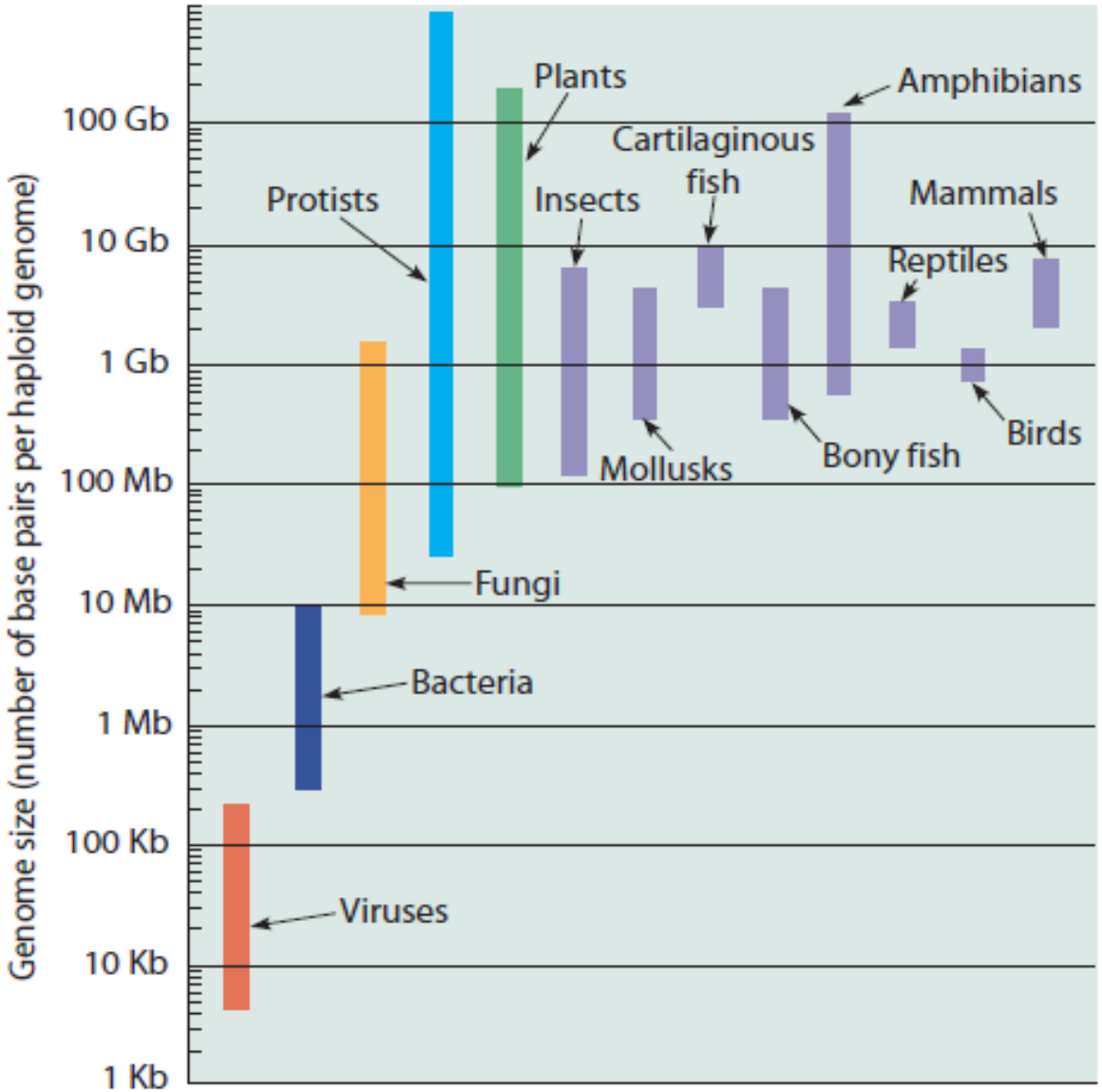
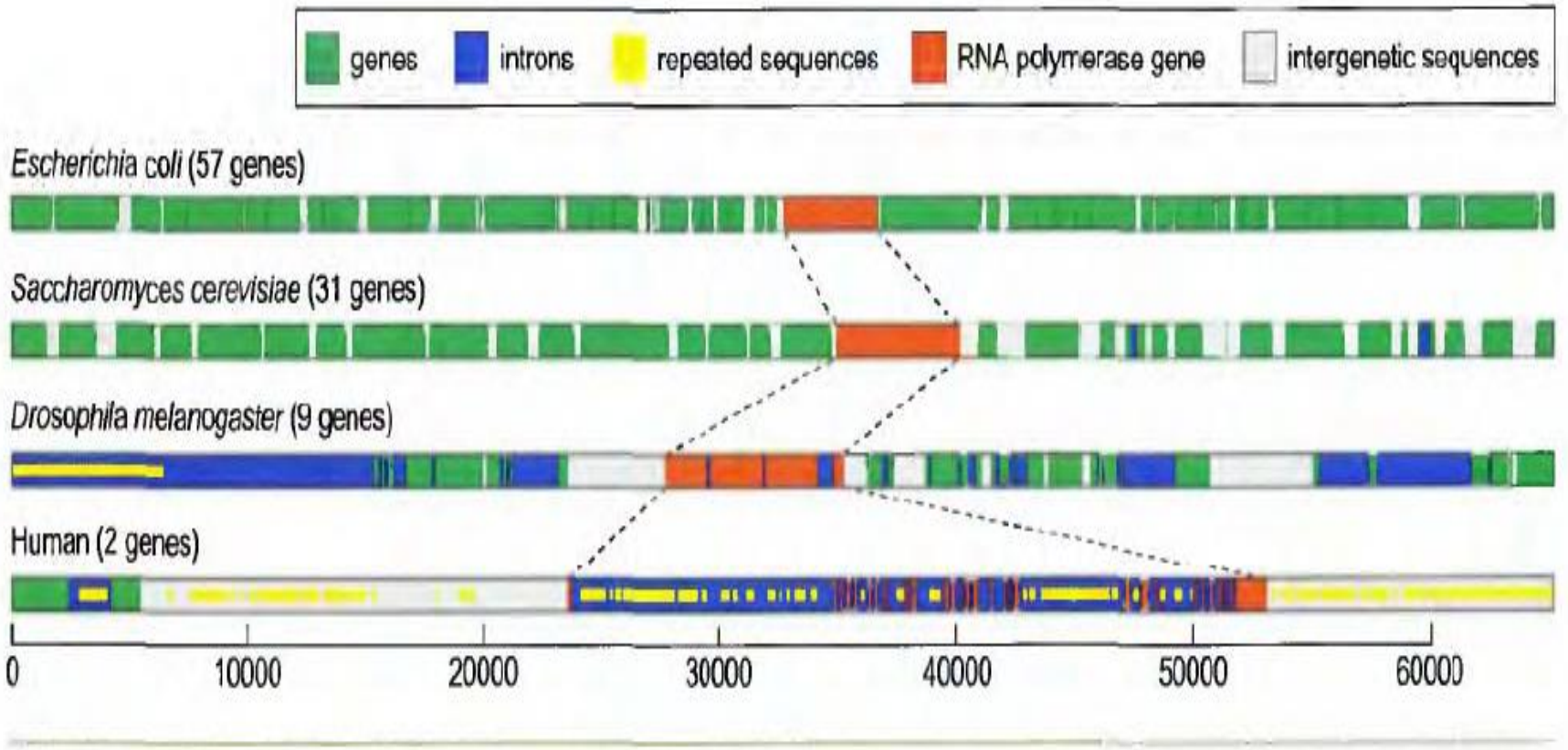
Molecular Biology , Sem III

Organization of DNA



Relationship Between Genome Size and Type of Organism.

Comparison of chromosomal gene density



Bacteria have appx 1000 genes/Mb gene density

Organization into chromosomes??

- It makes the DNA compact so that it fits in the cell
- It protects the DNA from damage/ makes them more stable
- Only a packaged DNA can be efficiently passed on to the daughter cells during cell division.
- Chromosomes confers an overall organization of each molecule of DNA to facilitate gene expression and recombination

Prokaryotic DNA

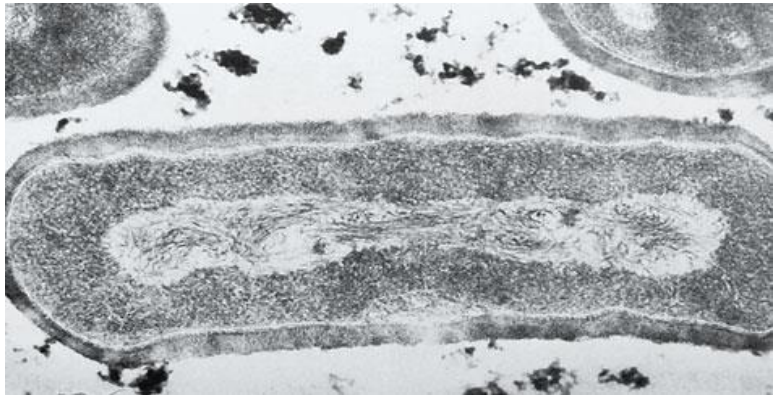
- A prokaryotic cell generally contains a single chromosome composed of double stranded circular DNA, which contains over 4×10^6 base pairs.
- Because DNA molecules are so large, they require special organization/packaging to enable them to reside within cells.
- *E. coli - the circular DNA is* supercoiled and attached to an RNA-protein core.
- **Bacteria Package DNA in Bacterial Chromosomes and Plasmids**

Bacterial Chromosomes

- Bacteria can have single or multiple, circular or linear chromosomes (*Agrobacterium tumefaciens*- 3 circular and 1 linear chromosome); the most common arrangement, however, is a single circular DNA molecule that is bound to small amounts of protein and localized to a special region of the bacterial cell called the **nucleoid.**
- Although the nucleoid is not surrounded by a membrane, the bacterial DNA residing in this region forms a threadlike mass of fibers packed together in a way that maintains a distinct boundary between the nucleoid and the rest of the cell.

Other features

- DNA is negatively supercoiled and folded into an extensive series of loops averaging about 20,000 bp in length.
- The two ends of each loop are anchored to structural components that lie within the nucleoid, the supercoiling of any individual loop can be altered without influencing the supercoiling of adjacent loops.
- The loops are thought to be held in place by RNA and protein molecules.
- Treatment with ribonuclease releases some of the loops, although it does not relax the supercoiling.
- Nicking the DNA with a topoisomerase relaxes the supercoiling but does not disrupt the loops.
- The supercoiled DNA that forms each loop is organized into bead like packets containing small, basic protein molecules, analogous to the histones of eukaryotic cells.
- DNA molecule is wrapped around particles of the basic protein.
- **Thus, from what we know so far, the bacterial chromosome consists of supercoiled DNA that is bound to small, basic proteins and then folded into looped domains.**



Organization of DNA in Eukaryotes

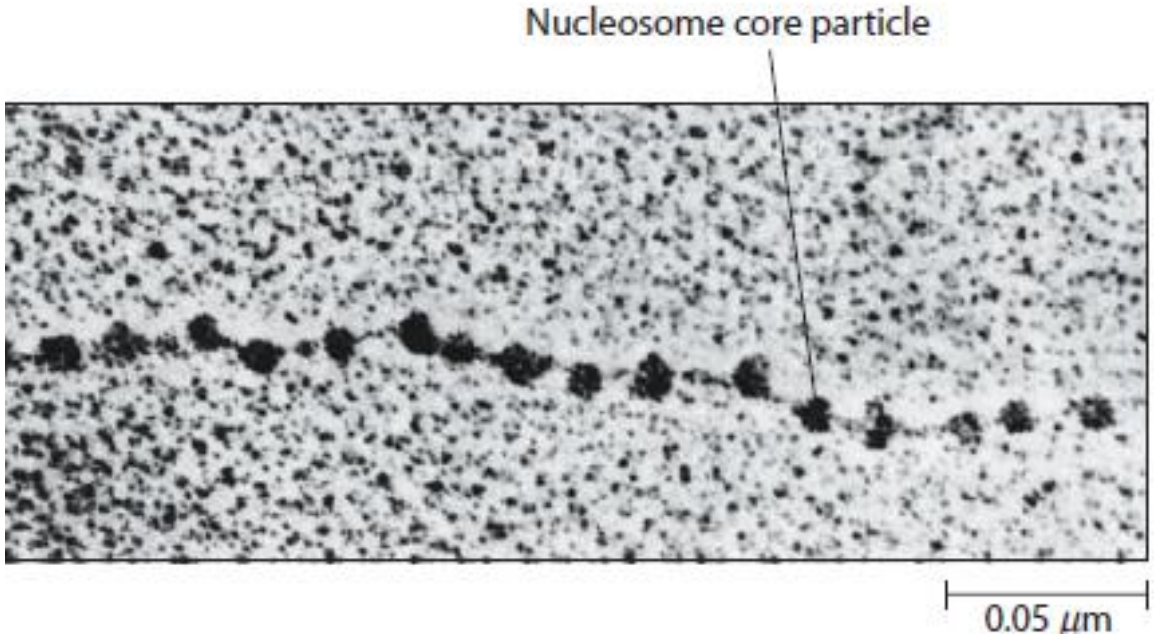
- **Eukaryotes Package DNA in Chromatin and Chromosomes**
- Nucleus itself is usually no more than 5–10 mm in diameter. DNA in a typical nucleus would measure 1 meter or more in length.
- DNA packaging becomes more complicated.
- “beads-on-a-string” appearance, in 1974, when Ada Olins and Donald Olins published electron micrographs of chromatin fibers isolated from cells.
- Dean Hewish and Leigh Burgoyne, discovered that rat liver nuclei contain a nuclease that is capable of cleaving the DNA in chromatin fibers.
- The molecular architecture of the nucleosome emerged from the work of Roger Kornberg, who was awarded a Nobel Prize in 2006 for a series of fundamental discoveries concerning DNA packaging and transcription in eukaryotes

Different Levels of Organization of Eukaryotic DNA :

- *Nucleosomes*
- Chromatin fibres
- *Solenoid structure*

Eukaryotic DNA

- Eukaryotes contain over 1,000 times the amount of DNA found in prokaryotes.
- Organizing or packing DNA is much more complex.
- A typical human cell contains 46 chromosomes, whose total DNA is approximately two meter in length.
- The packing of DNA in a chromosome represents a 10,000 fold shortening of its length from primary B-form DNA.
- In resting non-dividing eukaryotic cells, the chromosomal material is called **chromatin**.
- Chromatin is made up of **nucleosomes.**


Nucleosome core particle
0.05 μm