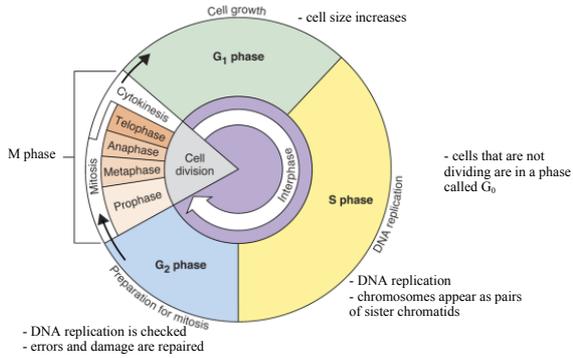
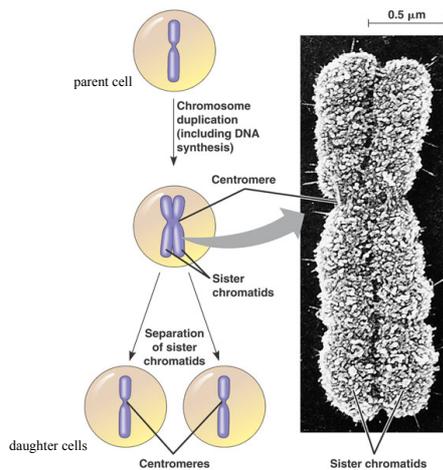


Why might it be important for cells to divide at a specific rate and time?
 Normal Growth
 Normal Development
 Maintenance

Different cells types divide at different frequencies
 What types of cell might divide more frequently?
 Some cells can divide, but don't divide often.
 Some cells do not appear to divide after maturity.



1. What functions does cell division accomplish?
2. Do all of the cells in your body divide at the same rate? Explain.



3. State the phase that is described by each of the following events during mitosis.
 - a) The chromosomes move apart and go to opposite poles of the cell.
 - b) The nucleolus and nuclear envelope reappear.
 - c) The centrioles complete their own replication.
 - d) The cell grows in size.
 - e) The spindle has reached its full development.
 - f) Chromosomes becomes shorter and thicker strands.

4. Looking under a microscope, you notice that some cells have several nuclei within the cytoplasm of a single cell. Which phase of the cell cycle is not operating correctly to form such cells?

5. Why must cytokinesis occur after, rather than before, anaphase?

6. Identify the difference between cytokinesis in animal cells and plant cells.

7. A drug interferes with the construction of the mitotic spindle. What effect would this drug have on cells?

8. Why is the replication process during interphase so important to cell division?

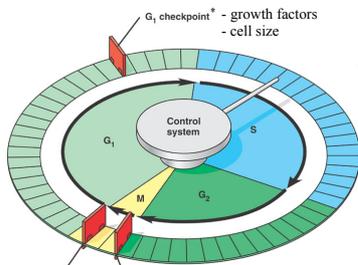
Cell cycle is driven by molecular signals

- Internal (e.g., the cell can't enter mitosis until all of the chromosomes are replicated)
- External (e.g., growth factors that stimulate the growth and division of cells)



Signals indicate if key cellular processes have been completed correctly.

- a checkpoint is a time when the cell decides to either stop or proceed
- the cell checks that certain things have been completed before proceeding
- normally, the cycle is stopped at a checkpoint until all conditions can be satisfied
- most cells are actually permanently in G₀ and never divide
- density-dependent inhibition
- anchorage dependence

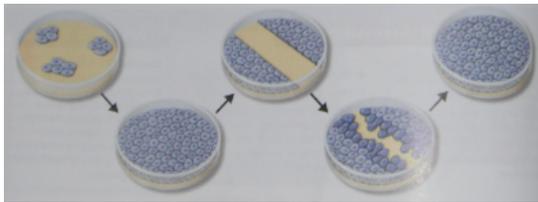


G₁ checkpoint* - growth factors
- cell size

* - called the restriction point because it is the point of no return
- if the cell passes this checkpoint it **MUST** divide
- if all signals are not satisfactory, the cell enters G₀

G₂ checkpoint
- DNA replication complete
- DNA damage
- internal protein signals

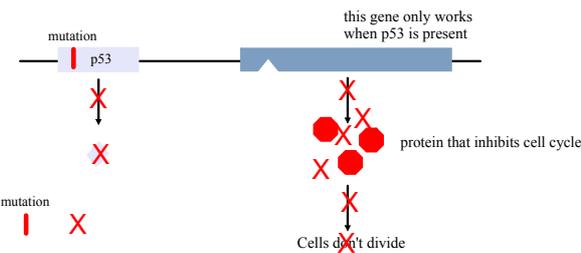
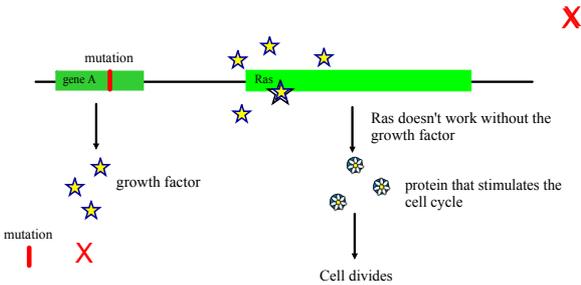
M checkpoint
- chromosomes attached to spindle



Some genes stimulate cell division while others inhibit it.

- proto-oncogenes
- normally stimulate cell division
- they become "oncogenes" (cancer-causing) by mutation or increased expression
- e.g., ras is mutated in 30% of human cancers

- tumor-suppressor genes
- normally inhibit cell division
- can cause cancer by decreased expression or mutation
- e.g., p53 is mutated in 50% of human cancers



9. a) Imagine that a drug is developed that forces cells to remain in G₁ of the cell cycle. What would be the effect on the cell?
b) On the individual?

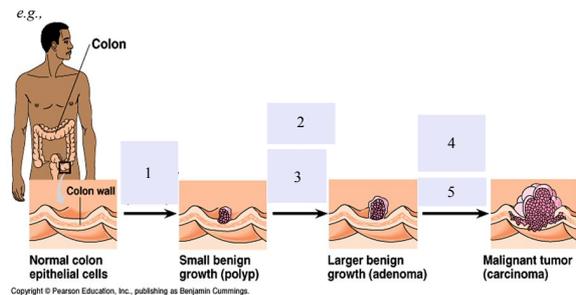
10. What signals control the growth and division of normal cells?

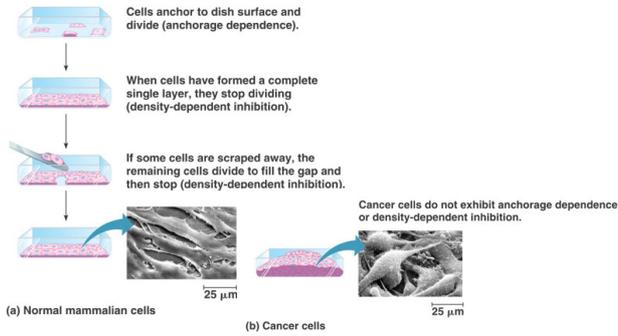
How do cancerous cells form?

What has to go wrong?	How does it happen?
unlimited growth	turn on growth promoter genes (e.g., ras)
ignore checkpoints	turn off tumor suppressor genes (e.g., p53)
escape apoptosis	turn off suicide genes
immortality (i.e., unlimited divisions)	turn on chromosome maintenance genes
promote blood vessel growth	turn on blood vessel growth genes
overcome anchorage & contact inhibition	turn off touch-sensor gene

What triggers the changes?
- exposure to UV and other radiation
- chemical exposure
- genetics

That's why the risk increases with age.

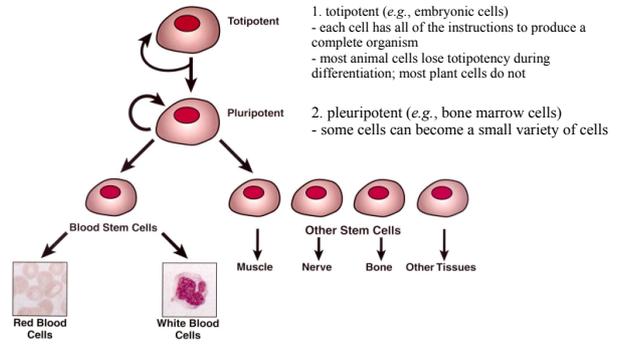




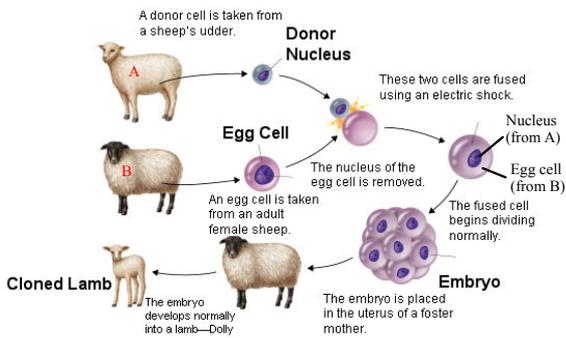
- each cell has all the instructions to produce a whole human
- differentiation allows cells to become specialized
- differentiation is permanent

How do cells become different?

- molecules in the cytosol and molecular signals they receive from nearby cells



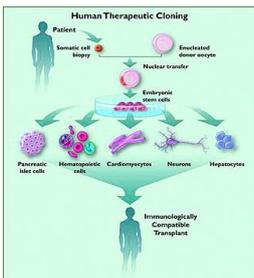
- current research is aimed at learning how to make these cells become the type of cell we want



Nuclear transfer

How can cloning be useful?

- research diseases
- produce genetically identical organisms which carry a useful gene
- create compatible transplants

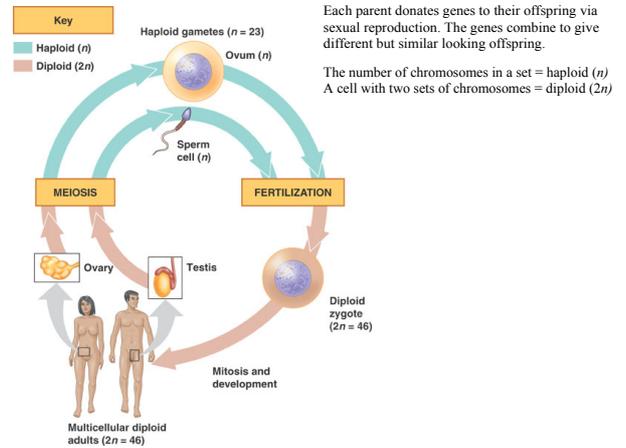
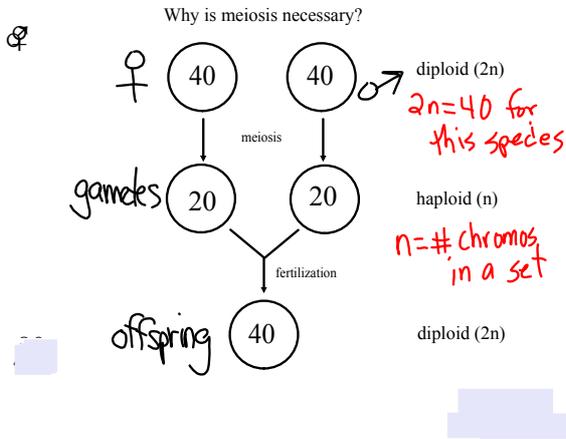


11. How can mutagens cause cancer?

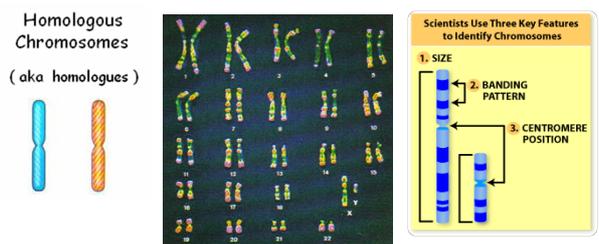
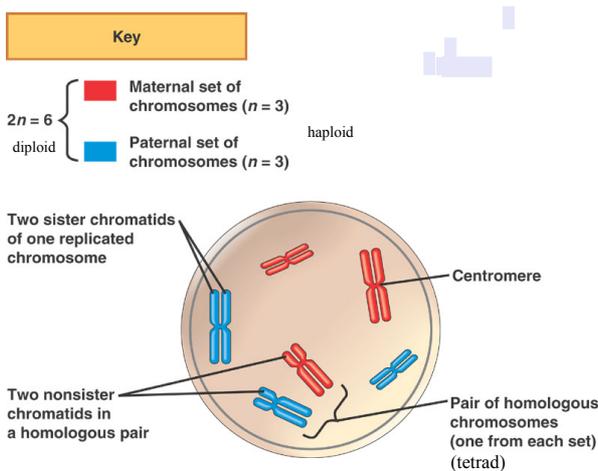
12. Cancer cells are unusual in a variety of ways: they are immortal, they metastasize, don't perform their normal function, and they can form tumors. Explain each of these characteristics at the cell level.

13. a) What evidence suggests that cells contain a biological clock or counter?
b) How might understanding the biological counter help extend human life span?

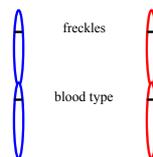
14. How can stem cells be used in addressing the problems of organ transplantation?



Humans have 46 chromosomes consisting of 23 homologous pairs. Each parent donates one chromosome to each of the 23 homologous pairs.

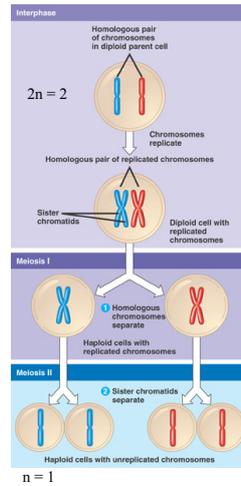


Homologous chromosomes are the same length and carry the same genes in the same location. Those genes could be different versions.
 e.g., the gene on one chromosome could say "freckles" while the other says "no freckles"



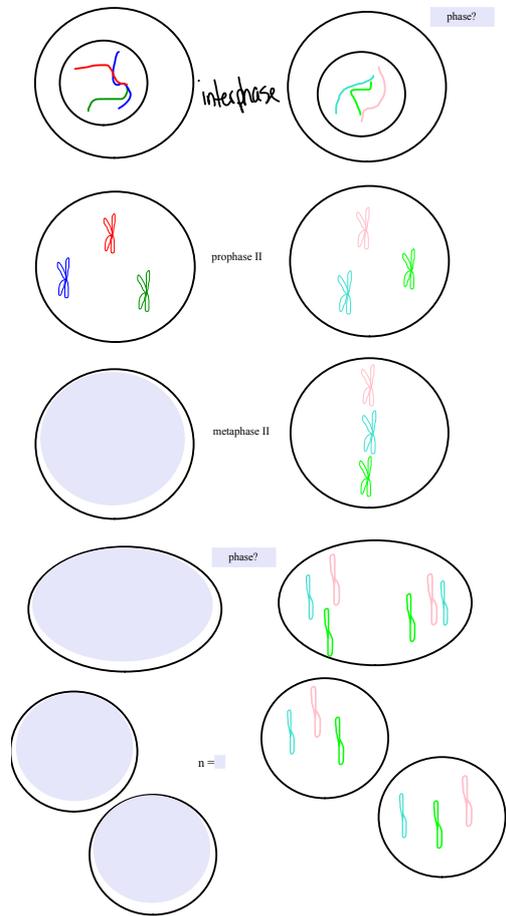
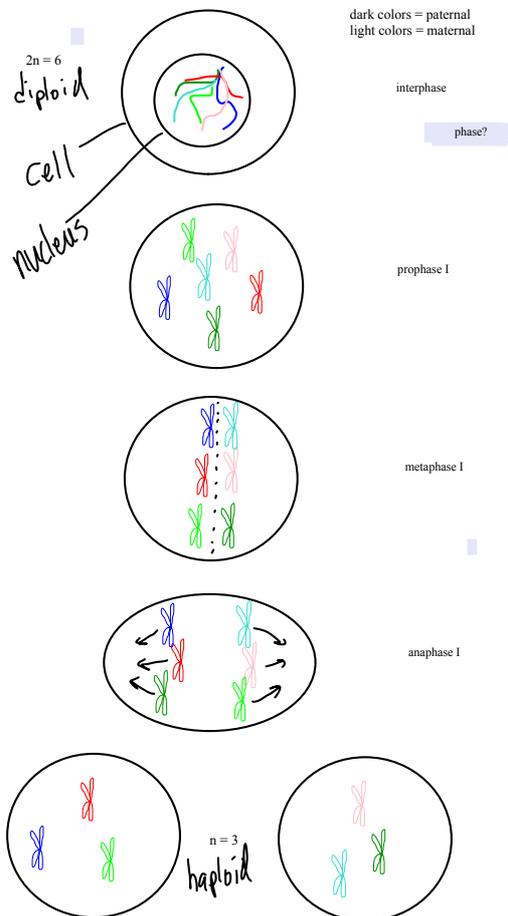
- this is for autosomes only
- for the **sex chromosomes**, females have a homologous pair (XX) while males do not (Xy)

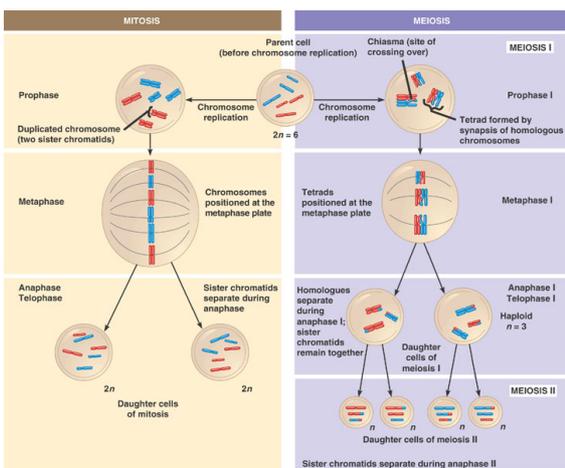
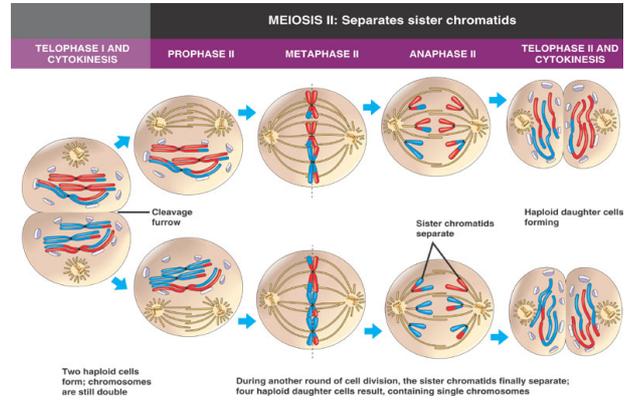
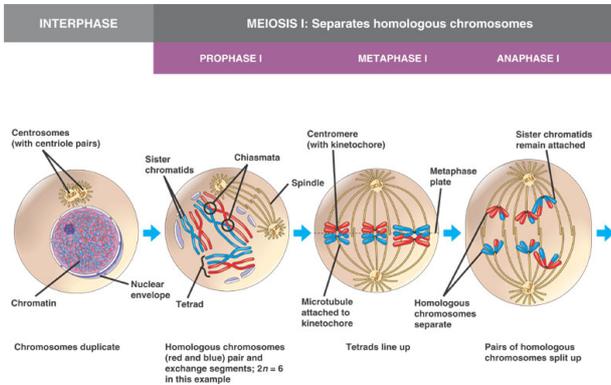
- 15. What are chromosomes other than sex chromosomes called?
- 16. Distinguish between haploid and diploid cells in humans. Apply them to the terms "somatic cell" and "sex cell."
- 17. Do homologous chromosomes have the same number of genes? Do they have identical genes? Explain.



these are gametes

Meiosis animation [Back](#)





daughters are clones
daughters are somatic

daughters are different
daughters are sex cells

18. a) A cell with 10 chromosomes undergoes mitosis. Indicate the number of chromosomes you would expect in each of the daughter cells.
b) What about after meiosis?

19. Match the events to the correct phase of meiosis.
a) pairs of homologous chromosomes line up along the equator of the cell
b) synapsis occurs and the four chromatids form a tetrad
c) replication of the genetic material
d) homologous pairs become separated
e) sister chromatids split at the centromere and move toward opposite poles

20. A muscle cell of a mouse has 40 chromosomes. Indicate the number of chromosomes you would expect to find in each of the following cells of the same mouse
a) daughter cell formed after mitosis
b) skin cell
c) egg cell
d) fertilized egg

21. a) If a cell has a diploid number of 32, what would be the chromosome number of a cell in late Prophase I of meiosis?
b) What about at the end of Telophase II?

22. Compare and contrast meiosis and mitosis.

Genetic diversity leads to evolutionary change.

update order

If an offspring inherits a combination that gives it a better survival advantage, there is an increased chance that combination will be passed on.

Over time, there will be an accumulation of favorable characteristics.

During meiosis, three things contribute to genetic diversity:

1. Independent assortment of chromosomes

- Random orientation of homologous pairs of chromosomes

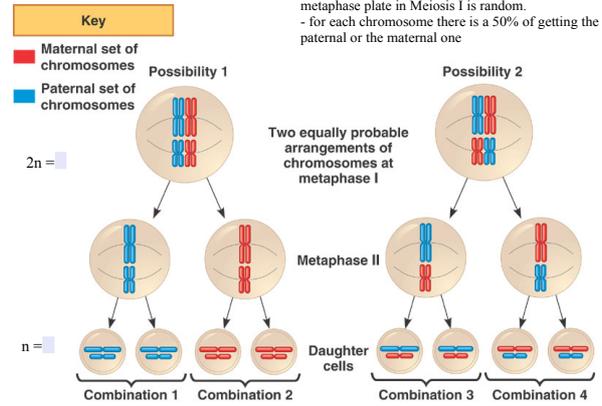
- in metaphase

2. Random fertilization

- any sperm can fertilize any egg

3. Crossing over

- pieces of chromosomes switch places



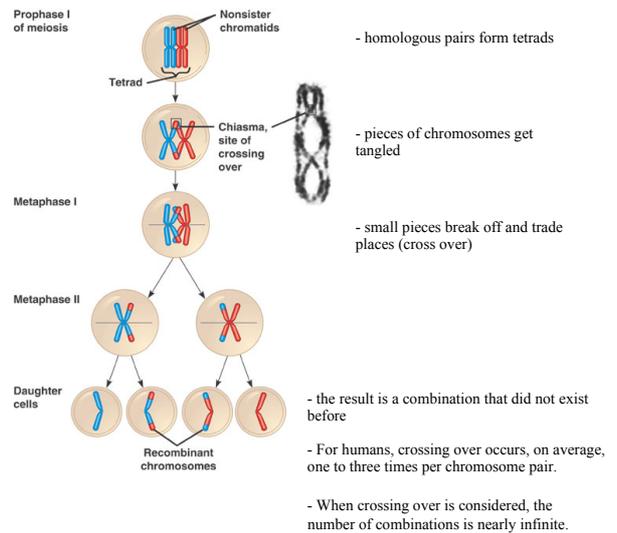
The number of possible orientations is 2^n , where n is the haploid number. For humans, the number is $2^{23} = 8.4$ million.

Random fertilization

Any of a male's 8.4 million sperm can fertilize any of a woman's 8.4 million eggs. The total number of combinations is over 70 trillion.



Sebastian Kaulitzki/Shutterstock



23. Explain how the production of gametes and sexual reproduction increase genetic variation.

24. Explain how synapsis often leads to the exchange of genetic material between chromosomes.

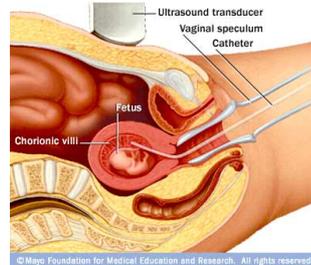
Do chromosomes always separate perfectly, just like they're supposed to?

Amnioentesis

- 15 to 20 weeks pregnant but can be done as early as 11
- amniotic fluid is tested for chromosomal abnormalities or for particular alleles
- results are available in 2 weeks
- risk of pregnancy loss is 0.6-0.86%.

Chorionic villus sampling (CVS)

- can be done at 10-12 weeks pregnant or as early as 8 weeks
- a small piece of tissue is removed from the placenta
- risk of pregnancy loss is 0.5-1%



Non-invasive prenatal diagnosis (or testing)

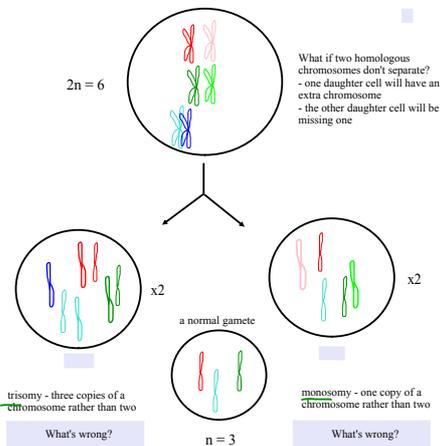
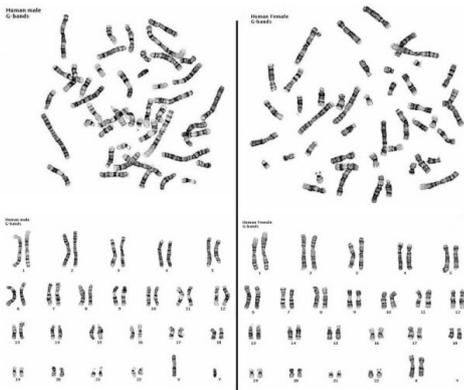
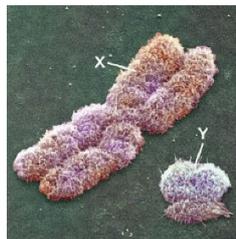
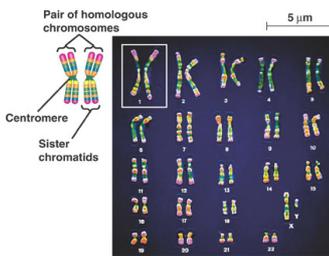
- fetal cells from the placenta get into the maternal blood
- fetal DNA in the maternal plasma can be detected
- detection rate for several chromosomal disorders range between 92-99%

So what if we discover a problem?

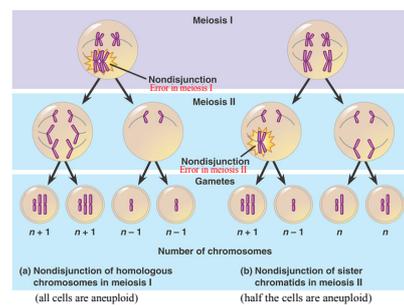


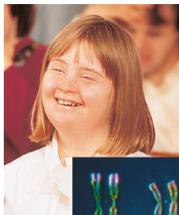
1. Harvest fetal cells.
2. Culture them *in vitro*.
3. Remove the chromosomes and arrange them in pairs to be photographed.

We can detect abnormalities in chromosome number, shape, or size.



- every cell of the organism will then have the abnormal chromosome number.
- it is believed that many cases of mental retardation are linked to chromosomal defects.
- pieces of chromosomes sometimes get moved to a different place in the genome (this is called a chromosomal translocation) which cause specific cancers.
- e.g. chronic myelogenous leukemia (CML) occurs when a large fragment of chromosome 22 switches places with a small fragment from the tip of chromosome 9.





- characteristic facial features
- short stature
- heart defects
- mental retardation
- increased risk of respiratory infection and developing leukemia and Alzheimer's disease
- most are sexually underdeveloped and sterile
- shorter life span (on average)

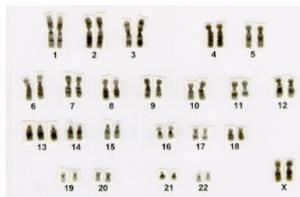
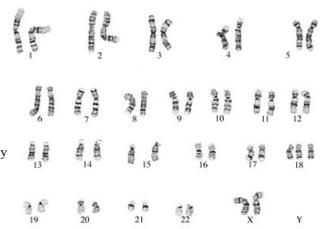


Frequency
1/750 in Canada

Mother's age	Rate
20	1/1600
25	1/1300
30	1/1000
35	1/365
40	1/90
45	1/30
49	1/12

Edward's syndrome

- small, abnormally shaped head, small jaw and mouth
- long fingers that overlap, with underdeveloped thumbs and clenched fists
- cleft lip and palate (a gap or split in the upper lip and/or the roof of the mouth)
- heart, kidney, breathing and feeding problems
- intestines or other organs protruding outside the body (omphalocele)
- severe mental retardation
- life span is usually less than 10 weeks
- frequency is 1 in 3,000 conceptions and approximately 1 in 6,000 live births



- Patau syndrome
- intellectual disability and motor disorder
 - microcephaly
 - spinal defects
 - polydactyly (extra digits)
 - cyclopia
 - proboscis
 - omphalocele (abdominal defect)
 - overlapping of fingers over thumb
 - cutis aplasia (missing portion of the skin/hair)
 - cleft palate
 - abnormal genitalia
 - kidney defects
 - heart defects

- life span is rarely more than one year and more than 80% of children die within the first month

Frequency 1/12,000



- sometimes abnormal crossing over causes pieces of chromosomes to be incorrectly attached or even lost altogether
- usually, these errors cause a variety of cancers but can also cause other disorders
- cri-du-chat is caused by a specific deletion in chromosome 5
- feeding problems because of difficulty swallowing and sucking (the characteristic cry is caused by a defect in the larynx)
- low birth weight and poor growth
- severe cognitive, speech, and motor delays
- behavioral problems such as hyperactivity, aggression, tantrums, and repetitive movements
- unusual facial features (hypertelorism)
- excessive drooling
- constipation
- microcephaly
- 1/50,000 births

- individuals are anatomically male but have abnormally small testes that fail to descend
- usually sterile
- female secondary sex characteristics develop
- normal intelligence
- condition exists in roughly 1 out of every 1,000 males. One in every 500 males has an extra X chromosome but does not have the syndrome

- it is possible that nondisjunction occurs in other chromosomes but the consequences are lethal

- nondisjunction of the sex chromosomes is also possible
- produces many combinations of sex chromosomes

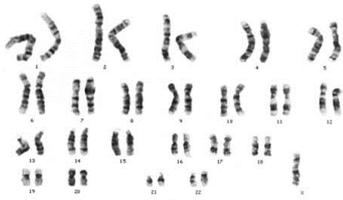
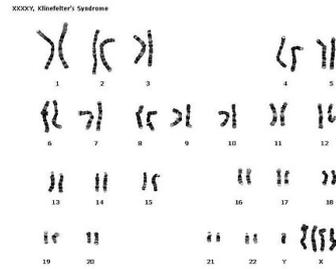
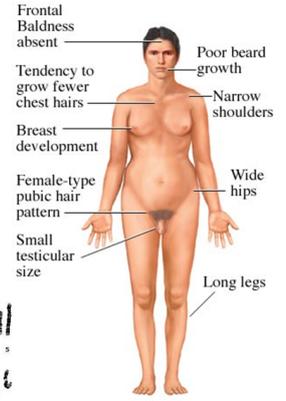
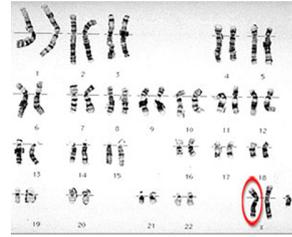
XXX females

- trisomic X females are indistinguishable from normal females
- frequency is estimated at 1/1000
- unsure because not usually diagnosed unless genetic screening for some other purpose

Xyy males

- indistinguishable from normal males (although might be slightly taller)
- estimated at 1/1000

Why are aneuploid conditions of the sex chromosomes less serious?



Frequency 1/2000 - 1/5000

- phenotypically female
- short stature, swelling, broad chest, low hairline, low-set ears, and webbed necks, congenital heart disease, hypothyroidism, diabetes, vision problems, hearing concerns, many autoimmune diseases, a specific pattern of cognitive deficits
- usually sterile as the sex organs do not mature
- estrogen replacement therapy helps with the development of female secondary sex characteristics



25. What is a karyotype and where would one get the cells to make one?

26. Describe nondisjunction and its effect on the chromosomal composition of a cell.

27. As any pair of chromatids can fail to separate during meiosis, theoretically there are 23 possible kinds of monosomy and trisomy. However, monosomies and trisomies for most of the 23 chromosome pairs are quite rare (or unheard of). Why do you think this is so?

Attachments

Cri Du Chat.mp4