Describe the differences between prokaryotic and eukaryotic genomes

There are many differences in the composition and storage of genetic material in prokaryotes and eukaryotes. Chromosomes in prokaryotes consist of a single nucleic acid molecule which can be either DNA or RNA. There is comparatively little genetic material for example E. coli genome is 1200 micrometres while a single human chromosome is between 12000 and 73000 micrometers in size. Unlike in eukaryotes the genetic material in viral prokaryotes can be single or double stranded RNA or DNA. It can also be linear or circular. Only in viruses can the genetic material be RNA.

For example in HIV the virus can infect a host cell and use an enzyme transciptase to sequence a DNA molecule which is then incorporated into the genome of the cell to produce viral proteins or genetic material. Like eukaryotic chromosomes bacterial chromosomes are double stranded DNA and can be associated with proteins. These proteins are histones HU and H1 which are positively charged and are attracted to the negative charges on the phosphate molecules of the DNA. Bacterial and viral genetic material is often supercoiled.

Bacterial DNA is circular and forms structures called plasmids which condense into structures known as nucleoids. Eukaryotic chromosomes differ in the quantity of genetic material and its organisation. Eukaryotic chromosomes contain a lot more genetic material. They often have more than one chromosome. The chromosomes are separated from the intracellular environment by the nuclear membrane. The genetic material is packaged with proteins known as histones of which there are 5 ; H1 H2A H2B H3 and H4. The DNA and octamer of histones forms a nucleosome.

The first level of packing reduces the entire double helix DNA by a third of its length. The further packing of DNA forms solenoid fibres which then form chromatin which packs into a chromatid. Chromosomes have four chromatids. Each chromosome is 1400nm in diameter. Unlike eukaryotic genes prokaryotic genes are transcribed and translated as a single unit and there is no processing after the transcription phase. More than one gene can be transcribed together as a single unit which produces polycistronic mRNA. Prokarotes contain operons. The promoters of prokaryote genes have two distinct sequences.

TATA which is located 10 nucleotides upstream from the transcription start site and a TTGACA which is located 35 nucleotides upstream from the start site for transcription. Gene density is high, one gene per kilo base. Typically one per cent of the genome is non-coding. Many genes are polycistronic and introns are extremely rare. genome size increases with organism complexity. Unlike in prokaryotes eukaryotic mRNA transcripts need processing. This is because of the presence of introns, non-coding DNA. Processing includes 5′ caps and 3’poly (A) tails to complete the RNA splicing.

The gene density decreases with increasing organism complexity. There is a shift from polycistronic to monocistronic transcripts and the intron density and size increases with increasing organism complexity. The difference between genomes is due to increased amounts of repetitive DNA sequences. For example in humans half the human genome is repetitive DNA.

In eukaryotic genomes much of the repetitive DNA consists of transposons which are sequences of DNA which has moved from one location to another

in the genome There are two classes short interspersed elements e. g. Alu family and long interspersed elements e. g. L1 family. There are two classes of repetitive DNA satellite DNA, short sequences repeated many times, and tandem repeats, sequences of DNA that is repeated in tandem. The repetitive DNA can also consist of mutigene families which are families of genes consisting of identical DNA sequences that are clustered tandomly or families if related genes with different DNA sequences and different functions e. g glob in gene superfamily. Bacteria have the minimum number of genes for self-reproducing organisms.

Gene expression is controlled by regulatory mechanisms which are different in prokaryotes and eukaryotes. The majority of regulation of gene expression in prokaryotes is at the transcription level. Regulating gene expression usually involves inhibiting polymerase binding to the promoter. In prokaryotes genes that code for enzymes with related functions are organised and transcribed as a single unit: operon. Regulation focuses on inducible or repressible systems which promote or prevent transcription of the operon. Dissimilarly in eukaryotic gene expression regulation can occur before and after transcription and after translation.

For example before transcription chromatin can be modified, folding can make the gene available for polymerase to bind. After transcription RNA modification can occur and after translation cleavage or chemical modification of the protein or degradation of the protein can occur. histones can be modified chemically or structurally which effectively controls the availability of the DNA for transcription. In prokaryotes the binding of the polymerase to the promoter is controlled while in eukaryotes the

transcription factors are controlled in an attempt to mediate gene expression. Promoters, enhancers and silencers are involved in gene regulation.