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UNIT 1 Organisation of Chromosomes

1.1. PROKARYOTIC CHROMOSOMES

The Prokaryotic (bacterial) genetic material is usually concentrated in a specific clear region of the cytoplasm called nucleoid. The bacterial chromosome is a single, circular, double stranded DNA molecule mostly attached to the plasma membrane at one point. It does not contain any histone protein

Escherichia coli DNA is circular molecule 4.6 million base pairs in length containing, 4288 annotated Protein coding genes, seven ribosomal RNA (rRNA) operons, and 86 Transfer RNA (tRNA) genes

Besides the chromosal DNA many bacteria may also carry extra chromosomal genetic elements in the form of small, circular and closed DNA molecules called Plasmids. They generally remain floated in the cytoplasm and bear different genes based on which they have been studied. Some of the different types of plasmids are F plasmids, R plasmids virulent plasmids, metabolic plasmids etc.

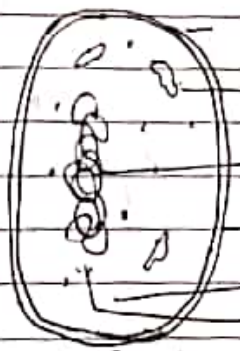

Fig showing Bacterial DNA

The Prokaryotes are very small unicellular organisms that do not contain nuclear envelop, mitochondria, endoplasmic reticulum mitotic apparatus etc and they generally divide by fission. Bacterial have a rigid cell wall which surrounds their cytoplasmic membrane. Their cytoplasm consists of ribosomes, mesosomes and several granular inclusions, about 1/5 of the cell volume is occupied by their genetic material the DNA. The most common example of Prokaryotes are Bacteria.

Bacterial cells do not contain a typical nucleus, but two or more discrete cell body called nucleoids. The bacterial genome is confined to this nucleoid which is more of less compact structure without any membrane.

Bacterial chromosomes — Bacterial chromosome is a double stranded circular DNA ranging from 1100 Pm to 1400 um in length. E coli contains a 1.3 mm long DNA. Such a long DNA molecule is greatly folded and to get accommodated into a small space, The bacterial chromosomes is folded into loops or domains about 100 in number.

A chromosomal domain may be defined as a discrete structural entity independent of other domains.

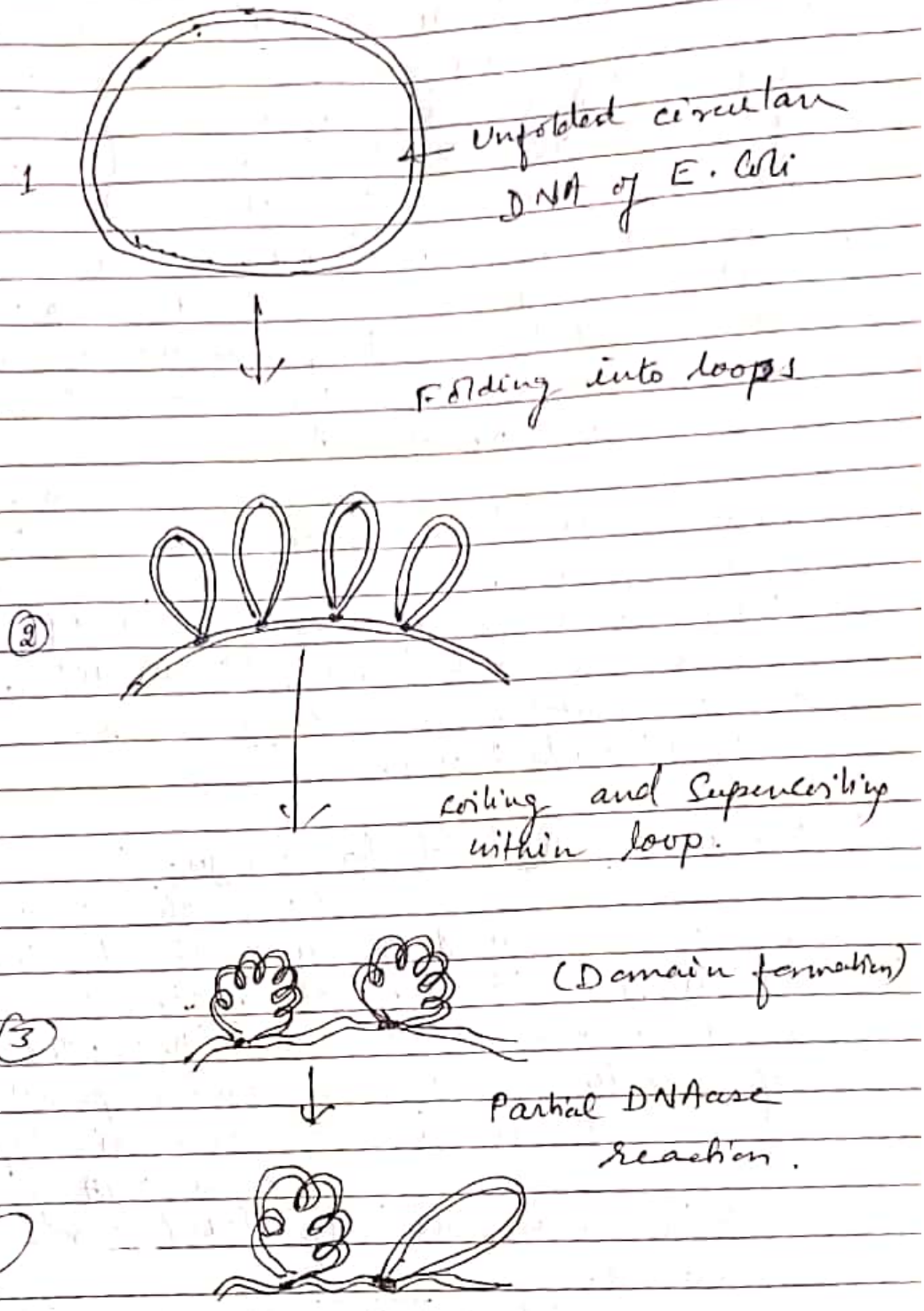

Fig - A model of the genome of E. Coli, coiling and supercoiling and formation of Domains, effect of endonuclease in one domain that becomes unfolded and enlarged while the other domains remains unaffected.

The different domains maintain a different degrees of Supercoiling. The ends of the loop are bound in such a way which does not allow rotational events to propagate from one domain to another. If an endonuclease puts a nick or cut in DNA strand of one domain this loop becomes larger due to uncoiling without affecting the other domain. Each domain consists of about 40 Kbp of DNA.

In E. coli a number of Proteins have been isolated similar to histone proteins of Eukaryotic chromosomal Protein. These protein are HU, IHF (Integration host factor), HI (H-NS) and R. These proteins are involved in nucleoid condensation.

Replication of Bacterial chromosomes —

Bacterial chromosome is single replicon. Autoradiographic studies have shown that it replicates bidirectionally in a semi-conservative manner. The rate of replication is 50,000 base pairs per minute faster that Eukaryotic replication.

Thus the DNA of bacteria is a covalently closed circular molecule.

Each bacterial cell normally has a single chromosome containing a single circular DNA molecule.

There is a coiling and supercoiling in this DNA molecule to get accumulated in a small space.

States of circular DNA in a prokaryotic cell.

(1) Relaxed — A circular DNA molecule without any supercoiling is said to be in a relaxed state. In this state the stranded right handed DNA double helix contains about 10 nucleotide pairs/turn of the helix.

(2) Bubble → If one or two strands are rotated through 360° to unwind one complete turn of helix and cut ends are released the circular DNA may produce a region of unpaired bases called a bubble.

(3) Super coil → The base pair may twist in a direction opposite to that of unwinding and produces a negatively supercoiled circular DNA molecule.

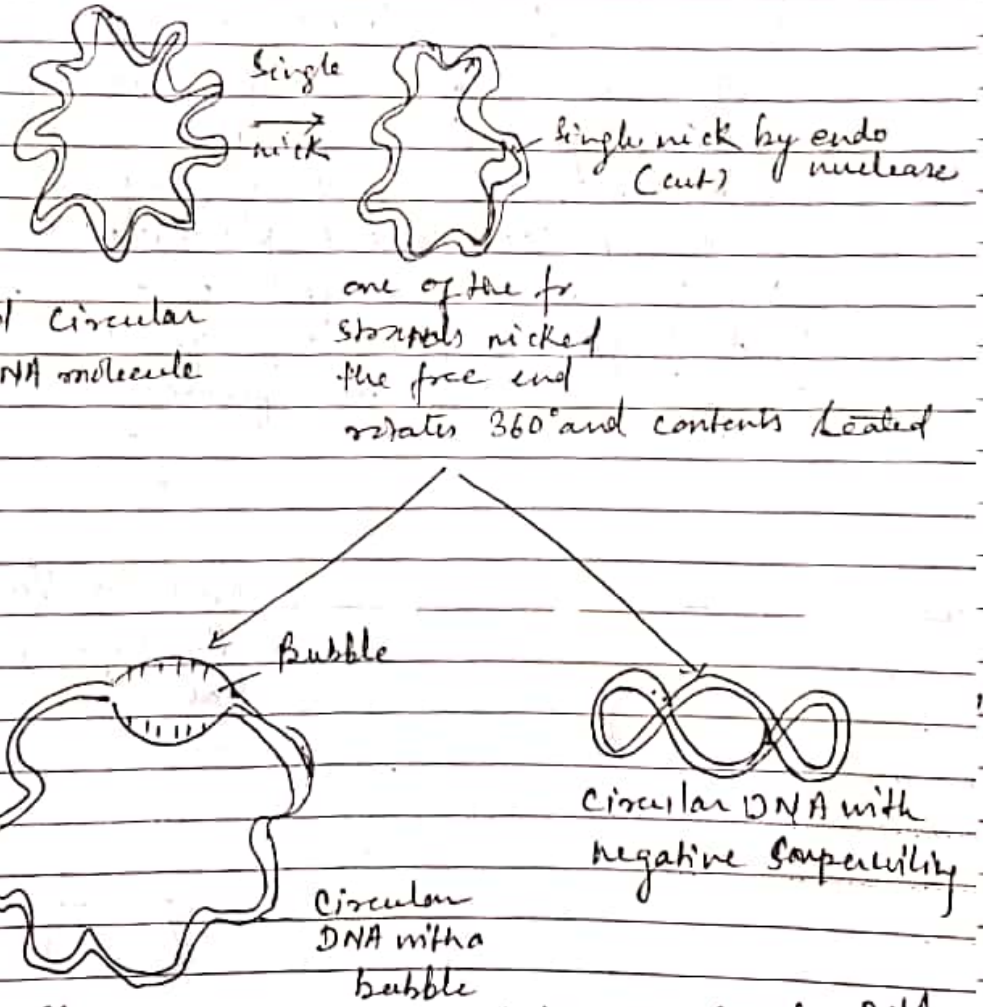

Fig - Showing different states of circular DNA

Plasmids- A plasmid is a small, circular double stranded DNA molecules that is distinct from a cell's chromosomal DNA. Plasmids naturally exist in bacterial cells and in some eukaryotes.

Sometimes the genes carried in plasmids provide bacteria with genetic advantage such as antibiotic resistance. Plasmids have a wide range of lengths, from one thousand base pairs to hundred of thousands base pair.

Bacterial cell during it division divides all the plasmids contained in the cell and copied in such a way that each daughter cell recieved a copy a plasmid. Bacteria also transfers plasmid by a process called conjugation.

Plastids are used in microbiology as tool to clone, transfer and manipulate genes (Vectors). It can be used to insert DNA fragments to a plasmid vector for making recombinant plasmid. This plasmid can be used as a factories to copy DNA fragments in large quantities through a process called transformation.

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