**Module 6 – Microbial Genetics**

**Chapter 8**

**Structure and function of the genetic material**

* Genetics – science of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Study of what genes are, how they determine the characteristics of an organism, how they carry information, how the information is copied, how information is passed on to subsequent generations and between organisms
* Genome: all the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a cell
  + Includes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Genomics: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, characterization of genomes
* Chromosomes: a structure that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the \_\_\_\_\_\_\_
  + Physically carries the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, genes
  + Bacteria typically have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* DNA is twisted and *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* to fit into cell
  + DNA is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ longer than entire cell
* Genes: segments of DNA that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Genetic code: the set of rules that determines how a nucleotide sequence is converted into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of nucleotides provides the information for making proteins
* Much of anabolism is making \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + When product is made from a gene, the gene is *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*
* Genotype: an organism’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + The information \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Represents *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* characteristics
* Phenotype: and organism’s \_\_\_\_\_\_\_\_\_\_\_\_\_ properties
  + Eg, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Phenotype is the display of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Genotype is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Phenotype is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**DNA**

* Polymer of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:
* Strands are held together by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_
* Strands are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**DNA Replication**

* One *\_\_\_\_\_\_\_\_\_\_\_\_* DNA molecule converted into 2 identical *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* molecule
  + Parental DNA strand acts as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Process of DNA replication*

* Double stranded DNA molecule unwound by *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* enzyme
* Exposed bases matched up with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in cytoplasm
* *DNA polymerase* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to forming DNA molecule
* Each new DNA molecule contains one \_\_\_\_\_\_\_\_\_\_\_\_ strand, one \_\_\_\_\_\_\_\_\_\_\_\_ strand 🡪 *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* replication

**RNA and Protein Synthesis**

* Genetic information from DNA follows the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”
  + \_\_\_\_\_ is used to make \_\_\_\_\_, which is used to make \_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_ synthesis
* \_\_\_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_ synthesis

*Transcription*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_
  + Using \_\_\_\_\_\_\_\_\_ as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recall, RNA is \_\_\_\_\_\_\_\_\_\_\_\_\_\_ stranded, uses \_\_\_\_\_\_ instead of T
* Three kinds of RNA:
  + Ribosomal RNA, rRNA: \_\_\_\_\_\_\_\_\_\_\_\_\_ part of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Transfer RNA, tRNA: involved in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Messenger RNA, mRNA: carries \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for making \_\_\_\_\_\_\_\_\_\_\_\_
* mRNA is synthesized from a gene by enzyme called *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*
* Transcription begins when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ binds to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sequence
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ joins \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into new \_\_\_\_\_\_\_\_\_\_\_\_\_\_ strand using \_\_\_\_\_\_\_\_\_\_\_ as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + New \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to DNA template
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ binds to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_ DNA
* RNA is synthesized by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with the nucleotides on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of DNA
* Transcription continues until RNA Polymerase reaches the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are released, and the \_\_\_\_\_\_\_\_\_\_\_\_\_ re-forms

*Translation*

* “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” the “language” of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into “language” of \_\_\_\_\_\_\_\_\_\_
* Codons: groups of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ used to translate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acids into \_\_\_\_\_\_\_\_\_\_\_ acids
  + Each codon “codes” for an \_\_\_\_\_\_\_\_\_\_\_\_\_
  + Sequence of codon on \_\_\_\_\_\_\_ molecule determines sequence of \_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the genetic code

*The Genetic Code*

* Written as \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Two types of codons
* Sense codons: code for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_ codons for \_\_\_\_ amino acids
  + *Degeneracy of genetic code* - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Nonsense codons: code for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in translation
  + Aka *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*
* Translation starts with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Codes for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + In Bacteria, translation starts with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_ carries \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_ carries \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on one end ….
  + …. and has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at other end
  + Anticodon recognizes \_\_\_\_\_\_\_\_\_\_\_\_\_\_ on \_\_\_\_\_\_\_\_\_\_\_\_\_

*Process of translation*

* Components needed to begin translation come together
* Ribosome binds at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_ binds to \_\_\_\_\_\_\_\_\_\_\_\_
* Ribosome forms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Ribosome moves along mRNA in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ direction
* Translation continues until ribosome reaches \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Ribosome \_\_\_\_\_\_\_\_\_\_, mRNA, protein released

**Mutation**

* A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Mutations may be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: agent that causes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mutations: occur in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Types of mutations*

* Base substitution (point mutation): \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is replaced by a \_\_\_\_\_\_\_\_\_\_\_\_\_
  + May cause change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, create a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Frameshift mutation: one or a few \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (not in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + Shifts “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” of mRNA
  + Causes a change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Almost always result in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Outcomes of mutations*

* Silent mutation: mutations that have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Change in base, \_\_\_\_\_\_\_\_\_ change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of genetic code
* Missense mutation: mutations that result in an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ substitution in protein
* Nonsense mutation: mutation that introduces premature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*The Frequency of Mutation*

* Spontaneous mutations rate = \_\_\_\_\_\_\_\_\_\_\_ replicated base pairs or \_\_\_\_\_\_\_\_\_\_\_\_\_ replicated genes
* Mutagens increase to \_\_\_\_\_\_\_\_\_\_\_\_\_ per replicated gene

*Chemical mutagens*

* \_\_\_\_\_\_\_\_\_\_\_\_ with \_\_\_\_\_ to cause improper \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, deletions, \_\_\_\_\_\_\_\_\_\_
* Chemicals can convert bases to alter base pairing
* Nucleoside analogs – chemicals that are structurally similar to nitrogenous bases, but alter base pairing
  + Both cause base substitutions in base pairing
  + Eg, HNO2, 2-aminopurine
* Chemicals can cause deletion or insertions into DNA
  + Result in frameshifts
  + Usually slip in between bases, bases lost or gained during replication

Radiation Mutagens

* Ionizing radiation –
  + Ionize molecules
  + Cause \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, leads to errors in DNA replication
* Nonionizing radiation -
  + Causes deletions of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Genetic recombination**

* Exchange of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules
  + Contributes to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* In eukaryotes, genetic recombination happens regularly as part of \_\_\_\_\_\_\_\_\_\_\_\_\_
  + Recombination within one \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* In prokaryotes, transfer of genes happens by:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gene transfer
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gene transfer (recombination between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

*Horizontal Gene Transfer*

* \_\_\_\_\_\_\_\_\_\_\_\_\_ transfers part of its genome to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cell
* Recipient can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ part of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Rest is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recipient cell that incorporates DNA is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_ event, occurs between less than 1% of entire population

Three mechanisms of horizontal gene transfer:

*Transformation*

* Transfer of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”\_\_\_\_\_\_\_ in environment
* Transformation - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of DNA
* Recombination – integration of \_\_\_\_\_\_\_\_\_\_\_\_\_ into \_\_\_\_\_\_\_\_\_\_\_\_
* Cell that recombines \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cell
* Frederick Griffith experiment, 1928, demonstrated that:
  + Transformation is possible
  + DNA is genetic material
* In nature, some bacteria release DNA into environment
  + After \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, cell \_\_\_\_\_\_\_\_\_\_\_
* Some bacteria can take up this DNA \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Occurs naturally in some bacterial genera
* Competence: physiological state in which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ via transformation
  + ie, *Haemophilus* can take up DNA only when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Transduction*

* DNA transferred as a part of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Two types of transduction
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ transduction – phage mediated transfer of \_\_\_\_\_\_\_\_\_\_\_\_\_ segments of DNA
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ transduction – phage mediated transfer of \_\_\_\_\_\_\_\_\_\_\_\_\_ segments of DNA
  + ie, some phages transfer only \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Process of generalized transduction -
  + Phage \_\_\_\_\_\_\_\_\_\_\_\_ the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ bacterial cell. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DNA
  + Phage DNA and proteins are made and the bacterial chromosome is \_\_\_\_\_\_\_\_\_\_\_\_\_
  + Phage particle are assembled. Some phages mistakenly package \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Phage carrying bacterial DNA (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ phage) infect new host cell, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can occur, producing a \_\_\_\_\_\_\_\_\_\_\_\_ with a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ different from both the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells.

*Plasmids*

* Plasmids are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules of DNA
  + Small, about \_\_\_\_\_\_\_\_\_\_\_\_\_ of genome
  + Often carry genes that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for survival
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ plasmids: carry genes for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Conjugation*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dependent DNA transfer
* Requires \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Conjugating cells must be of opposite “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_”
  + Donor cells must \_\_\_\_\_\_\_\_\_\_\_\_
  + Recipient cells must \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Bacterial sex

*The F (Fertility Factor)*

* Conjugation requires \_\_\_\_\_\_\_\_\_ between donor (\_\_\_\_\_\_\_\_) and recipient (\_\_\_\_\_\_\_\_) cell
* \_\_\_\_\_\_\_\_\_\_ for conjugation on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Hfr cells*

* Sometimes F factor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* F+ cell becomes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cell

*Hfr Conjugation*

* Conjugation between Hfr and F- transfers \_\_\_\_\_\_\_\_\_ of donor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recipient is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but still \_\_\_\_\_\_\_\_

*Plasmids*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ plasmids: carry genes for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ plasmids: carry genes crucial for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* R factors: provide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_