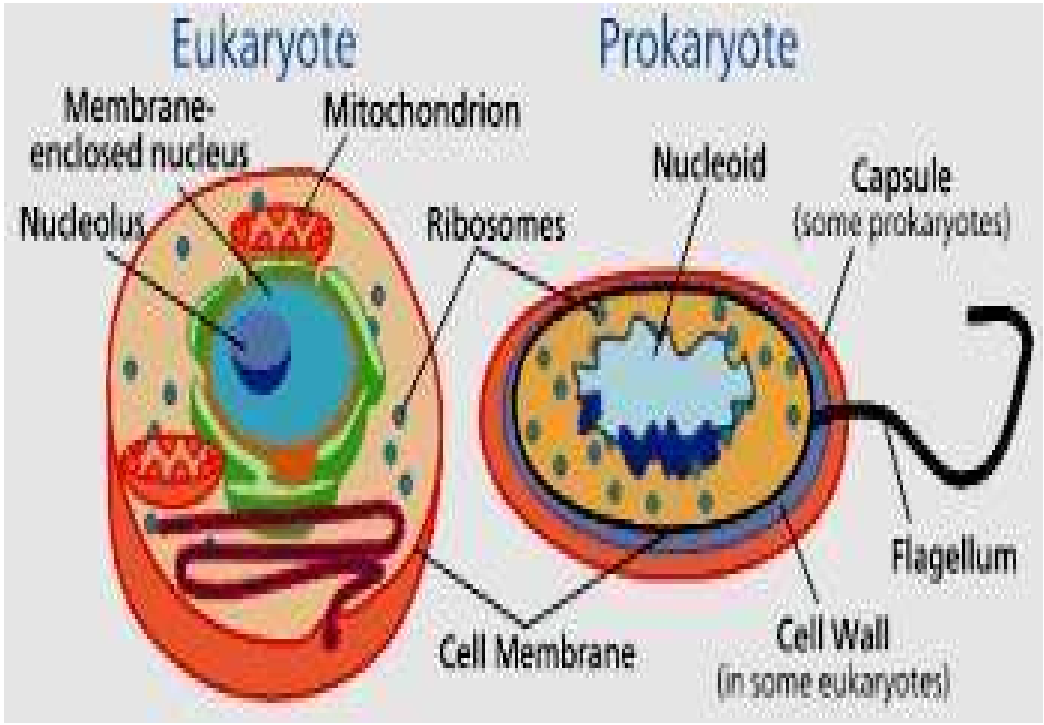
Genetic organization of Eukaryotes and Prokaryotes



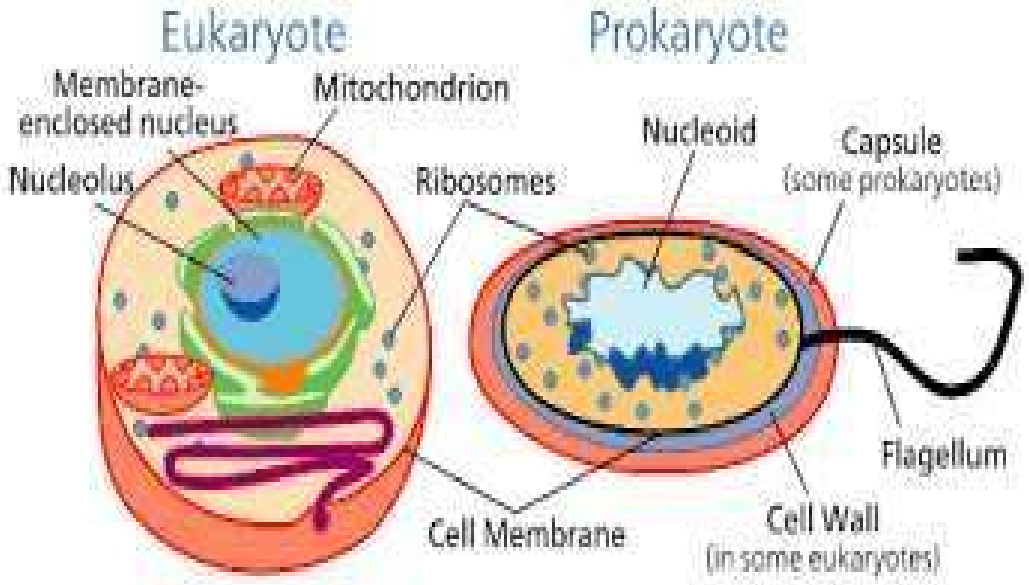
GENOME

Gene : A gene is the basic physical and functional unit of heredity. Genes are made up of DNA.

GENOME- entire collection of genes and all other functional and non functional DNA sequences in an organism in a haploid set of chromosomes.

It includes structural genes, regulatory genes and non functional nucleotide sequences

- Structural genes- DNA segments that code for some specific RNAs or proteins. Encode for mRNAs and tRNAs
- Functional sequences- Regulatory sequences- occur as regulatory elements (initiation sites, promoter sites, operatorsites,etc.)
- Nonfunctional sequences- Introns and repetitive sequences. Needed for coding, regulation and replication of DNA. Much more in number than functional sequences.

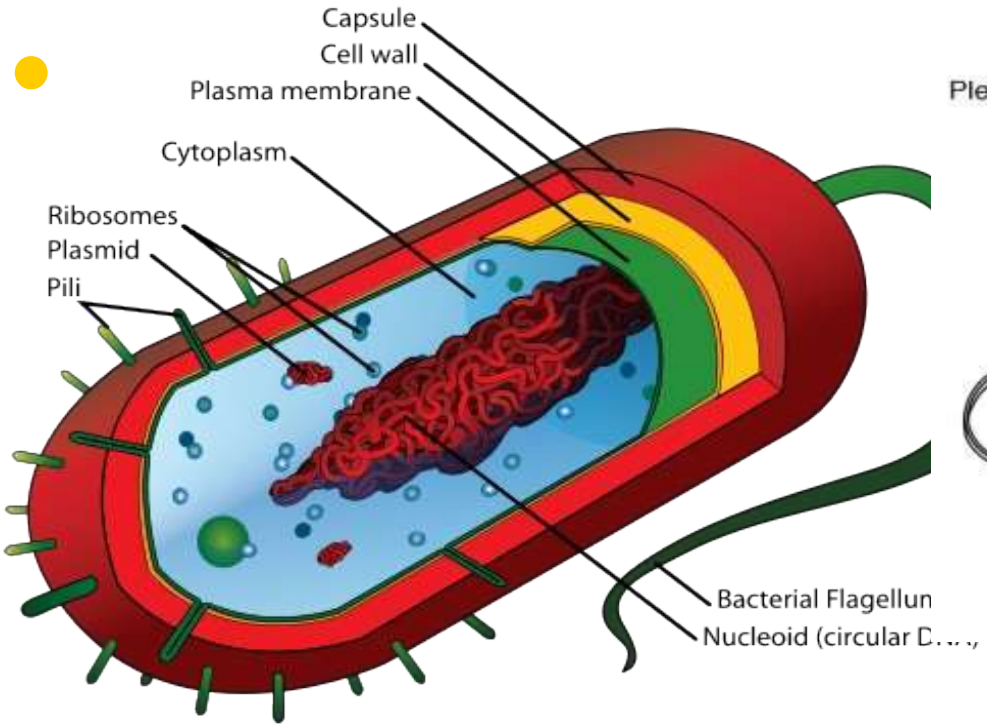


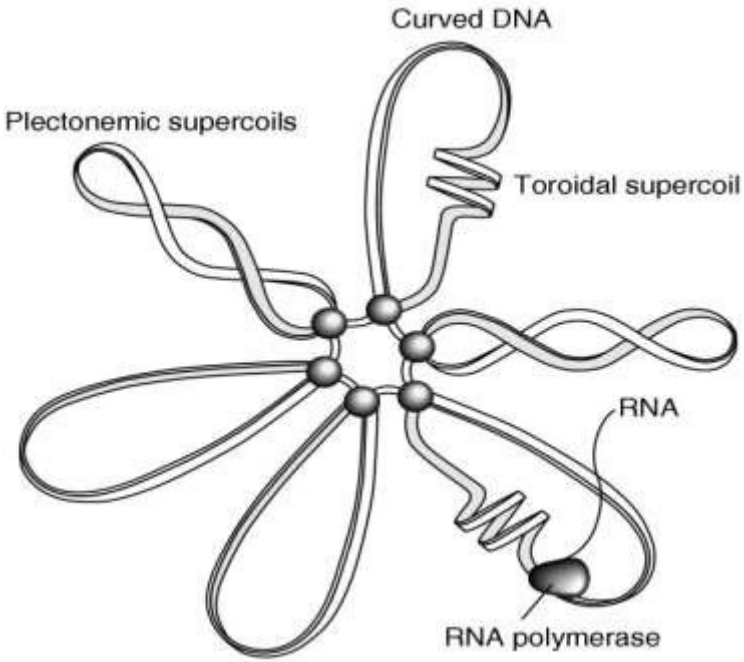
- In Prokaryotic cells- Genomic DNA forms a single circular chromosome, without basic proteins , lies in the cell cytoplasm in nucleoid region

- In Eukaryotic cells- DNA is associated with basic proteins(histones), form long chromatin fibers. Chromatin fibers form a network, enclosed in a double layered nuclear envelop, condenses into chromosomes during cell division

PROKARYOTIC GENOME

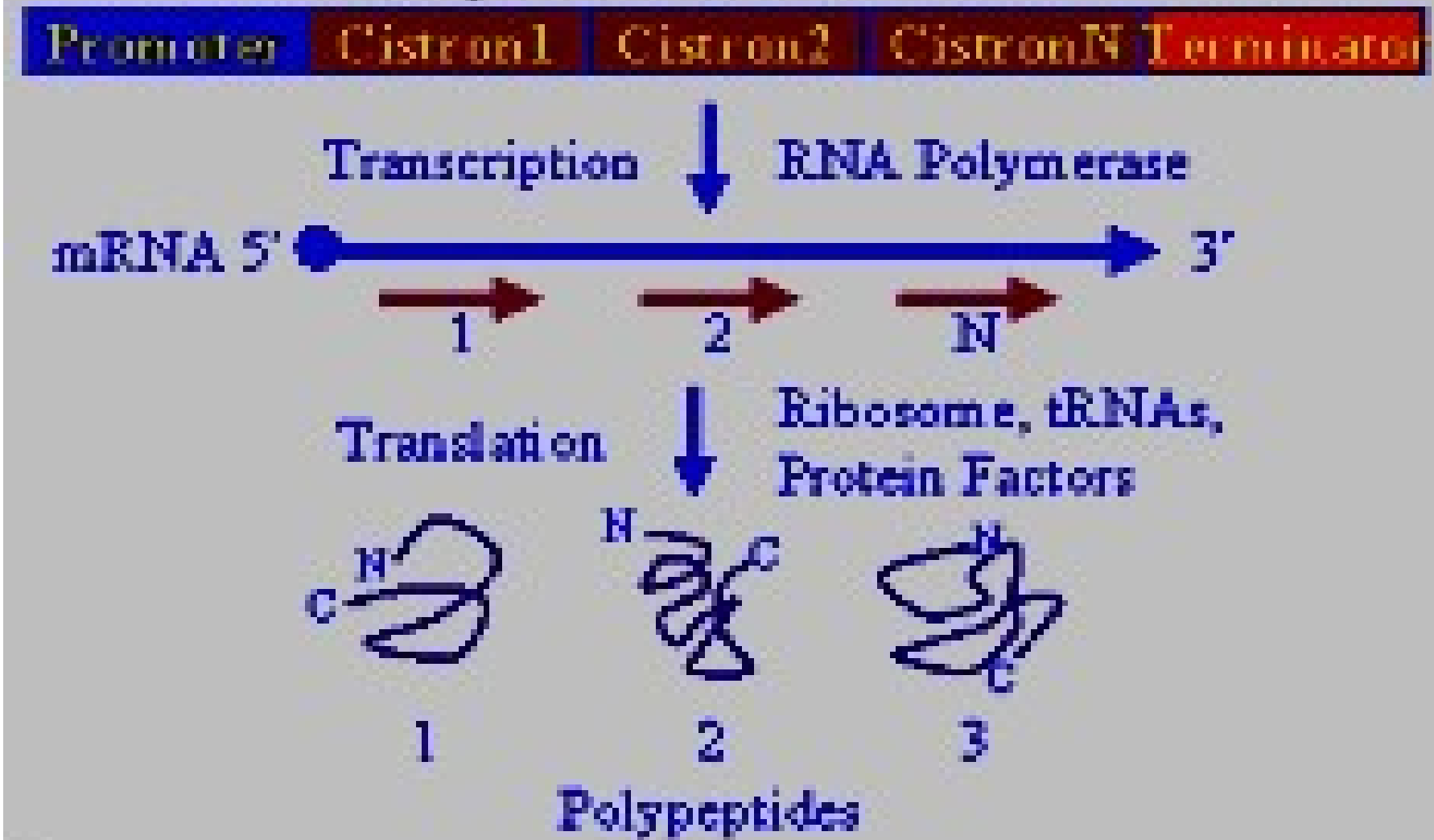
- **It is circular, double stranded piece of DNA**. Commonly referred to as NUCLEOID.
- Length varies widely but is generally few million base pairs.
- Nucleoid is composed of 60% DNA and small amounts of RNA and protein.
- Nucleoid proteins help to maintain the supercoiled structure of DNA.
- DNA supercoiling refers to over or under winding of a DNA strand.

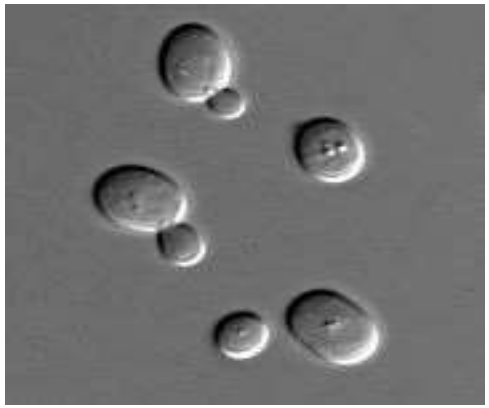




- It is important for DNA packing within all cells.
- 2 structures-toroid and plectoneme
- In prokaryotes, plectonemic super coils are predominant because of circular DNA and small amount of genetic material.

Prokaryotic Gene Expression





EUKARYOTIC GENOME

- *Saccharomyces cerevisiae* was the 1st eukaryote to have its complete genome sequence determined.
- The nucleus is heart of the cell, which serves as the main distinguishing feature of the eukaryotic cells. Nucleus contains many thread like coiled sructures remain suspended in the nucleoplasm which are known as chromatin substance'
- Genome is in the form of nucleoprotein complex called chromatin.
- Chromatin is made up of DNA,proteins, RNA and is dispersed in nuclear matrix form of network of chromatin threads
- The major proteins involved in chromatin are histone proteins; although many other chromosomal proteins have prominent roles too.
- The functions of chromatin is to package DNA into smaller volume to fit in the cell, to strengthen the DNA to allow mitosis and meiosis and to serve as a mechanism to control gene expression and DNA replication.

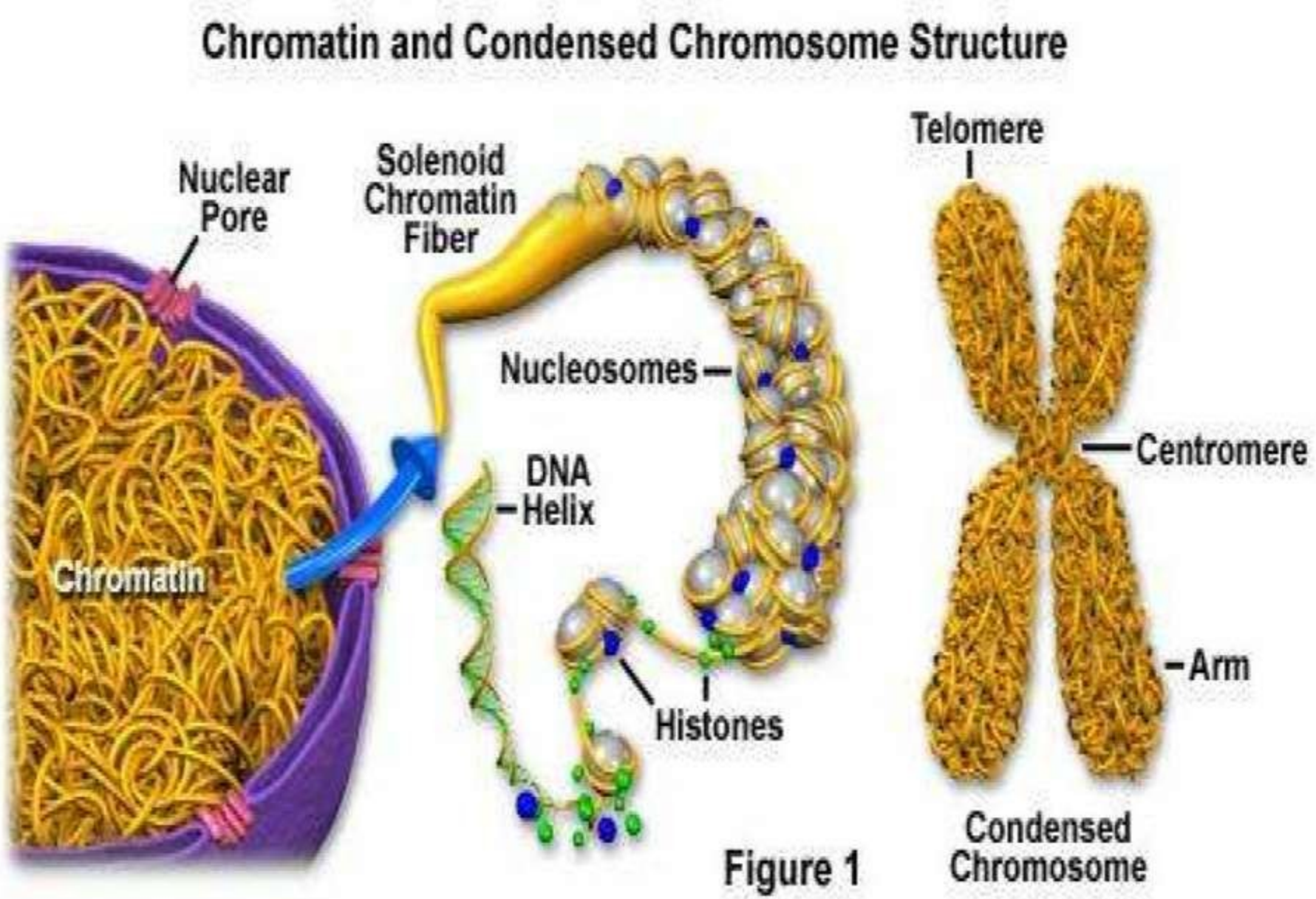
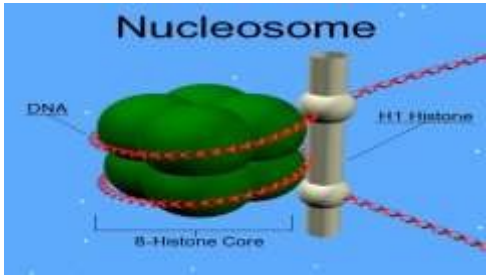

Chromatin and Condensed Chromosome Structure
Nuclear Pore
Solenoid Chromatin Fiber
Telomere
Nucleosomes
Centromere
DNA Helix
Chromatin
Arm
Histones
Condensed Chromosome

Figure 1

Organization of Chromatin



Structural Proteins- Histones (Packing proteins):

- main structural proteins found in eukaryotic cells
- low molecular weight basic proteins with high proportion of positively charged amino acids, bound to DNA along most of its length, bound to DNA along most of its length,
- the positive charge helps histones to bind to DNA and play a crucial role in packing of long DNA molecules.

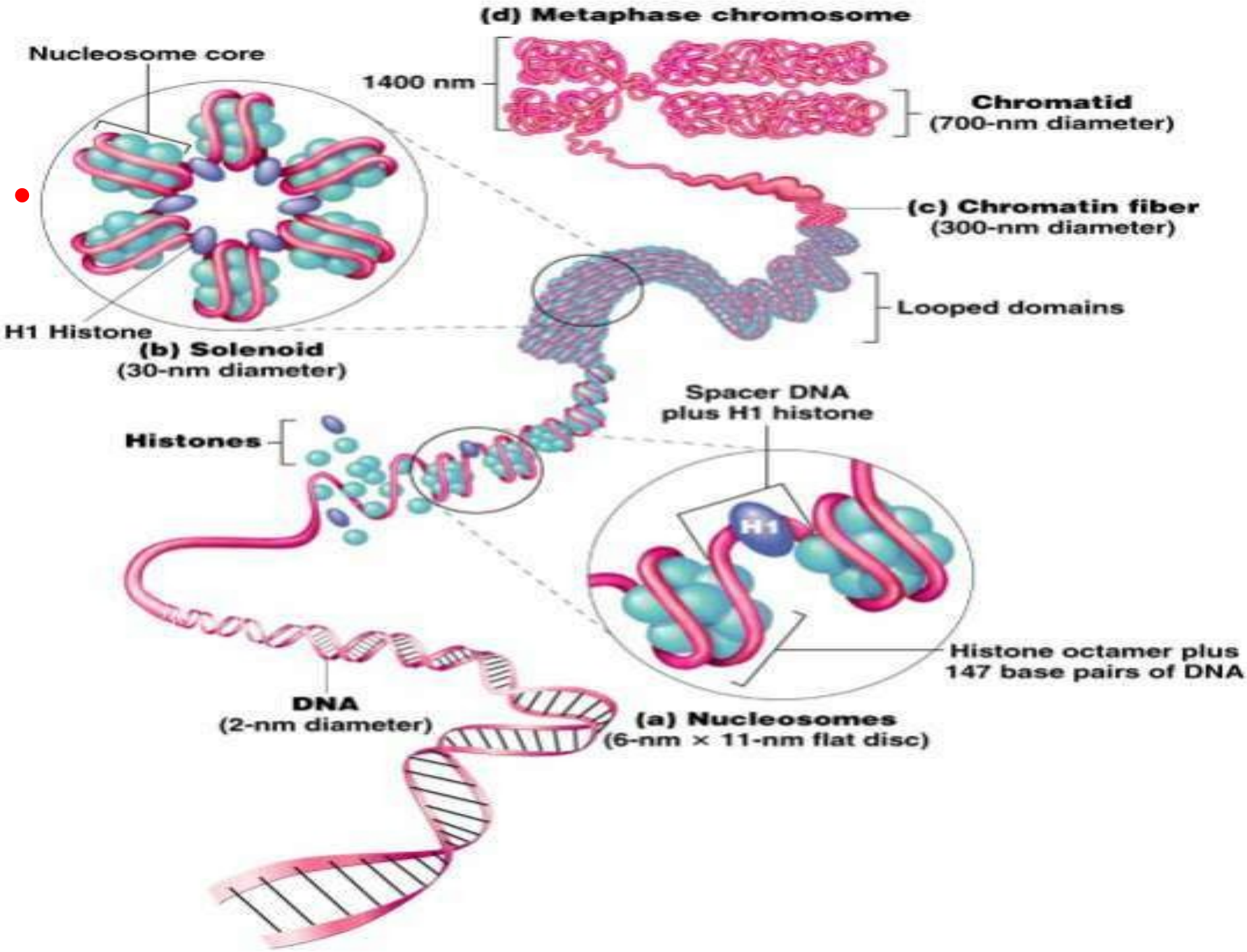
Functional Proteins- Non- Histones:

associated with gene regulation and other functions of chromatin.

Nucleosomes are condensed several times to form the intact chromatids.

- A nucleosome is the basic structural unit of DNA packaging in eukaryotes. The structure of a nucleosome consists of a segment of DNA wound around eight histone proteins and resembles thread wrapped around Core particles are connected by stretches of linker DNA

- Nucleosome has octamer of histones H2A,H2B,H3,H4 & a strand of DNA having 146 base pair wrapped tightly around this.
- DNA strand linking 1 nucleosome to another is called linker DNA


(d) Metaphase chromosome
Nucleosome core
1400 nm
Chromatid
(700-nm diameter)
(c) Chromatin fiber
(300-nm diameter)
Looped domains
H1 Histone
(b) Solenoid
(30-nm diameter)
Spacer DNA
plus H1 histone
Histones
H1
Histone octamer plus
147 base pairs of DNA
DNA
(2-nm diameter)
(a) Nucleosomes
(6-nm × 11-nm flat disc)

Chemical composition of chromatin

- DNA= 20-40 %- most important chemical constituent of chromatin
- RNA=05-10 %-associated with chromatin as;
  - Ribosomal RNA-(rRNA)
  - Messenger RNA- (mRNA)
  - Transfer RNA- (tRNA)

- Proteins=55-60%-associated with chromatin as;

Histones: very basic proteins, constitute about 60% of total protein, almost 1:1 ratio with DNA.

FIVE TYPES: H1, H2a, H2b, H3 and H4

:

- Non-Histones: They are 20% of total chromatin protein

- 50% structural contractile proteins (actin, L & B tubulin and myosin)- function during chromosome condensation and in the movement of chromosomes during mitosis and meiosis.

- 50% include all enzymes and co-factors –involved in replication, transcription and regulation of transcription.

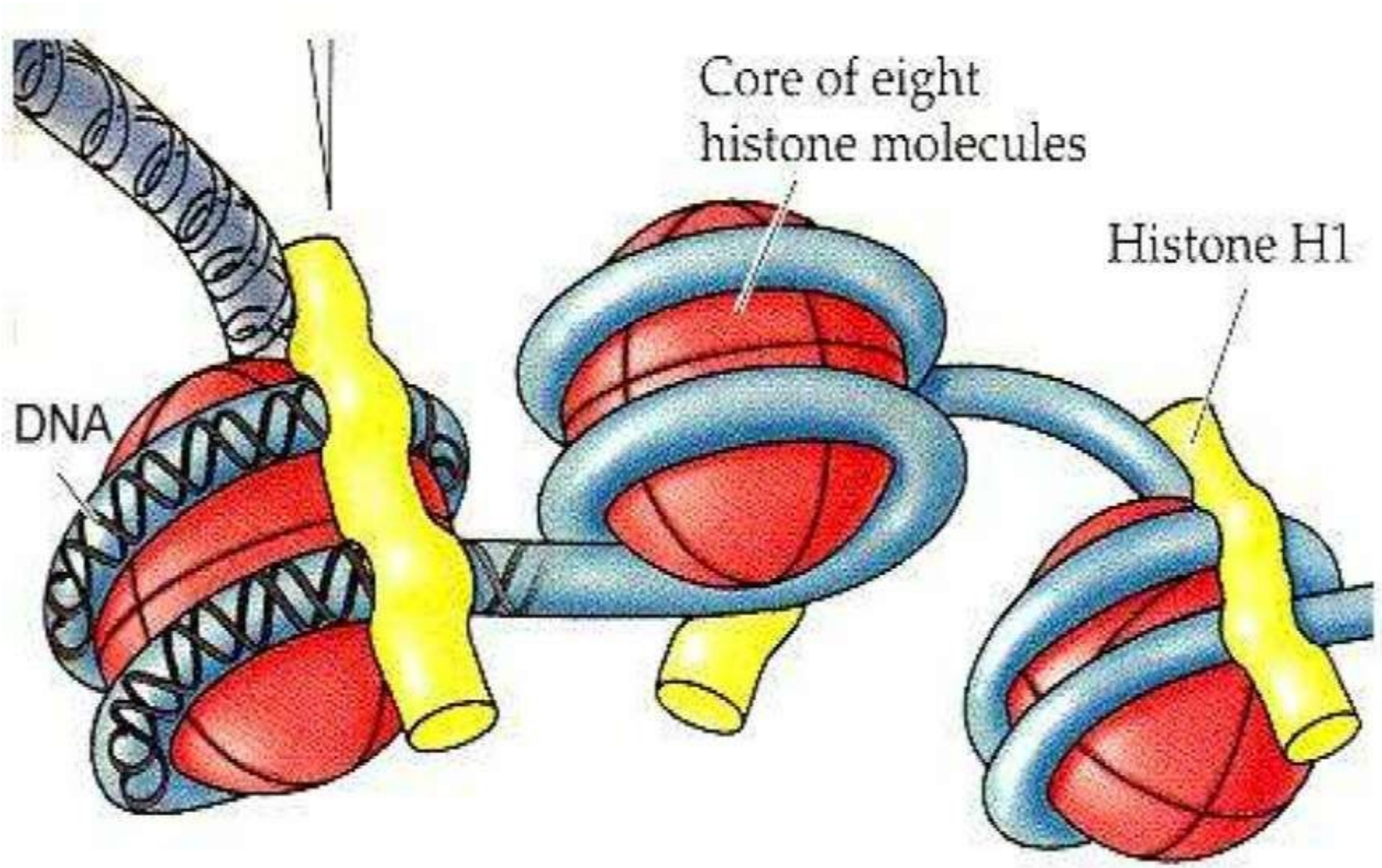
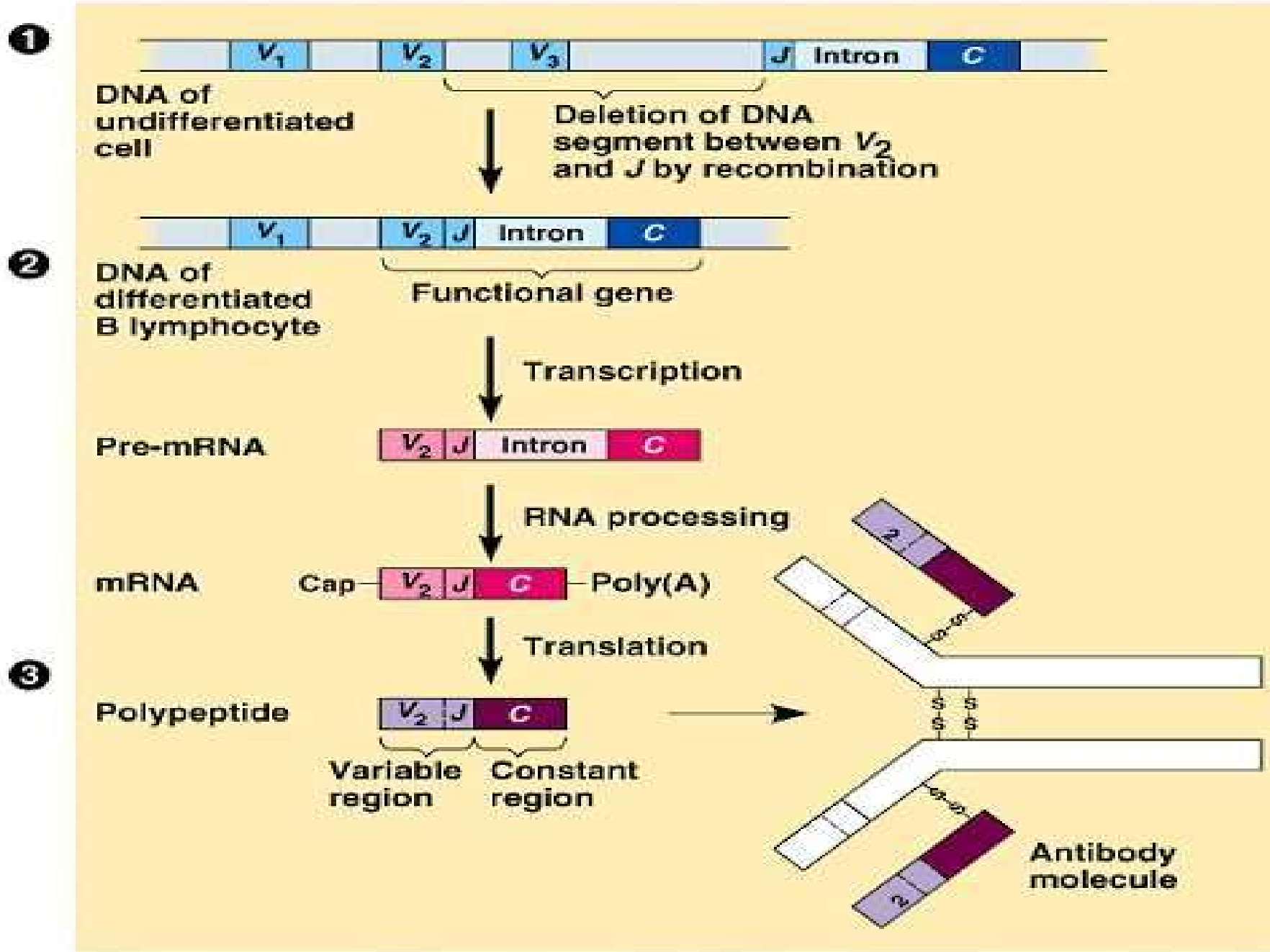
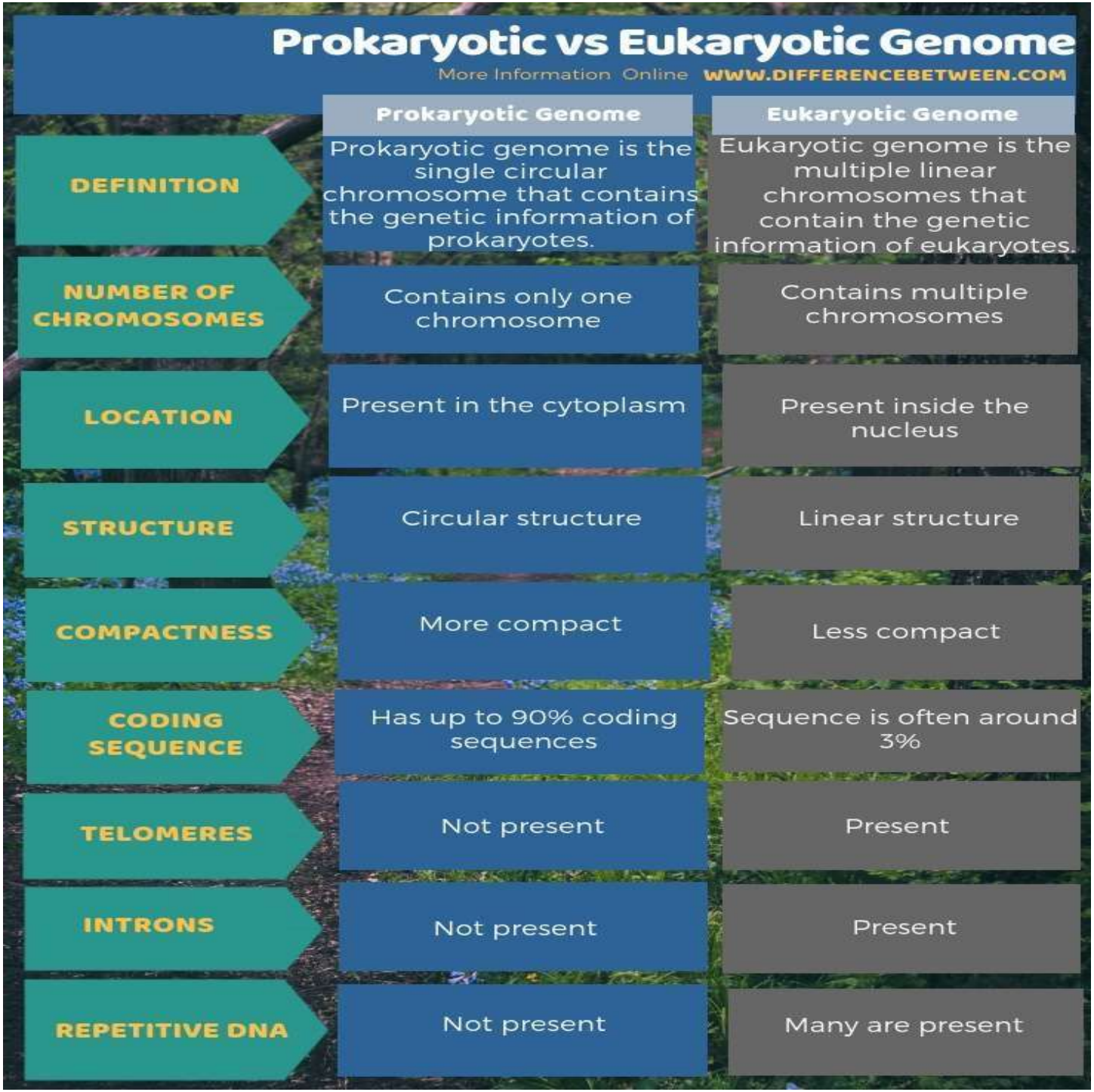


Fig.. Nucleosome with histone H_1




Prokaryotic vs Eukaryotic Genome
More Information Online WWW.DIFFERENCEBETWEEN.COM
Prokaryotic Genome
Eukaryotic Genome
DEFINITION
Prokaryotic genome is the single circular chromosome that contains the genetic information of prokaryotes.
Eukaryotic genome is the multiple linear chromosomes that contain the genetic information of eukaryotes.
NUMBER OF CHROMOSOMES
Contains only one chromosome
Contains multiple chromosomes
LOCATION
Present in the cytoplasm
Present inside the nucleus
STRUCTURE
Circular structure
Linear structure
COMPACTNESS
More compact
Less compact
CODING SEQUENCE
Has up to 90% coding sequences
Sequence is often around 3%
TELOMERES
Not present
Present
INTRONS
Not present
Present
REPETITIVE DNA
Not present
Many are present

Thank You