DNA History

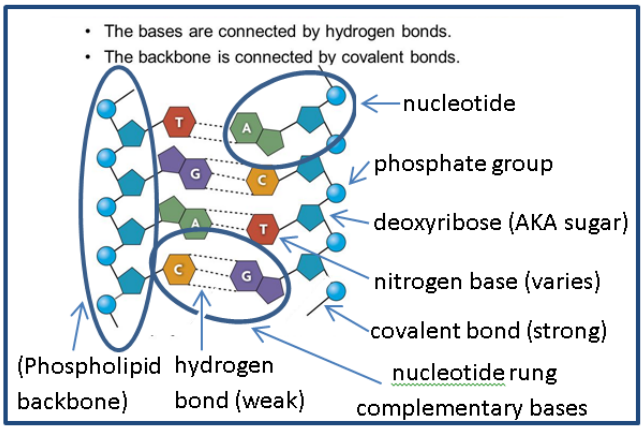
People	Significance	Research
Griffith	Transforming principle	• Dead lethal S bacteria, combined with harmless live R bacteria, killed mice • so a transforming material had to pass to R bacteria, making it deadly
Avery	DNA is genetic material	• Used enzymes to test what is passed to offspring • When enzymes broke down proteins or RNA, transformation still occurred • When they broke down DNA, it stopped; so DNA must be transforming
Hershey & Chase	Confirm DNA is genetic material	• Studied bacteriophages: its proteins have mostly sulfur, DNA phosphorus • When infected with radioactive sulfur (affecting proteins), no change • With radioactive phosphorus, radioactivity found in bacteria
Chargaff	A=T, G=C	Chargaff's rules: equal amounts of adenine & thymine; guanine & cytosine
Franklin & Wilkins	double helix	Used x-ray crystallography to suggest DNA's double helical shape
Watson & Crick	3D DNA model	Built on others' research to discover DNA structure • DNA is genetic material: from Griffith, Avery, Hershey & Chase • DNA is double helix: from Franklin & Wilkins • DNA is made up of two complementary (opposites that fit together) strands of A and T, C and G: explains Chargaff's rules

DNA Replication: creates exact copies of genetic info

1. helicase unzips double helix by breaking weak hydrogen bonds
2. free-floating nucleotides pair up to form complementary strands
3. two identical molecules of DNA formed, one old strand and one new strand
4. DNA polymerases find and correct errors

Replication is carried out by	enzymes
Helicase	unzips double helix
Polymerase	finds and corrects errors
Importance of hydrogen bonds	Hydrogen bonds are easily broken, allowing unzipping
Source of new nucleotides	Free-floating in nucleus
Result of replication	One old strand, one new strand
How can replication occur in a few hours?	It begins at many different points throughout the strand

DNA Structure



Pyrimidine: single ring	Purine: double ring
Cytosine (C)	Guanine (G)
Thymine (T)	Adenine (A)

Chargaff's Rule
amount of adenine = amount of thymine
amount of guanine = amount of cytosine

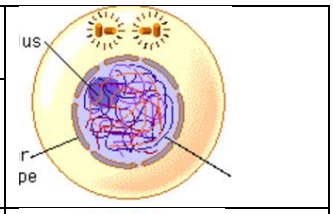
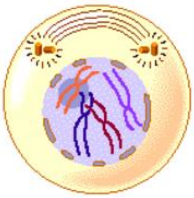
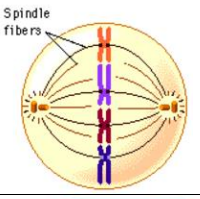
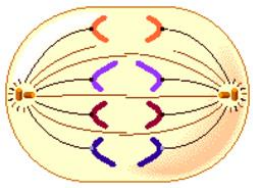
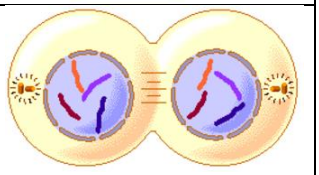
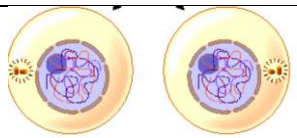
Cell Cycle

Interphase	
Gap 1 (G_1)	Normal functions cell size increases, more organelles
Synthesis (S)	Cell copies nuclear DNA, resulting in 2 complete sets
Gap 2 (G_2)	Normal functions, more growth Checkpoint: must be adequate size, undamaged DNA
Mitosis (M)	
Mitosis	Division of cell nucleus and contents
Cytokinesis	Divides cytoplasm, makes 2 identical daughter cells

Rates of cell division	Vary widely Usually faster in prokaryotes
Why do cells divide?	Volume increases faster than surface area, the area of cell membrane that supports cell, so more SA needed

What cells undergo **mitosis**?	Somatic cells
What takes place before mitosis?	DNA replication (interphase)
What does mitosis produce?	2 diploid genetically identical daughter cells
What regulates the cell cycle?	External (physical) factors that trigger internal (chemical) factors
What is apoptosis?	Programmed cell death

Mitosis

Interphase	Before mitosis: Prepares cell to divide by replicating DNA	
Prophase	• DNA condenses into chromosomes • Nuclear envelope breaks down • Centrioles move to poles • Spindle fibers form	
Metaphase	Chromosomes line up in middle	
Anaphase	Chromatids separate to opposite sides of cell	
Telophase	• Nuclear membrane begins forming • Chromosomes begin to uncoil • Spindle fibers fall apart	
Cytokinesis	Separate stage during telophase: cytoplasm divides, make 2 identical daughter cells w/ full sets of DNA	

Cancer	Uncontrolled cell division
Tumor	Disorganized clump of cells
Benign	Harmless: cancer cells remain clustered together, doesn't spread
Malignant	Harmful: Cells break away (metastasize) from tumor and spread through body
How does it form?	Normal cells suffer damage to genes that make proteins for cell division
Causes	Carcinogens, inherited, radiation
Carcinogen	Substance known to cause cancer
Treatment	Radiation, chemotherapy

Sexual reproduction	**Asexual reproduction**
Joining of two specialized cells (egg & sperm)	Offspring comes from single parent
Offspring genetically unique	Offspring genetically identical
Eg: meiosis	Eg: **binary fission** (in prokaryotes)
In changing environments, **genetic diversity** increases survival chances	In non-changing environments: well-suited to environment and efficient

Meiosis	**Mitosis**
2 cell divisions (PMAT)	1 cell division
Produces 4 haploid cells	Produces 2 diploid cells
Offspring genetically unique	Genetically identical
Sexual reproduction	Asexual

Chromosomes

Somatic cells	Diploid body cells (most common), in tissues & organs
Germ cells	Cells in reproductive organisms, develop into gametes in meiosis
Gamete (sex cells)	Haploid cells (egg and sperm) that pass DNA to offspring in chromosomes
Autosome	First 22 homologous pairs of homologous chromosomes
Chromosome	One long continuous thread of DNA; 46 in humans
Sex chromosomes	Last pair of chromosomes controlling development of sexual characteristics
Homologous chromosomes	Pair of chromosomes, one from father and one from mother
Chromatid	Identical half of a chromosome
Centromere	Holds together 2 sister chromatids in middle
Telomere	Found at ends of DNA molecules so they don't come apart
Chromatin	Loosely condensed, unwound DNA
Diploid	Two copies of each chromosome, in somatic
Haploid	One copy of each chromosome, in gametes
Histones	Protein that DNA wraps around
Gene	Code to program production of structural & functional proteins 22,000 genes store code in nucleotides

Levels of Organization
Cells
Tissues
Organs
Organ Systems

Stem Cells	
Stem cell	Undifferentiated cell that can become any other cell
Types	Fertilized egg Embryonic stem cell Adult stem cell
importance	Treat leukemia, lymphoma may repair damaged organs may cure diseases (diabetes)
Cell different-iation	Unspecialized cells develop into their mature forms: cells have full set of DNA, but use certain genes to become specific to a function