Chromosomes

The genome is organized into discrete elements known as **chromosomes**

bacteria contain a single, unpaired (i.e., haploid) chromosome.

The bacterial chromosome contains all genes essential for viability and exists as a double-stranded, closed circular, naked (i.e., not enclosed within a membrane)

Chromosomes

The molecule is extensively folded and twisted (i.e., supercoiled)

The fact that the linearized, unsupercoiled chromosome of the bacterium *Escherichia coli* is about 1300 µm in length but fits within a 1 µm × 3 µm cell attests to the extreme compactness that the bacterial chromosome must achieve.

Chromosomes

In contrast to the bacterial chromosome, the chromosomes of parasites and fungi number greater than one per cell, are linear, and are housed within a membrane structure known as the nucleus.

This difference is a major criterion for classifying **bacteria as prokaryotic organisms**, while classifying **fungi and parasites as eukaryotes.**

Chromosomes

The genome of viruses may be referred to as a chromosome, but the DNA (or RNA) is contained within a protein coat rather than within a cell.

Nonchromosomal Elements of the Genome

Many genes are also located on plasmids and **transposable elements.**

Both of these are able to replicate and encode information for the production of various cellular products.

They are not as stable as the chromosome and may be lost during cellular replication, often **without severe detrimental effects on the cell.**

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Plasmids exist as “miniature” chromosomes in being double-stranded, closed, circular structures with size ranges from 1 to 2 kilobases up to 1 megabase or more.

The number of plasmids per bacterial cell varies extensively, and each plasmid is composed of several genes.

whereas others encode products that **provide a survival edge such as determinants of antimicrobial resistance.**

Unlike most chromosomal genes, **plasmid genes do not usually encode for products essential for viability.** Plasmids, **in whole or in part, may also become incorporated in the chromosome**

Transposable elements

Transposable elements are pieces of DNA that move from one genetic element to another, from plasmid to chromosome or vice versa.

Unlike plasmids, they do not exist as separate entities within the bacterial cell because they must either be incorporated into a plasmid or the chromosome.

The two types of transposable elements are:

insertion sequence (IS)

Transposons

These extrachromosomal elements play a key role in the exchange of genetic material throughout the bacterial, including genetic exchange among clinically relevant bacteria.

REPLICATION AND EXPRESSION OF GENETIC INFORMATION

Replication

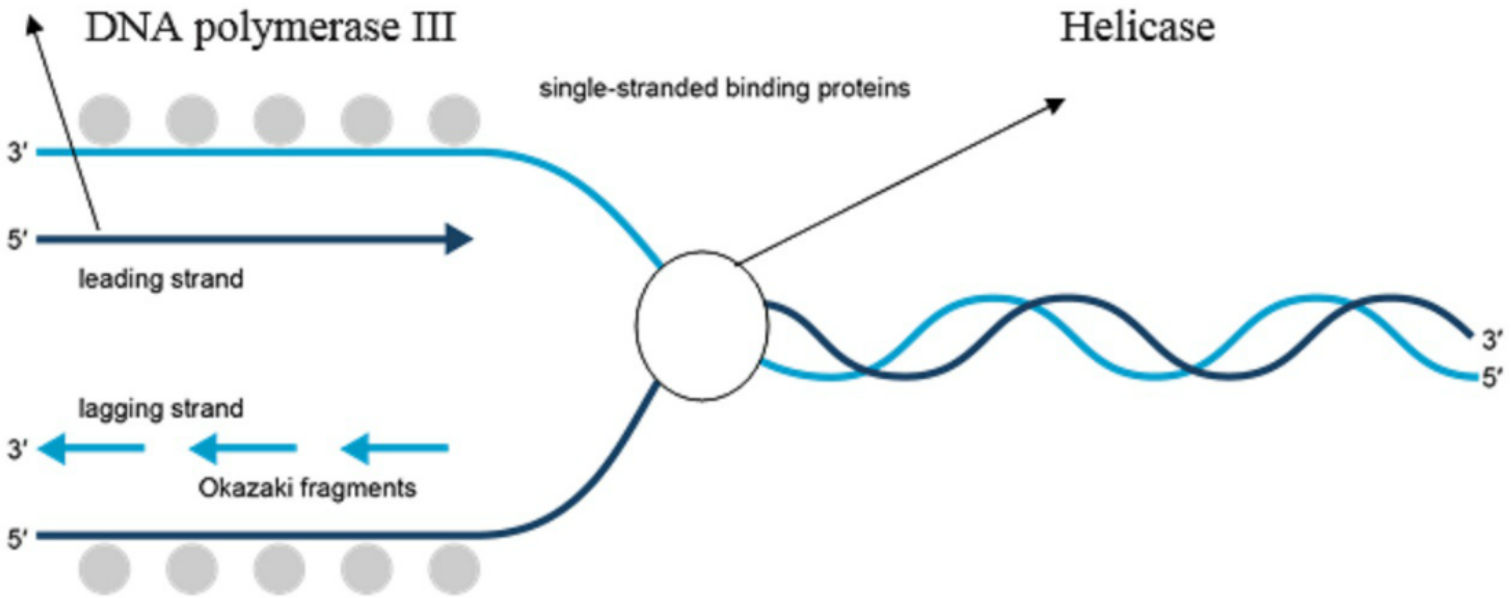
Replication is a complex process that is mediated by various enzymes, such as DNA polymerase and cofactors; replication must occur quickly and accurately. For descriptive purposes, replication may be considered in four stages:

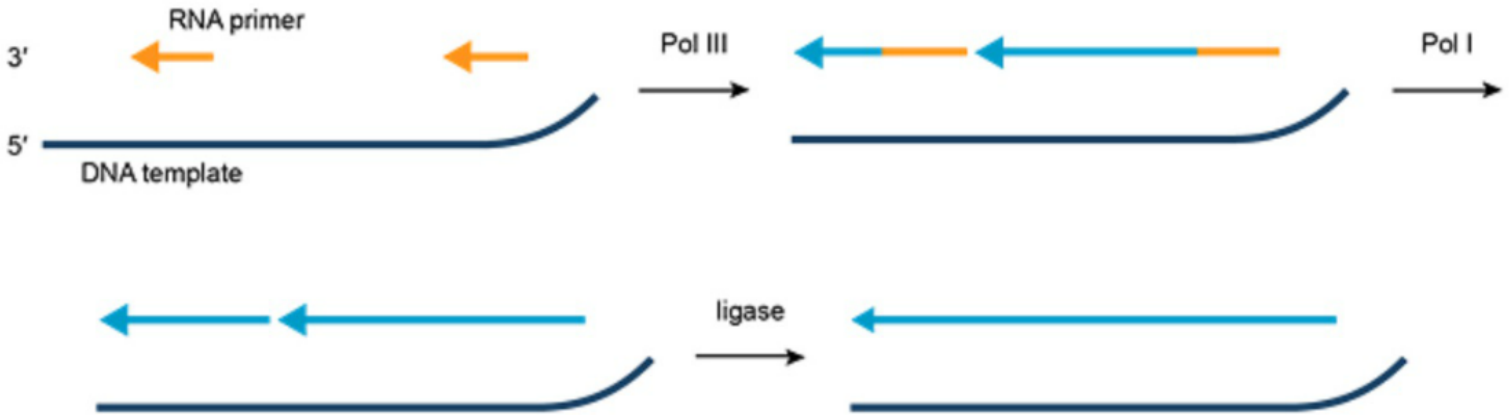
1. Unwinding or relaxation of the chromosome's supercoiled DNA

2. disconnecting, the complementary strands of the parental DNA so that each may serve as a template (i.e., pattern) for synthesis of new DNA strands

3. Synthesis of the new DNA strands

4. Termination of replication with release of two identical chromosomes, one for each daughter cell


DNA polymerase III
Helicase
single-stranded binding proteins
3′
5′
leading strand
lagging strand
3′
Okazaki fragments
5′
3′
5′

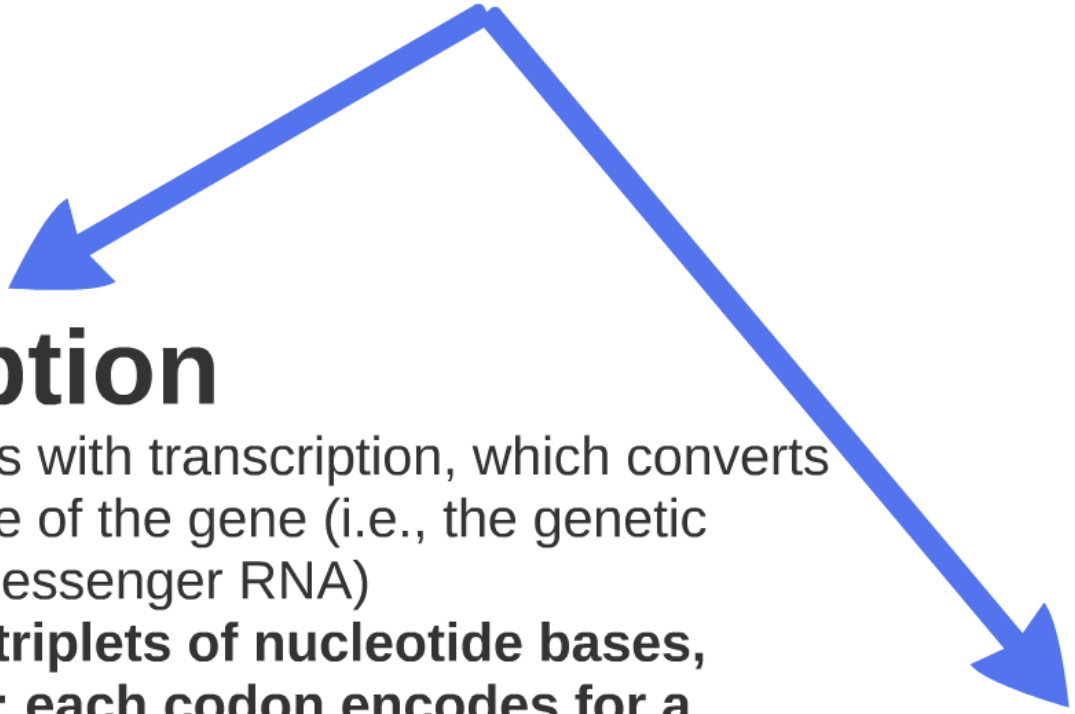

RNA primer
3′
5′
DNA template
Pol III
Pol I
ligase

I

Expression of Genetic Information

Gene expression is the processing of information encoded in genetic elements (i.e., chromosomes, plasmids, and transposons) that results in the production of **biochemical products.**

Expression of Genetic Information



transcription

Gene expression begins with transcription, which converts the DNA base sequence of the gene (i.e., the genetic code) into an mRNA (messenger RNA)

The code consists of triplets of nucleotide bases, referred to as codons; each codon encodes for a specific amino acid.

translation

involves three steps: initiation, elongation, and termination. Following termination, bacterial proteins often undergo posttranslational modifications as a final step in protein synthesis.

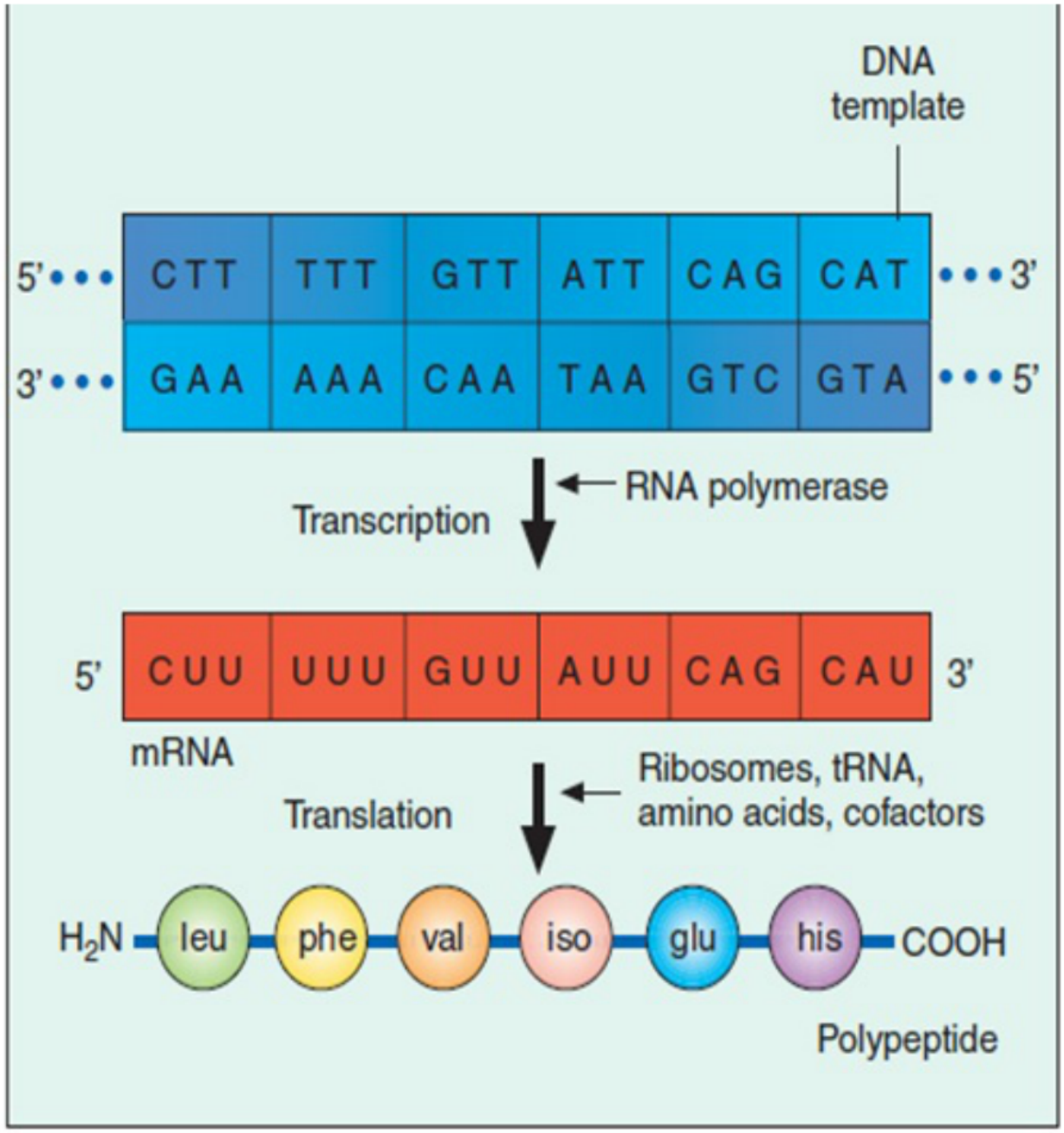
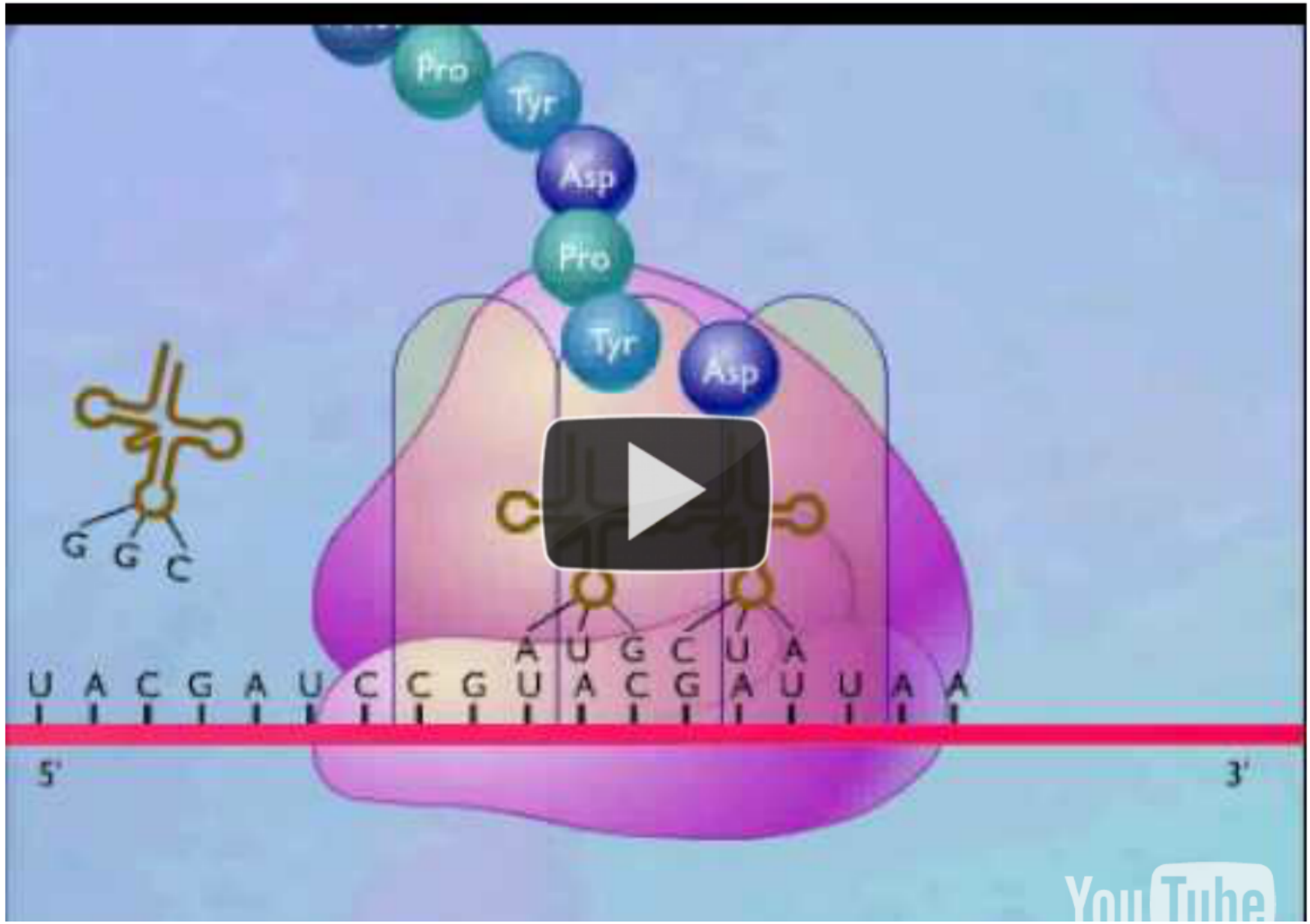


Figure 2-5 Overview of gene expression components; transcription for production of mRNA and translation for production of polypeptide (protein).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