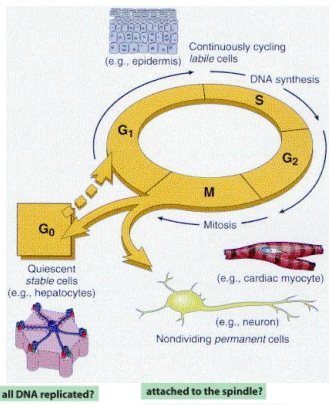
The factors that promote organ or organism growth can be operationally divided into three major classes:

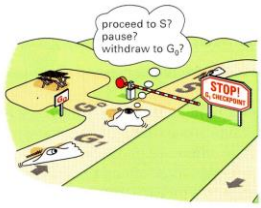
1. *Mitogens*
   stimulate cell division, primarily by relieving intracellular negative controls that otherwise block progress through the cell cycle.
2. *Growth factors*
   stimulate cell growth (an increase in cell mass) by promoting the synthesis of proteins and other macromolecules and by inhibiting their degradation.
3. *Survival factors,*
   promote cell survival by suppressing apoptosis.



Regulation of Cell Cycle

- Check points or switches control the rate of the cell cycle
- Intracellular and extracellular control
- G0 state is the resting state
- G1 checkpoint or the start checkpoint is said to be the beginning of the cell cycle.





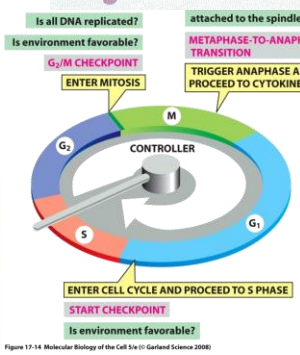
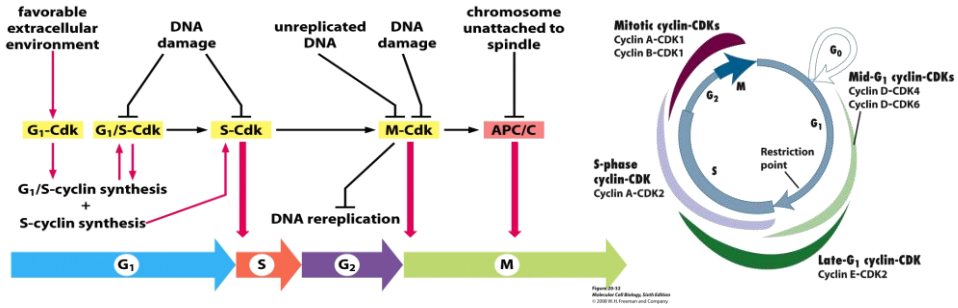


Figure 17-14 Molecular Biology of the Cell 5/e (© Garland Science 2008)



An overview of the cell-cycle control system. The core of the cell-cycle control system consists of a series of cyclin-Cdk complexes *(yellow).* The activity of each complex is also influenced by various inhibitory checkpoint mechanisms, which provide information about the extracellular environment, cell damage, and incomplete cell-cycle events *(top).* These mechanisms are not present in all cell types; many are missing in early embryonic cell cycles.

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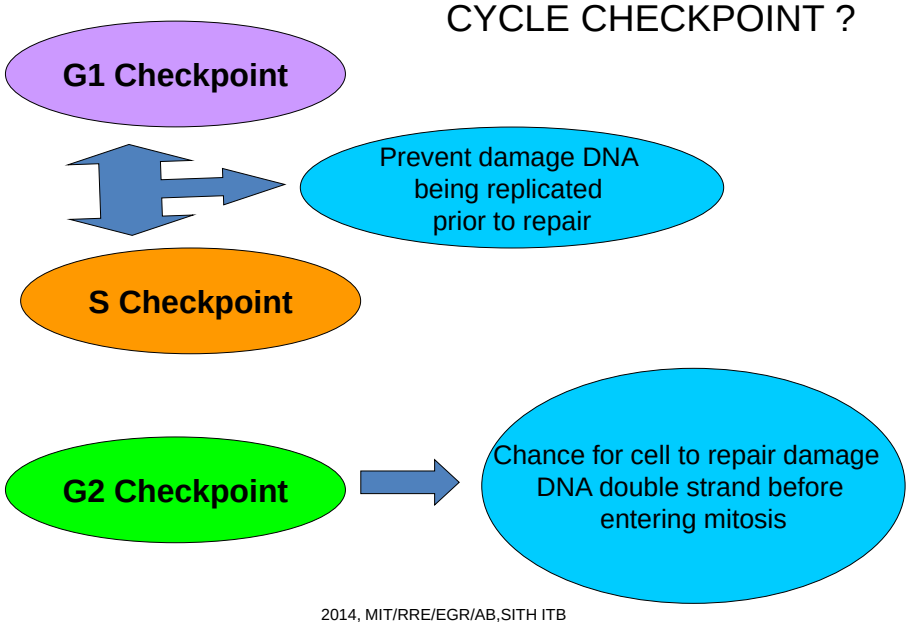
ACTIVATION OF CELL CYCLE CHECKPOINT ?



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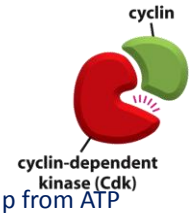
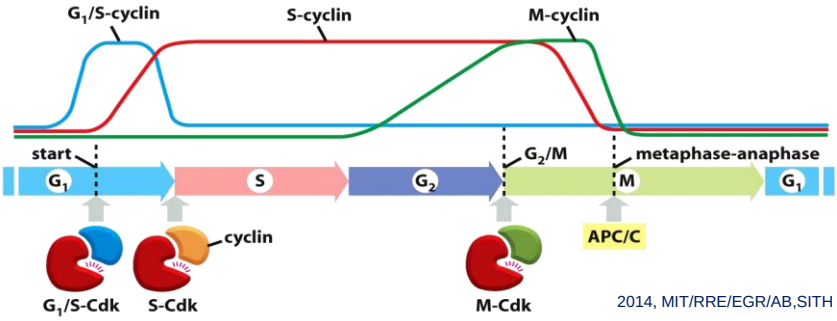
Cyclin and CDK



- Cyclin binds to CdK
- CDK (cyclin dependent kinases)
  - Protein Kinases → enzymes that transfer a phosphate group from ATP to a target protein
  - These Kinases are regulated by cyclins
- Cyclin Cdk complexes regulate the passage of cells from G1 into S phase and from G2 into M phase.



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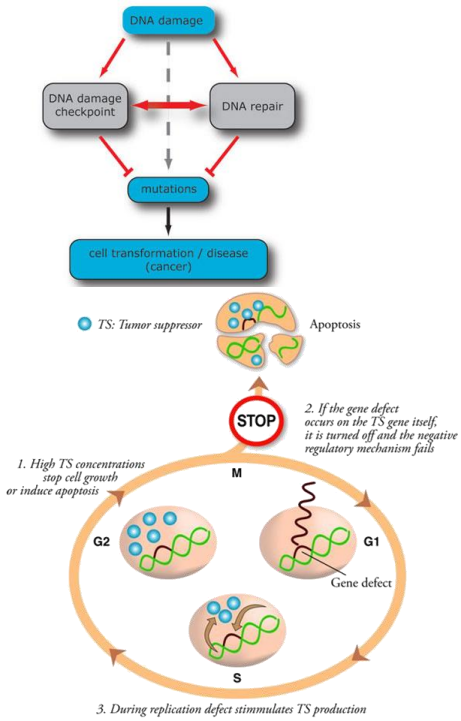

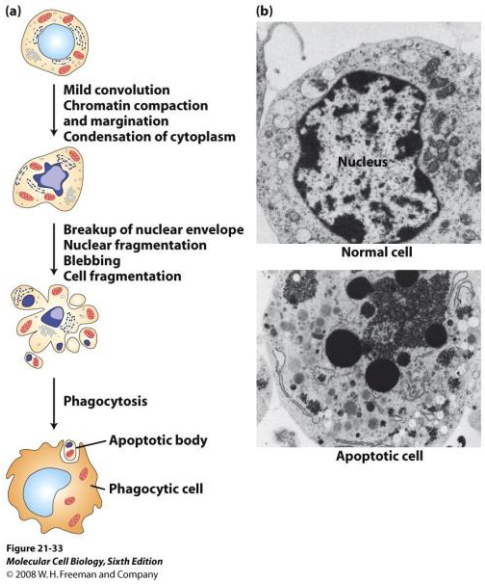

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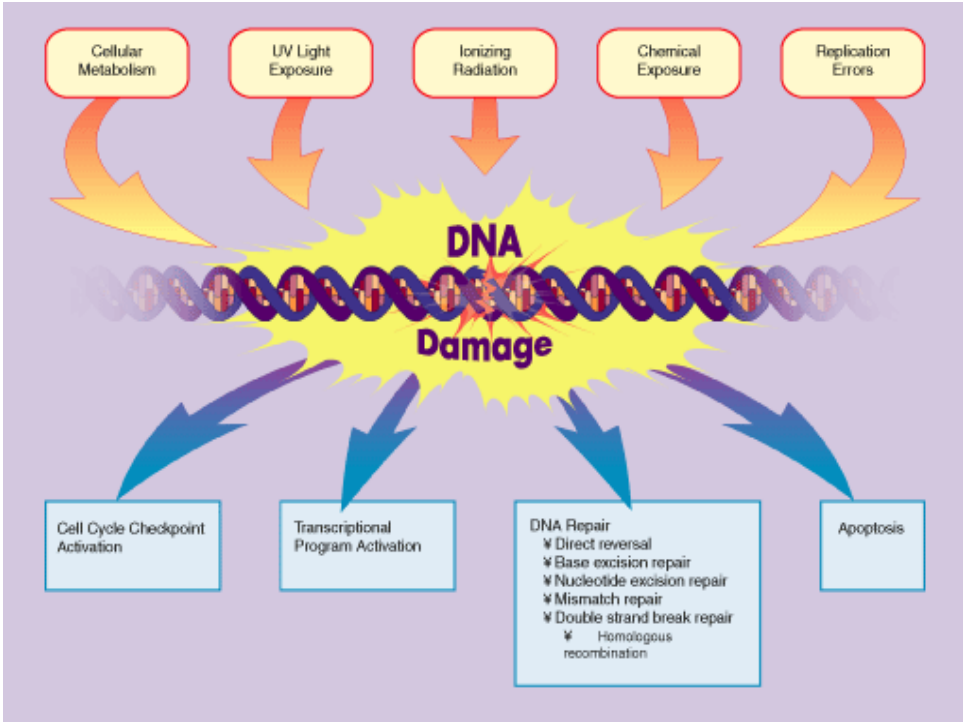
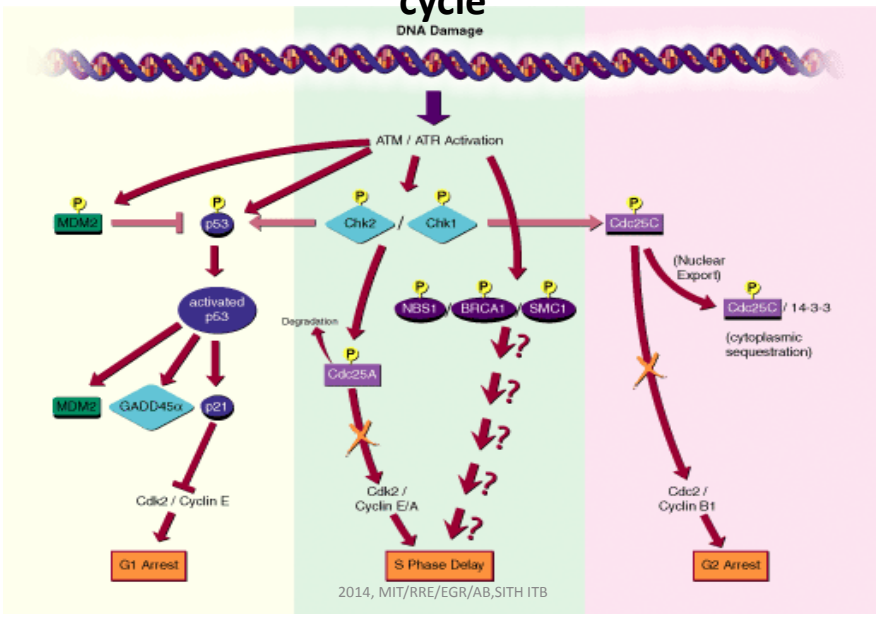
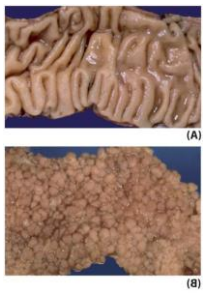
EXAMPLES OF DISEASES/ CONDITION CORRELATED WITH CELL CYCLE



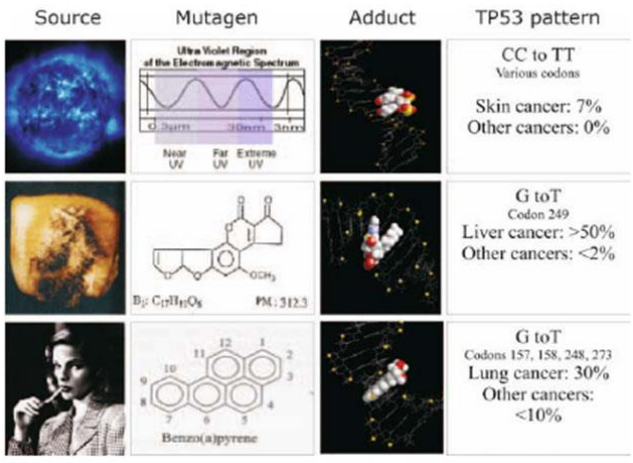
DNA damage, tumor supressor gene and cell cycle



Tumor suppressor mutation and cancer

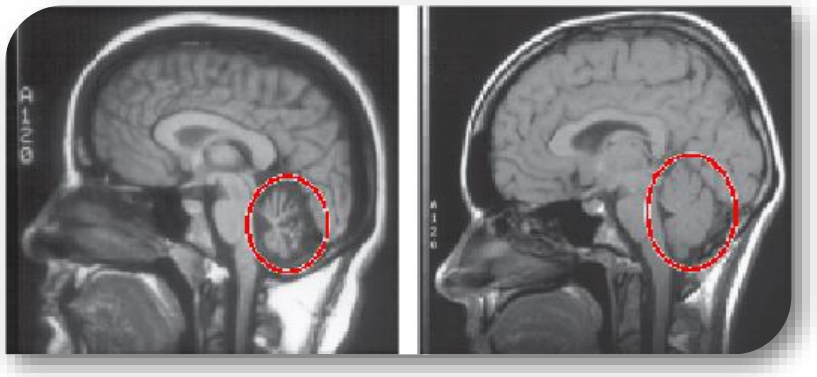


- ATM/ATR (Ataxia telangiectasia)
- P53 (tumor suppressor gene) regulate cell cycle

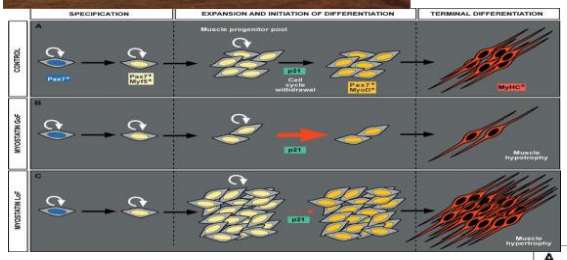


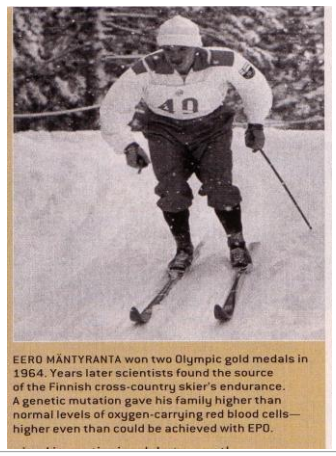
Ataxia: disease → progressive damage in nervous system, Fe toxicity, free radical

Diagram scanning results from Ataxia brain and normal brain
FXN mutation: frataxin (Chr9), mitochondrial nerve and muscle



Atrophy cerebellum (shrink) Normal cerebellum

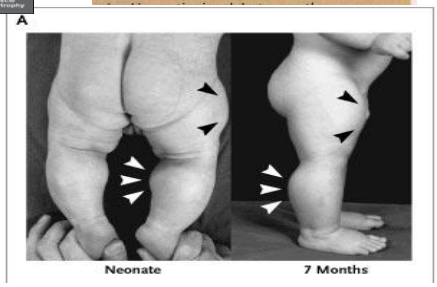


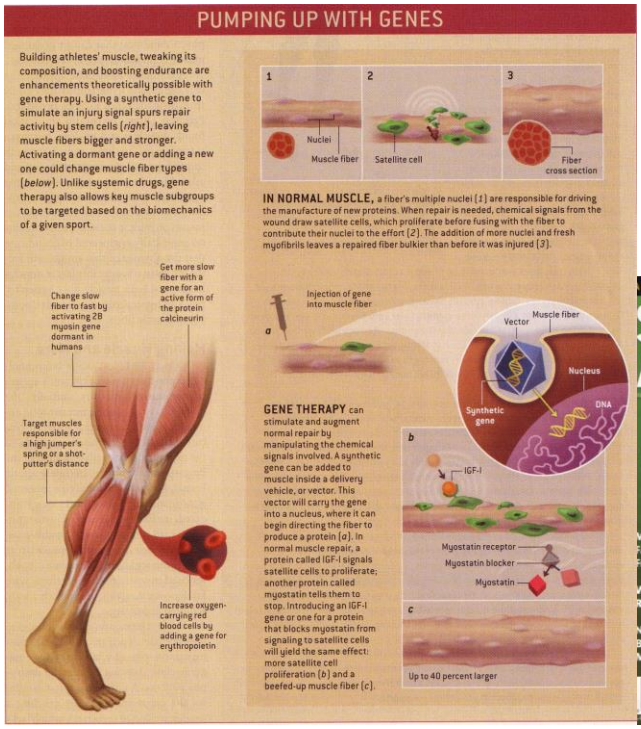


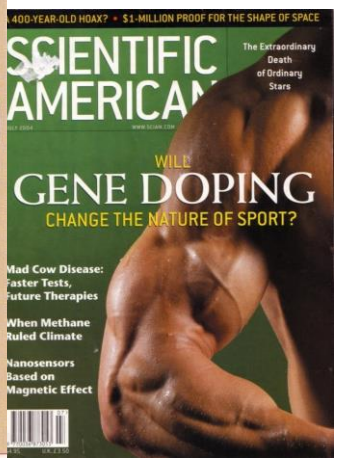
EERO MÄNTYRANTA won two Olympic gold medals in 1964. Years later scientists found the source of the Finnish cross-country skier's endurance. A genetic mutation gave his family higher than normal levels of oxygen-carrying red blood cells—higher even than could be achieved with EPO.

Myostatin acts by inhibiting the growth of muscles, It prevents muscles from growing too large i.e. **inhibits proliferation of myoblasts** that fuse to form skeletal muscle cells.

- Mutation in myostatin → proliferation & growth >>>
- Inactivated myostatin → German Superboy




PUMPING UP WITH GENES
Building athletes' muscle, tweaking its composition, and boosting endurance are enhancements theoretically possible with gene therapy. Using a synthetic gene to simulate an injury signal spurs repair activity by stem cells (right), leaving muscle fibers bigger and stronger. Activating a dormant gene or adding a new one could change muscle fiber types (below). Unlike systemic drugs, gene therapy also allows key muscle subgroups to be targeted based on the biomechanics of a given sport.
1
2
3
Nuclei
Muscle fiber
Satellite cell
Fiber cross section
IN NORMAL MUSCLE, a fiber's multiple nuclei (1) are responsible for driving the manufacture of new proteins. When repair is needed, chemical signals from the wound draw satellite cells, which proliferate before fusing with the fiber to contribute their nuclei to the effort (2). The addition of more nuclei and fresh myofibrils leaves a repaired fiber bulkier than before it was injured (3).
Get more slow fiber with a gene for an active form of the protein calcineurin
Change slow fiber to fast by activating 2B myosin gene dormant in humans
Target muscles responsible for a high jumper's spring or a shot-putter's distance
Increase oxygen-carrying red blood cells by adding a gene for erythropoietin
Injection of gene into muscle fiber
a
Muscle fiber
Vector
Nucleus
DNA
Synthetic gene
GENE THERAPY can stimulate and augment normal repair by manipulating the chemical signals involved. A synthetic gene can be added to muscle inside a delivery vehicle, or vector. This vector will carry the gene into a nucleus, where it can begin directing the fiber to produce a protein (a). In normal muscle repair, a protein called IGF-I signals satellite cells to proliferate; another protein called myostatin tells them to stop. Introducing an IGF-I gene or one for a protein that blocks myostatin from signaling to satellite cells will yield the same effect: more satellite cell proliferation (b) and a beefed-up muscle fiber (c).
b
IGF-I
Myostatin receptor
Myostatin blocker
Myostatin
c
Up to 40 percent larger


400-YEAR-OLD HOAX? • $1-MILLION PROOF FOR THE SHAPE OF SPACE
SCIENTIFIC AMERICAN
The Extraordinary Death of Ordinary Stars
WILL
GENE DOPING
CHANGE THE NATURE OF SPORT?
Mad Cow Disease: Faster Tests, Future Therapies
When Methane Ruled Climate
Nanosensors Based on Magnetic Effect