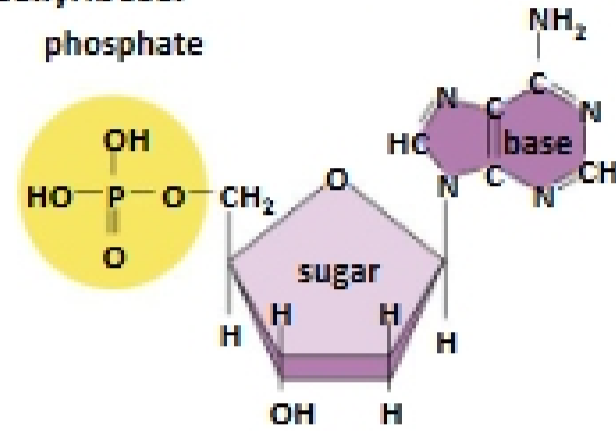


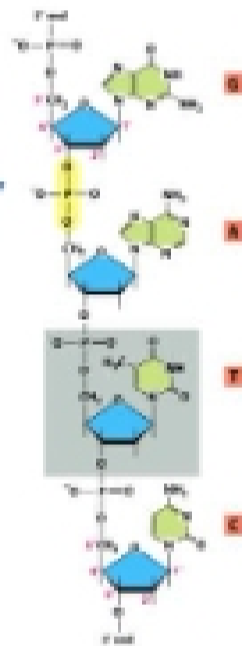
DNA and Chromosomes

Nucleotides are composed of a base, sugar, and phosphate group.

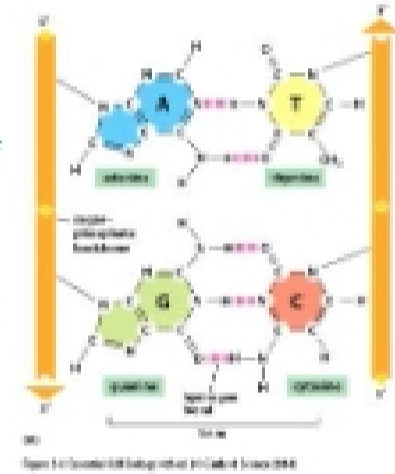
- In **deoxyribonucleic acid (DNA)**, the sugar is **deoxyribose**.



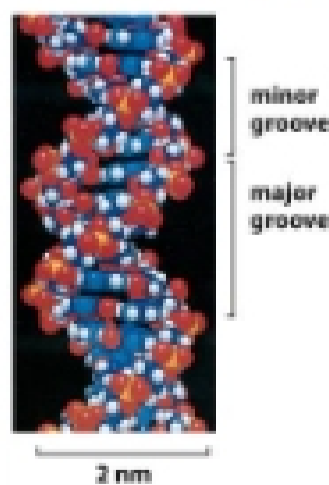
- Nucleotides are linked via **phosphodiester bonds** to form nucleic acids
 - phosphodiester bonds form via **condensation reactions**
- DNA nucleotides can be **purines (G/A)** or **pyrimidines (T/C)**
- DNA strands have a **polarity (5' versus 3')**
- DNA strands are **negatively charged**



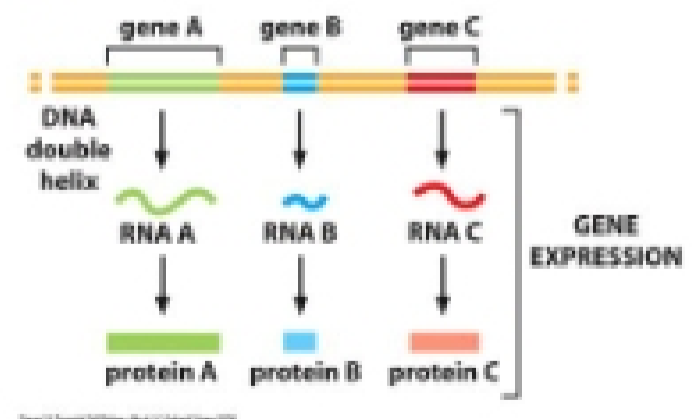
- Double-stranded DNA consists of two **complementary chains** of nucleotides in an **anti-parallel** conformation
- The DNA strands are held together by **hydrogen bonds**



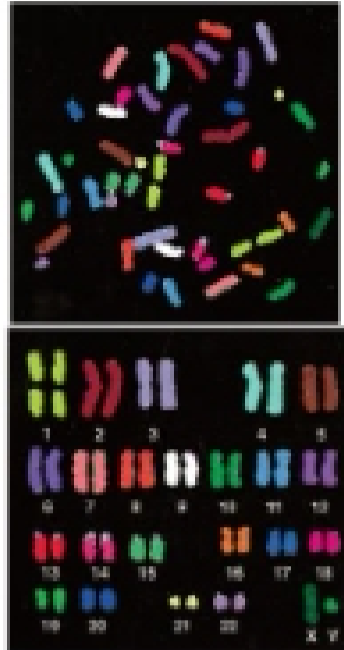
The **DNA double helix** contains **10 base pairs (bp)** per turn.



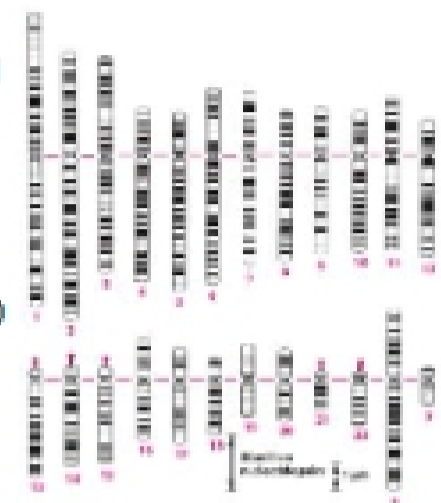
Most genes contain information to make proteins



- A **genome** is all the information contained within an organism's DNA
- Eukaryotic DNA is divided into **chromosomes**
 - **homologous chromosomes (homologues)**: one pair of chromosomes; one maternal and one paternal
- **Karyotype**: display of the mitotic chromosomes



- Human Genome** (draft sequence 2001, finished 2004)
- 22 autosomes and 2 sex chromosomes
 - 3.2 billion base pairs
 - approximately 25,000 genes
 - 1.5% of the genome encodes exons



The duplication and segregation of chromosomes occurs through an ordered cell cycle

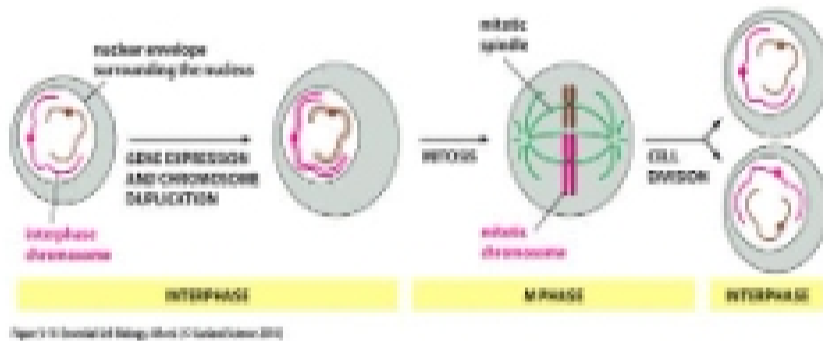
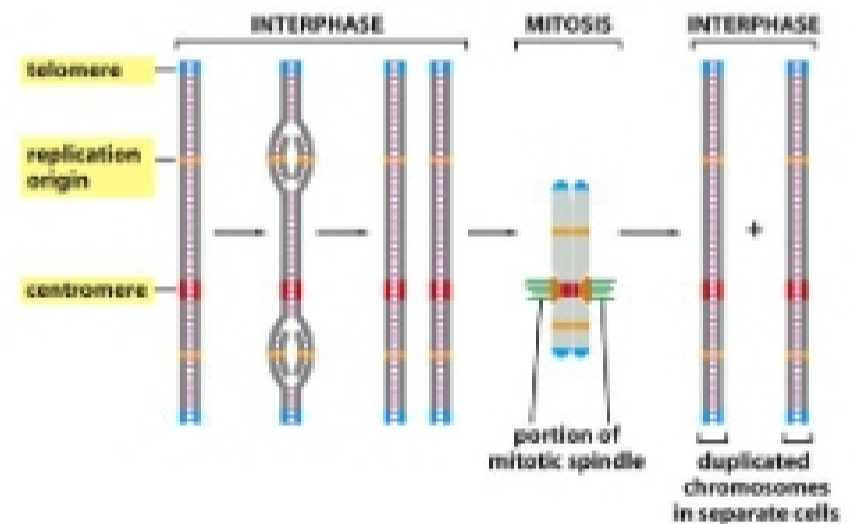
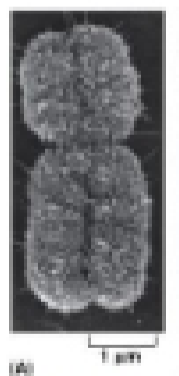


Figure 11-10 Essential Biology, 4th ed. © Garland Science 2011

Three DNA sequence elements ensure chromosomes can be replicated (**replication origin** and **telomere**) and segregated (**centromere**).



Chromosomes in a cell are condensed.



mitotic chromosomes: most condensed



interphase chromosomes: less condensed

Chromatin: DNA and its associated proteins

Nucleosomes are the basic unit of chromatin packing.

- consist of 4 pairs of histones (8 total)
 - Histones are highly conserved, small, positively charged proteins
- 147 bp piece of DNA

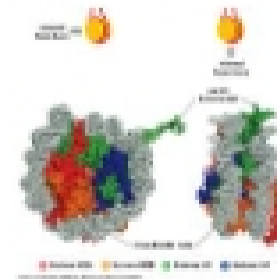
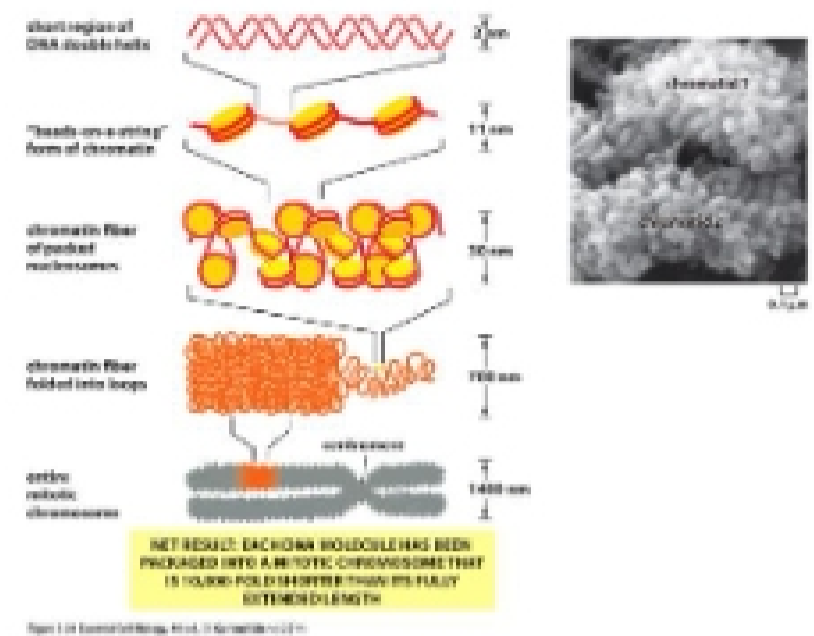
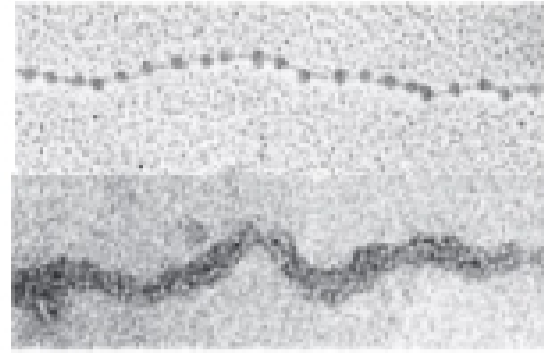


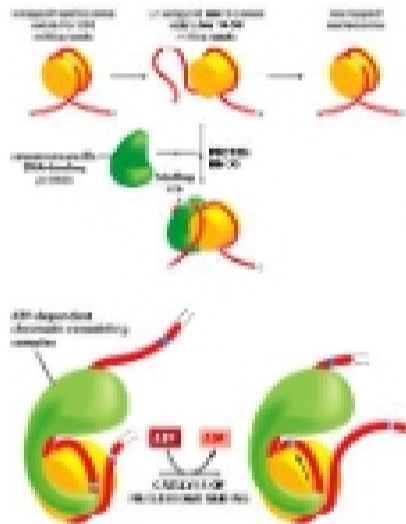
Figure 1-21 Essential Cell Biology, 4th ed. © Garland Science 2011

Nucleosomes are further packed into 30 nm fibers via:

1. interactions between histone tails
2. binding of histone H1

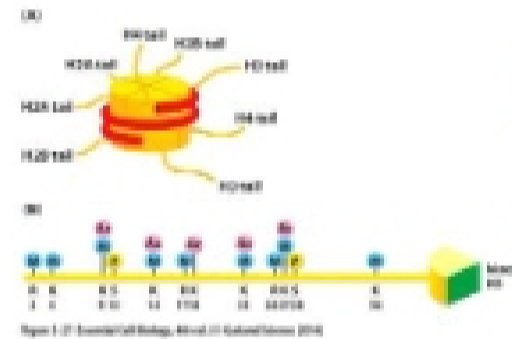


Nucleosome-wrapped DNA is accessible to other DNA binding proteins via:



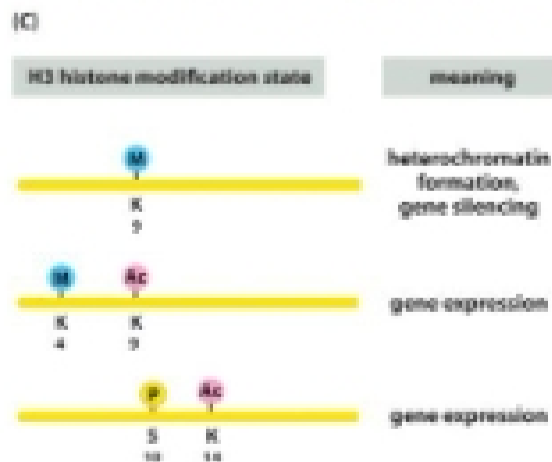
1. nucleosome structure is fluid and dynamic
2. chromatin remodeling complexes slide DNA in nucleosomes in an ATP dependent manner

Nucleosome-wrapped DNA is accessible to other DNA binding proteins via:



3. Modification of histone tails by modifying proteins
 - disrupts stability of the 30 nm fibers and higher order packing
 - recruits proteins that condense or decondense chromatin

The pattern of histone modification indicates the status of the nearby chromatin.



There are two levels of interphase chromatin condensation.

1. heterochromatin
 - most condensed
 - induced by tail modifications, including methylation of lysine 9 on the histone H3 tail
 - gene poor regions (centromeres and telomeres)
 - genes are not expressed