Glossary

5’ overhang- Restriction enzymes that cleave the DNA asymmetrically leave several single stranded bases. If the single-stranded bases end with a 5’ phosphate, the enzyme is said to leave a 5’ overhang.

3’ overhang- Restriction enzymes that cleave the DNA asymmetrically leave single-stranded bases. If the single-stranded bases end with a 3’ hydroxyl, the enzyme is said to leave a 3’ overhang.

-10 site- A part of the promoter that is ~10 base pairs upstream of the +1 site or the site where RNA transcription starts. The –10 + -35 site constitute the sites to which RNA polymerase binds.

-35 site- A part of the promoter that is ~35 base pairs upstream of the +1 site. The –10 + -35 site constitute the sites to which RNA polymerase binds.

+1 site- The base at which RNA polymerase starts polymerizing RNA.

3' to 5' exonuclease – A subunit of all DNA polymerases capable of removing nucleotides from an exposed 3’ end. This is the editing (proofreading) function used to ensure that the right nucleotide was added by DNA polymerase III to a growing DNA chain.

α fragment – The first ~60 amino acids of β-galactosidase that can combine with the last ~960 amino acids of β-galactosidase (the ω fragment) to form an active enzyme.

ω fragment – The last ~960 amino acids of β-galactosidase that can be combined with the α-fragment of β-galactosidase to form an active β-galactosidase.

Activation- (of a gene, operon or regulon) A mechanism of gene regulation that requires the induction of the expression of the genes. Frequently, activation involves a regulatory factor binding to the promoter region and activating the promoter.

Alkylating agent- Mutagenic chemicals that attach an alkyl group (methyl or ethyl) to a base and change the base's hydrogen bonding capabilities. Guanine is the most sensitive to alkylating agents.

Allele- A unique form of a given gene. For example, the wild-type copy of a gene is one allele and a mutant copy of the same gene is also an allele of that gene. Allele is a genetic term used to describe the form of the gene present in the cells.

Allele number- A unique number or letter given to each mutation. Different mutations are distinguished by their allele numbers.

Anabolic – The process or the enzymes that build (i.e. synthesize) a substrate rather than break a substrate down. An example is the amino acid tryptophan, whose synthesis requires the action of four different enzymes encoded by five different genes.

Annotated sequence- The sequence of a piece of DNA that lists, in addition to the order of the bases, other features of the DNA including promoters, mRNA start sites, open reading frames, transcription and translation regulation sites and other unusual sequences. These features can be either predictions or biologically determined entities.

Antibiotic resistance determinant – A gene whose protein product confers resistance to a specific antibiotic. The mechanism of resistance differs for each antibiotic. Some antibiotics are inactivated by cleaving them, some by modifying them and some by simply pumping them out of the cell as fast as they come into the cell. The most commonly used antibiotic resistant determinants for *E. coli* are ampicillin, kanamycin, tetracycline and chloramphenicol resistance.

Antiparallel – A description for the opposite polarities of the two strands of a DNA molecule. One strand is orientated 5' to 3' and the other strand is 3' to 5'.

AP endonuclease – An enzyme that catalyzes the breakage of phosphodiester bonds within a DNA molecule at a site upstream and downstream of an apurinic or apyrimidinic site.

Apurinic site- A site in the DNA where a purine has been removed from the DNA phosphate-sugar backbone. The bond affected is the N-glycosidic bond.

Apyrimidinic site- A site in the DNA where a pyrimidine has been removed from the DNA phosphate-sugar backbone. The bond affected is the N-glycosidic bond.

Assimilation- The part of the homologous recombination process where the RecA-ssDNA filament binds to and unwinds another dsDNA, promoting base pairing of the complementary nucleotides.

ATPase- An enzyme that degrades ATP. Frequently, the ATPase provides the energy released from the degradation of ATP to other proteins that require energy to carry out their function.

Artificial chromosome- A cloning vector based designed to accept 40-1000 kb of cloned DNA. These vectors rely on the features that make up a chromosome for their replication and partitioning into daughter cells.

Attenuation – A regulatory mechanism of some anabolic operons (i.e. *trp* operon) that controls the efficiency of transcription after transcription has initiated, but before mRNA synthesis of the operon's genes takes place.

Autophosphorylation - The ability of an enzyme to phosphorylate itself. The addition of phosphate groups to an enzyme often results in the activation of the enzyme's function.

Bacteriophage – A virus that infects bacteria. Bacteriophage (or phage for short) are usually specific for a single bacterial species.

Bacteriocidal- Any compound or physical treatment that kills the bacteria.

Bacteriostatic- Any compound or treatment that prevents bacteria from growing but does not kill them.

Basal level of transcription – The basal level of transcription refers to the amount of transcription that originates at a given promoter when the promoter is functioning at its lowest level. For a promoter that is activated by a protein, it is the amount of transcription in the absence of the activator protein. For a promoter that is repressed by a protein, it is the amount of transcription in the presence of the repressor protein.

Base analogues –Chemicals with similar properties to the natural occurring bases (A,T,G,C,U). DNA polymerase III will incorporate base analogues into a growing DNA strand as if they were the naturally occurring nucleotide.

Base modifiers – Chemicals that modify the structure of bases so that they no longer base pair in a predictable manner (A with T and G with C).

Base substitution mutations- A mutation where one base has been substituted for another. Base substitutions are also another name for point mutations.

Bidirectional DNA synthesis - DNA replication proceeding outward from the origin in both directions at the same time. The consequences of this are that the leading and the lagging strands are synthesized at the same time.

Bioinformatics - Defined as the "study of information content and information flow in biological systems and processes." Bioinformatics bridges the biological sciences with the computer sciences.

Biopanning-The process of screening a library of clones for a clone with a useful characteristic. Biopanning frequently refers to screening a phage display library for a phage with a useful or interesting insert.

Blue/white screen – The visual screen that is used to tell when a plasmid has a cloned insert. The blue color results from an α-fragment of β-galactosidase combining with an ω-fragment of β-galactosidase to form an active β-galactosidase molecule. When the α-fragment is inactivated by a cloned insert, no active β-galactosidase is made.

Blunt ends- A double stranded DNA end where both strands end at the same base. Some restriction enzymes cleave symmetrically in their recognition sequence. There are no single-stranded bases after the enzyme has cut the DNA. These enzymes are said to leave blunt ends.

Broad host range plasmids – Plasmids that can be stably maintained in more than one species. They must contain an origin that functions in different species or more than one origin.

Building blocks – A group of small molecules that are used to build macromolecules. For example, the four bases and the phosphate sugars used for the backbone are the building blocks of DNA. Amino acids are the building blocks for proteins.

Burst size- The number of phage produced by one phage infecting one bacterium.

Bypass suppressors- Suppressor mutations that bypass the need for the gene containing the primary mutation. Bypass suppressors also work with deletions in the gene containing the primary mutation.

Capsid – The protein coat that surrounds the phage genome in a phage particle.

Capsule or **capsular polysaccharide**– The thick slime layer composed of polysaccharides that surrounds the cell and protects it from dehydration and the immune system. A given bacterial species can produce more than one type of capsule.

Carbohydrates – Carbohydrates are composed of simple sugars and are used as a source of energy for the cell as well as a component of several cell structures.

Catabolic – The process or enzymes that break down a substrate rather than build a substrate. An example is the enzyme β-galactosidase, which breaks lactose into glucose and galactose.

Catabolite repression – Cells growing in medium containing glucose do not express, at high levels, certain sugar metabolizing operons (i.e. *lac*) even if the inducers of those operons are present. Catabolite repression relies on the levels of cAMP and CAP protein to relay information on the sugars that are present.

Chain initiation, chain elongation and chain termination- The steps needed to produce RNA molecules. RNA polymerase must bind to a promoter, initiate RNA chain formation, elongate the RNA chain and then terminate it at the appropriate place.

Chemotaxis – Chemotaxis is the movement of a bacterial cell towards a favorable environment and away from a harmful environment. The rotation of the flagella is used to move the cell.

Chi site- The specific DNA sequence used in the homologous recombination process. The sequence of chi is 5' GCTGGTGG 3'. Once RecBCD passes the Chi site in the correct orientation, its 3'-5' exonuclease activity is inhibited. This generates ssDNA for RecA to bind and assimilate.

Circular permutation – The genomes of some bacteriophage always contain the same genes but they are not always present on the infecting phage in the same order. For example, one phage may have the order ABCDEFG, another may have CDEFGAB and another may have DEFGABC. These different phage genomes are circularly permuted with respect to each other.

Cloning – The process of putting a piece of chromosomal or other DNA into a vector using in vitro manipulations of the DNA.

Coding strand- The strand in a dsDNA molecule that matches the base sequence of the RNA that is made from it.

Coinheritance – The ability to inherit two genes in a single genetic cross.

Cointegrate - A structure that contains two copies of a transposon in a single DNA molecule. The transposons are arranged as direct repeats.

Cold sensitive- A secondary phenotype caused by some mutations. The gene product containing the mutation is not functional at low temperatures.

Colony- The group of cells that are formed when bacteria are plated on a solid growth media and incubated for a period of time. If the cell concentration is low enough, each colony is formed from one bacterium. For E. coli, the average colony contains ~ a million cells.

Colony blotting – A version of Southern blotting where colonies on an agar plate are transferred to a fi;ter and lysed in situ. The DNA from the colonies is attached to the filter. The filter is exposed to a tagged probe the same as for a standard Southern blot. Colony blots are used to fish specific genes out of libraries of clones.

Competence - A transient physiological state in which the bacteria can take up naked DNA and transport it into their cytoplasm.

Competent- Cells that are in the physiological state where they can take up naked DNA.

Competence factors - Small peptides that act to induce the expression of the genes needed to make the cell able to take up naked DNA. Some competency factors bind to surface receptors and initiate a relay of information across the membrane and into the cytoplasm. Other competency factors are transported into the cell to effect a change in regulation.

Composite transposons – Complex transposons that are composed of modular units. They have insertion elements on either end. The central piece of DNA can encode many different functions.

Concatamer – A long DNA molecule that contains multiple copies of the same DNA seqeunces linked end to end. Concatamers are frequently the result of rolling circle replication. An example of a concatamer is a phage genome that is arranged in a head to tail manner in a concatamer. (i.e. if the genes in the phage DNA are arranged ABC, then in a concatamer the genes would be ABCABCABCABC).

Conjugation – The process of moving DNA from one cell to another through cell to cell contact and using a specialized plasmid that encodes an F-pilis such as an F factor or an R factor. The proteins needed for conjugation are encoded by a plasmid.

Consensus sequence – A base sequence generated from closely related sequences with similar function. For example, many operons are controlled by cAMP-CAP binding to their promoter regions. The DNA sequence that cAMP-CAP binds to is not identical in every operon. If all of the sequences are aligned, a most probably binding site or consensus sequence can be derived.

Contigs- A group of clones whose inserts contain DNA sequences that overlap with each other. Contigs are used to reconstruct the sequence of a genome in the computer.

Constitutive – The synthesis of a gene product continuously.

Construct- The molecule that is made by rearranging DNA sequences in vitro using cloning techniques.

Control regions- The sequences that are used in controlling the expression of a gene or genes.

Core RNA polymerase - The core subunits, ßß'a_2, of RNA polymerase that synthesizes RNA by adding ribonucleotides to a growing mRNA chain. Core RNA polymerase does not need a primer to begin synthesis. It does not specifically recognize promoters and begins RNA synthesis randomly.

***cos* -** The name describing λ's cohesive end sites. *cos* site are used to circularize the λ genome after it is injected into the cytoplasm of a cell.

Counterselection- A counterselection prevents cells of a specific genotype from growing. It is used in genetic crosses to ensure that the parental cells cannot grow and only recombinants can grow.

"cut-and-paste" transposition – Another name for non-replicative transposition.

Cytoplasm- The aqueous compartment surrounded by the inner membrane. It contains the chromosome, ribosomes, many enzymes used to degrade or build molecules. The cytoplasm is also the location for transcription and translation.

Deamination- The loss of exocyclic amino groups from cytosine, adenine or guanine.

Deletion- The loss of one or many base pairs from the DNA.

de novo protein synthesis – New protein synthesis needed for certain cellular processes. For example, many chromosomes need newly synthesized proteins to initiate DNA replication. This implies that a protein is used only once and then inactivated or degraded. The next time that the protein is needed, it must be newly synthesized.

Density labeling- A way tag specific cellular components using a heavy isotope of one of the naturally occurring element, for example ^{15}N instead of ^{14}N.

Deoxyribonucleoside – Also called, deoxynucleoside or nucleoside for short. This is the nomenclature used to describe a base attached to a sugar (Adenosine, Guanosine, Thymidine, Cytidine, Uridine)

Deoxyribonucleotide – Also called deoxynucleotide, or nucleotide for short. This is the nomenclature used to describe a base attached to a sugar containing a phosphate group (nucleoside 5' monophosphate: AMP, GMP, TMP, CMP, UMP).

Dephosphorylation- The removal of a phosphate from a molecule. Some proteins are activated or inactivated by the additional or removal of a specific phosphate.

Depurination- The removal of a purine from the DNA backbone, leaving an unpaired base on one strand of the DNA.

Diploid – A cell containing two complete copies of the chromosome.

Diploidy – The state of a cell that contains two complete chromosomes.

Direct repeats – DNA sequences that are repeated in a head to tail fashion. If the sequence is ATTGCC then it will be repeated ATTGCC-ATTGCC-ATTGCC.

DNA- Deoxyribonucleic acid. The molecule that is passed from generation to generation and specifies the physical characteristics of the cell that contains it. DNA is composed of a sugar-phosphate backbone and the four bases thymine, adenine, guanine and cytosine.

DNA dependent DNA polymerase I or DNA Pol I- An enzyme that uses a DNA template to polymerize nucleotides onto a free 3' OH of an existing RNA oligonucleotide (primer). DNA Pol I has a 3' to 5' exonuclease activity that is called an editing or proofreading activity. It also has a 5' to 3' exonuclease activity that removes nucleotides from a double-stranded DNA molecule's exposed 5' end. The polymerizing activity is used to fill in small gaps in a DNA molecule that have arisen due to the removal of mismatched base pairs and removal of the RNA primers during the editing process.

DNA dependent DNA polymerase II or DNA Pol II - An enzyme that uses a DNA template to polymerize nucleotides onto a free 3' OH of an existing RNA (primer). DNA Pol II has a 3' to 5' exonuclease activity that is called an editing or proofreading activity. This polymerase is primarily involved in DNA repair processes.

DNA dependent DNA polymerase III or DNA Pol III - An enzyme that uses a DNA template to polymerize nucleotides onto a free 3' OH of an existing RNA oligonucleotide (primer). DNA Pol III has a 3' to 5' exonuclease activity that is called an editing or proofreading activity. It also has a 5' to 3' exonuclease activity that can remove nucleotides from single stranded DNA. DNA Pol III is the major replicating enzyme in *E. coli*.

DNA gyrase - A topoisomerase that can introduce negative supercoils.

DNA ligase- An enzyme that catalyzes the formation of a phosphodiester bond between a free 5' phosphate and a free 3'OH (hydroxy) group.

DnaA box – A specific base pair sequence, 5'TTATCCACA3" present four times in the *oriC*. Ten to twelve molecules of DnaA protein bind the DnaA boxes to form an complex (primosome) needed for the initiation of DNA replication.

DnaA – Ten to twelve molecules of DnaA bind the DnaA boxes to force the hydrogen bonds of the AT rich region in the *oriC* to dissociate, thus opening the double-stranded DNA molecule for access by other initiator proteins (i.e. DnaB, DnaC) of the primosome.

DnaB – A helicase that is loaded onto the primosome. It's activity is used to further dissociate (unwind) the double strands of the DNA so that replication can be initiated by DnaG primase.

DnaC - An enzyme that adds DnaB helicase to the primosome.

DnaG- A DNA dependent RNA primase that synthesizes the short ribonucleotide primer (5-11 ribonucleotides in length). This short RNA primer provides a free 3'OH group for DNA polymerase III to use for adding on deoxyribonucleotides during replication.

Dominant mutation – A mutation that still exhibits a phenotype when it is in the presence of a wild type copy of the same gene.

Donor cell- In a bacterial genetic cross, the cell that is donating the DNA to the other cell (the recipient cell). For example, in an Hfr cross, the Hfr is in the donor cell and gets transferred into the recipient cell.

Duplication- A mutation resulting from a stretch of bases being repeated in the DNA sequence.

Early genes – Phage genes that are expressed first after the injection of phage DNA into a bacterium.

Editing- Some DNA polymerases contain 3' to 5' exonuclease acitivity that can be used to monitor if the correct base has been inserted into the growing DNA chain. If the wrong base was polymerized into the chain, the 3' to 5' exonuclease activity removes the wrong base giving DNA polymerase a second chance to get it right.

Efficiency of plating (EOP)- The efficiency with which a phage forms plaques on different host strains. Restriction and modification enzymes were discovered because the EOP of phage grown on different strains of *E. coli* was altered by up to four logs, depending on the last strain the phage was plated on.

Electroporation – The process of putting DNA into cells using a large jolt of electricity. Electroporation can be used for bacterial, yeast and mammalian cells.

Endonuclease - An enzyme that catalyzes the breakage of a phosphodiester bond within a DNA molecule.

Environment suppressors- Suppressor mutations that alter the cell environment and allow the gene product containing the primary mutation to function at some noticeable level.

Exconjugants – Cell that have undergone conjugation and exchanged DNA.

Expression vectors – Plasmid vectors that are designed to transcribe and translate a cloned gene.

Exonuclease – An enzyme that catalyzes the breakage of phosphodiester bonds, affecting the nucleotides at the very end of a DNA molecule. Exonucleases are described as having a 3' to 5' or a 5' to 3' nuclease activity. This describes which end of the DNA strand will have its nucleotides removed first.

Exponential growth – A phase in the growth of bacteria where the number of cells doubles in a set amount of time for a number of generations. Exponential growth requires an excess of nutrients. Once the doubling time is no longer constant, then exponential growth is over.

Extragenic suppressors- Suppressor mutations that occur outside of the gene containing the primary mutation.

F^+- A strain containing an F factor. The F factor is located extrachromosomally and contains only F DNA.

F factor – The plasmid that is capable of moving DNA from one cell to another. The F factor encodes all of the proteins necessary for transfer of the DNA.

F-pilus – The hair-like structure that is located on the surface of a strain carrying an F factor. The F-pilus is used to bring the two cells in close contact so that DNA can be transferred between them. The F pilus is 2-3 μm in length and F containing cells have between 1-3 of them.

F prime (F') – An F factor that is located extrachromosomally but carries chromosomal DNA in addition to F factor DNA.

Female cells- Cells that do not contain an F factor, an Hfr or an F'.

Filamentous phage- Phage whose infectious particles are long filaments of nucleic acid that are coated by protein.

Fimbriae – Hair-like projections that are attached to the outer surface of the outer membrane of certain bacteria. Fimbriae are made of protein and help bacterial cells adhere to animal cells.

Flagella – Flagella are long whip-like structures that are embedded in the membranes. At the base of each flagella in the inner membrane is motor that rotates the flagella and propels the cell. Flagella can rotate both clockwise and counterclockwise, resulting in the bacteria moving in different directions.

Flush ends- The ends of a linear dsDNA that do not contain any single stranded bases. Also known as blunt ends.

Forward mutation – Mutations that change the wild-type nucleotide sequence.

Frameshift mutations – The addition or deletion of one or two bases to a nucleotide sequence that results in the original genetic code being read out of frame during translation.

Gain of function mutation – A mutation that has acquired or exaggerated a specific phenotype. Gain of function mutations are frequently dominant.

Gel electrophoresis- The technique of separating molecules in a gel matrix in an electric field. Gels are frequently made of agarose or polyacrylamide.

Gene – A region of the DNA that specifies a protein, a tRNA or a rRNA.

Gene conversion – In a recombinational cross, both alleles in the cross are usually recovered. In a gene conversion event, one allele is recovered twice and one allele is lost. Gene conversion is caused when the mismatched base pairs in the heteroduplex DNA created during recombination are repaired to the mutant base pairs.

Gene linkage – Tendency of genes located close together on a chromosome to be inherited together in a recombinational cross. The higher the frequency of being inherited together, the closer the two genes are.

Gene product - The protein product that is translated from mRNA. If the RNA is not translated (tRNA, rRNA or stable RNA), then the RNA is the gene product.

Gene regulation – The mechanism(s) used to control the expression of a gene into its corresponding gene product. Gene regulation can occur transcriptionally, translationally, posttranscriptionally and/or posttranslationally.

Generalized transducing phage – A phage that can incorporate chromosomal DNA into its phage particle in place of phage DNA. Many different segments of the chromosome can be incorporated into different phage particles.

Generalized transduction – Movement of any piece of chromosomal DNA from one bacterium to another using a bacteriophage to carry the DNA.

Genetic recombination – The exchange of DNA sequences between two homologous DNA molecules. Genetic recombination is detected by the formation of new combinations of the sequence.

Genome – An organism's entire set of genes, including extrachromosomal genes from plasmids or resident DNA sequences such as from integrated phage.

Genotype – The information in the DNA that specifies the characteristics of a cell.

Green fluorescent protein (GFP) – A protein isolated from jellyfish that absorbs light at a specific wavelength and emits it at a different wavelength. The emitted light can be seen in living cells using low-light photography. Fusing GFP to a protein of interest allows the movement of the protein of interest to be monitored in vivo.

GST-fusion protein – GST is glutathione S-transferase, a protein that binds glutathione. GST, when fused to a protein of interest allows the fusion protein to be purified in a single step.

Haploid – A cell that contains only a single copy of the chromosome. Haploidy is the state of a cell that contains only one chromosome.

Head-full packaging – Inserting (packaging) DNA into phage heads until the head is completely full of DNA and no more DNA will fit inside.

Helicase - An enzyme that unwinds (i.e. separates) the strands of a DNA molecule by disassociating the hydrogen bonds between the paired bases. This enzymatic activity would be found at a replication fork when the two parental strands need to be separated so that they may be used as templates by the replication machinery.

Heteroduplex DNA - A segment on a double stranded DNA molecule in which the two DNA strands are of different origin and thus do not have perfectly complementary nucleotide sequences.

Hfr – A strain containing an F factor that has integrated into the chromosome of a bacterium.

High copy number plasmids- Plasmids that are present in the cell in greater than approximately 20 to 30 copies per cell.

Histidine tag – At least six histidine residues in a row that can be added to a protein of interest. The histidines bind to metal ions such as nickel or zinc ions. This allows fusion proteins that contain the his-tag to be purified in a single step.

Holoenyzme – A term used to describe an enzymes containing all of its subunits (both catalytic and regulatory). An example would be RNA polymerase, when this enzyme contains both its core catalytic subunits ($\beta\beta'\alpha_2$) and its regulatory subunit, sigma factor.

Homologous recombination – Recombination between two DNA molecules that have identical or nearly identical DNA sequences.

Homology- In the recombination process, homology refers to DNA sequences that are identical or nearly identical.

Host range - The bacterial species that can be infected by a specific phage.

Hotspots - Sites in the DNA where a given event occurs more frequently than is predicted for a random event. For example, some transposons insert preferentially at specific sites. Some transposons have

hotspots, others do not. A hotspot for one transposon will not necessarily be a hotspot for a different transposon.

Housekeeping genes- Those genes whose products are required at some level for the cells to grow. Housekeeping genes are always expressed.

Identical sequences- When comparing two or more sequences, the same base or amino acid is found in all sequences at a given place. Identical sequences can be either DNA or protein sequences.

Illegitimate recombination- Recombination that does not rely on homologous sequences to occur.

Incompatibility –The inability to maintain in the same cell two plasmids that utilize the same origin of replication. An example of this would be the inability of closely related F factors and R factors to be maintained in the same cell.

Inducer – A small molecule that can cause an operon to express its genes. An example of an inducer would be allolactose. The addition of allolactose results in the inactivation of the Lac repressor and the induction of the operon thus allowing the *lac* genes to be expressed.

Informational suppressors- Suppressors that affect a general cellular process such as transcription, translation or DNA replication to fix the primary mutation.

Inner membrane – The inner most membrane of *E. coli*. It forms the major barrier between the cytoplasm and the outside of the cell.

Insertion- Mutations that are the result of addition of base pairs to the genome.

Insertion elements – The simplest type of transposon. They are small (~750 to ~2000 bp) and encode only transposase, the protein needed to move them.

Interactive suppressors- Suppressors that compensate for the defect in the gene containing the primary mutation by mutating another gene whose product interacts with the primary gene product.

Intercalation- Certain chemicals that are large flat molecules are capable of slipping between the base pairs of the DNA helix. This mode of interacting with DNA is known as intercalation.

Intermolecular- Events or processes that happen between two distinct molecules.

Intragenic suppressors- Suppressor mutations that occur in the same gene as the primary mutation.

Intramolecular- Events or processes that happen within the same molecule.

Inversion- A mutation that results from a flipping of several base pairs in the DNA sequence.

Inverted repeats – DNA sequences that are arranged such that the sequence is inverted and repeated within the same molecule. If the sequence is ATTGCC then it will be repeated CCGTTA in the same molecule.

in vitro – Reactions that take place in a test tube and not inside a cell.

Jackpot- A mutation that occurs early in the growth of a culture. Jackpots affect the mutation frequency but not the mutation rate.

Kinase- An enzyme that adds phosphates to a specific molecule or substrate.

Lagging strand – During DNA replication, the lagging strand of DNA is synthesized in a discontinuous fashion using short DNA segments (Okazaki fragments) and relying on many initiating events.

Late genes – Genes that are expressed from phage DNA late in an infection. These usually include the genes that encode capsid and tail proteins.

Leader sequence – A short sequence of mRNA that is used to regulate specific operons. For example in the *trp* operon, the leader sequence contains two trp codons that are used to monitor tryptophan levels in the cell.

Leading strand – During DNA replication, the leading strand of DNA is synthesized in a continuous fashion, relying on only one initiation event.

Leaky mutations- Mutations that cause only a partial loss-of-function of the gene product.

Lesions - A term used to describe types of DNA damage.

Lethal selection- A selection where the cells that do not grow are actively killed by the selective agent. Most antibiotics can be used as lethal selection agents.

Library- A population of clones (usually tens of thousands) that each has one random pieces of chromosomal DNA cloned into a vector. Within the population, every piece of the chromosome can be found on at least one vector. The population is known a library. Libraries can be made for any large piece of DNA such as mouse, yeast, bacterial or human chromosomes.

Linkage – A measure of how close two genes are on the chromosome.

Lipids – Lipids are molecules composed of long chains of carbons. Their major property is that they are greasy, hydrophobic molecules. One type of lipid, know as a fatty acid is the major component of all membranes.

Lipopolysaccharides – Lipopolysaccharides (LPS) are specialized lipids that contain large carbohydrate side chains. The are embedded in the outer leaflet of the outer membrane of certain bacteria. LPS is very densely packed and helps protect bacteria from toxic compounds.

Localized mutagenesis – A technique used to limit mutagenesis to a specific and small region of the chromosome. For example, cells are mutagenized, P1 is grown on the cells and a specific region of the chromosome is selected in a transductional cross. Only the region of DNA that was incorporated into the transducing particle was mutagenized.

Loss of function mutation – A mutation that results in the inability of a gene product to carry out the same functions as the wild type gene product.

Low copy number plasmids – Plasmids that are maintained in cells in approximately 1 to 10 copies. Low copy number plasmids require an active partition system to ensure that they are transmitted from mother to daughter cells.

Lysate- After a cell has been broken open, the content of the cell is referred to as a cell lysate. The cell lysate is the starting material for purification of individual cell components.

Lysogeny – The growth phase of phage whereby the phage DNA is incorporated into the bacterial cell and remains in a stable, silent state.

Lysogen – A bacterium that contains a stable silent phage genome. The phage genome is inherited by the daughter cells of the bacterium.

Lysogenization – The process by which a phage DNA is incorporated stable into the bacterial cell and replicated and inherited by daughter cells.

Lysozyme – An enzyme, usually isolated from egg whites, that is capable of degrading the peptidoglycan cell wall of Gram-negative bacteria.

Lytic – The growth phase of phage that is designed to produce many offspring as quickly as possible.

Macrolesions- Mutations that involve more than one base pair.

Macromolecules – Large chemical structures in cells that are composed of smaller molecules known as building blocks. For example, DNA is a macromolecule that is composed of a sugar-phosphate backbone and the bases A, T, C, and G. Proteins are macromolecules that are composed of amino acids.

Male cells – Cells that contain an F^+, F' or Hfr.

Maltose binding protein (MBP) – An *E. coli* protein that binds to maltose. The gene encoding MBP can be fused to another gene so that a fusion protein is made. The fusion protein will bind to maltose, allowing purification of the fusion protein in a single step.

Merodiploid –A cell that contains two copies of some chromosomal DNA but not two complete chromosomes.

Messenger RNA – The RNA that is made by transcribing specific parts of the DNA molecule. mRNA encodes protein(s).

Methyl directed mismatch repair – A mechanism that identifies and corrects mismatched base pairs in a hemimethylated DNA molecule (the newly synthesized daughter strand is not methylated whereas the parental template strand is). The enzymes involved in this repair, MutHLS identify the mismatch base pair and excise the improperly placed base from the nonmethylated daughter strand. DNA polymerase I fills in the gap spanning the area that use to contain the mismatched base pair.

Methyltransferases - DNA repair enzymes with the capability of removing methyl groups from a base, such a guanine.

Microarray – A small solid support that carries DNA oligonucleotides representing every gene is a specific cell's genome. Microarrays can be used to monitor expression of all of the genes under a given condition.

Microhomology- Small regions of homology that can be used to make duplications and inversions.

Microlesions- Mutations that involve only one base pair.

Middle genes- The genes that are expressed from the phage genome between the early and late genes.

Mismatched base pair - A pair of nucleotides that do not hydrogen bond correctly and thus are not complementary.

Missense mutation - A base pair substitution that changes the nucleotide sequence encoding a polypeptide and also changes the corresponding amino acid sequence of the protein.

Mobilizable plasmids – Plasmids that do not contain all of the genes necessary for moving themselves from one cell to another but which can be moved from cell to cell using another plasmid's conjugation system.

Mobilization- The process of moving a plasmid from one cell to another using plasmid encoded proteins.

Modification- The process of modifying specific sites in the DNA to prevent restriction enzymes from digesting the DNA. If a bacteria contains a restriction enzyme it must contain a modification enzyme to protect its DNA.

Modification enzyme- The enzyme that modifies the site that a restriction enzyme cuts. Modification enzymes prevent restriction enzymes from digesting the DNA.

Mu – A bacteriophage that uses transposition as an integral part of its life style.

Multiple cloning site cassettes (MCS) – A sequence of DNA usually 50 to 75 base pairs in length that specify the recognition sites for restriction endonucleases.

Muropeptides – Strands of peptidoglycan that are added to a growing cell to build the cell wall.

Mutagens- Chemicals or physical treatments that alter DNA and increase the mutation rate.

Mutation- A change in the base sequence of a DNA molecule.

Mutation frequency- A simply but potentially inaccurate way to measure mutagenic potential. The frequency is simply how many mutations occurred in a given culture.

Mutation rate- An accurate way to measure mutagenic potential. The mutation rate is the probability that a specific gene will be mutated in one generation.

Negative regulation – A scheme for controlling the amount of a gene product that is made. This scheme relies on limiting production of a gene product by inhibiting its expression. Frequently, a protein (the negative regulator) binds to the promoter of the gene and prevents expression of the gene.

Neutral mutations- Mutations that have no phenotype.

Nitrosoguanidine- A powerful mutagen that tends to produce mainly transition mutations.

Non-composite transposons – Complex transposons that are not formed from modular units. They do not have IS elements at their ends.

Non-lethal selection- Selections where the cells that do not grow are not actively killed.

Non-replicative transposition – A mechanism for transposition where the transposon it cleaved from its original site and ligated into a new site. A minimal amount of DNA synthesis is carried out by mismatch repair enzymes to restore the duplex DNA.

Nonsense mutation - A base pair substitution, in which the nucleotide sequence of a codon encoding an amino acid has been changed to a codon encoding one of three termination codons (UGA, UAA, UAG).

Nucleic acids – Macromolecules composed of a sugar-phosphate backbone and four nucleotide bases. The two types of nucleic acids in living systems are DNA and RNA. DNA contains the bases adenine, cytosine, guanine and thymine. RNA contains the bases adenine, cytosine, guanine and uracil.

Nucleoside 5' triphosphate - The precursor to the nucleotide, it consists of a base, sugar and three phosphate groups (ATP, GTP, TTP, CTP, UTP).

Nucleotide excision repair - A DNA repair process that uses nuclease activity to remove damaged or mismatched nucleotides.

Null – A mutation that results in a non-functional gene product. When a transposon inserts into a gene, it disrupts the genes and no functional gene product can be made from that insertion, except in very rare instances.

Okazaki fragments – During DNA replication, one of the template strands is replicated in a discontinuous fashion (the lagging strand) using a mechanism that requires the synthesis of short stretches of nucleotides called Okazaki fragments.

Oligonucleotide- A short stretch of DNA, usually less than ~100 bp. Oligonucleotides are short enough to be synthesized in vitro.

Operator – The original nomenclature to describe a regulatory region in front of a group of coordinately regulated structural genes that interacts with a specific repressor protein to control the transcription of these genes.

Operon – A group of linked genes whose expression is coordinately regulated.

Operon fusions- A fusion of a gene of interest to a reporter gene in which the transcriptional signals come from the gene of interest and the translational signals come from the reporter gene.

Optical density – The measurement used to quickly monitor the growth of a culture of cells. Light at a specific wavelength is passed through the culture. The amount of light that is scattered by the culture is recorded. Light scatter is proportional to the number of particles or cells.

Origin for DNA replication (*ori*) – A DNA sequence that must be present in cis for replication of a DNA molecule to take place. The sequence is usually the binding site for number of proteins that are required for DNA replication.

Origin of transfer (oriT) – The place in the F factor where transfer of DNA to the recipient strain is initiated.

Outer membrane – The outer membrane is composed of a lipid bilayer, proteins and lipopolysaccharides. It is the outer most barrier of Gram negative cells and acts to protect them from toxic substances.

Overproduction suppressors- Suppressor mutations that increase the expression of either the mutant gene product or the rate-limiting component of the affected pathway.

Oxidative stress response regulon – A group of operons whose genes are coordinately regulated in response to oxidative stress.

***pac* site** – A site on the phage DNA where proteins bind and begin inserting the phage DNA into the phage head.

Pathogenic (pathogenicity)-The ability of an organism to cause damage or death to its host.

Peptidoglycan – The macromolecule that is used to build the rigid structure that surrounds the cell and maintains the cell's shape. Peptidoglycan is composed of several repeating sugar molecules.

Periplasm or periplasmic space – The aqueous compartment between the inner and outer membranes of *E. coli*. It contains proteins that transport nutrients into the cell, waste out of the cell, sense the environment and convey this information to the cytoplasm. The periplasm resembles the outside of the cell in osmolarity and solute concentration.

Permissive temperature- The temperature at which a cold sensitive or a temperature sensitive mutation is able to function.

Phage or bacteriophage- Viruses that infect bacteria.

Phage particles- Phage infect bacteria and can produce offspring. The offspring produced from an infection are called phage particles. Most of the phage particles are infective and can go on to produce more offspring. Sometimes something will be wrong with a phage particle and it will not produce offspring. While all phage are infective, not all phage particles are infective.

Phage genome-The nucleic acid enclosed in the phage particle that specifies the production of more phage.

Phenotypes – The physical characteristics of a cell that are specified by that cell's DNA.

Phosphatase- An enzyme that removes phosphates from a specific molecule or substrate.

Phosphodiester bond - A covalent bond between a free 5'-phosphate of one nucleotide and a free 3'-hydroxyl group of an adjacent nucleotide, formed by the catalytic activity of ligase. This type of bond links nucleotides together to form the phosphate-sugar backbone of DNA.

Phosphorylation- The addition of phosphates to a molecule or substrate.

Photoreactivation – A DNA repair process that reverses the effects of ultraviolet light through the use of visible light.

Photolyase – The enzyme used in photoreactivation to split apart pyrimidine dimers formed by exposure to ultraviolet light. The enzyme consists of two subunits and requires visible light to be active.

Pilus - A filamentous (hair-like) structure attached to the surface of the bacterial cell. (singular: pilus, plural: pili)

Plaques – Circular clear areas in a lawn of bacteria growing on an agar plate. Plaques contain phage but have few or no bacteria growing in them.

Plasmid – A piece of DNA that exists outside of the chromosome. Plasmids must contain an origin of DNA replication (*ori*) so that they can be replicated and inherited by daughter cells.

Point mutation - A microlesion involving the addition, deletion or substitution of one base pair.

Polar mutation- A mutation which affects the expression of downstream genes that are in the same operon.

Polycistronic mRNA – A mRNA molecule that yields two or more proteins.

Polymerase chain reaction- A technique for amplifying any specific segment of DNA in vitro. A piece of DNA is used as the template. Specific DNA primers, one for each strand, are used to initiate DNA synthesis and DNA polymerase from a bacterium that grows at 70ºC are used to synthesize the DNA. The DNA is synthesized by cycling the reaction through three temperatures. 94ºC is used to denature double-stranded DNA, a temperature between 40ºC and 55ºC is used to anneal the primers to the template and 70ºC is used for DNA synthesis. This cycle can be repeated 20 to 30 times so that a significant quantity of DNA can be synthesized.

Polypeptide or protein – A string of amino acids each linked together by a peptide bond.

Postreplicative Repair (PRR) - A repair mechanism that does not repair damaged DNA, but rather tolerates the lesions so that the damaged DNA can still be replicated. PRR uses homologous recombination to fill in gaps that form when DNA Pol III hits a lesion in the template and does not fill in a nucleotide, but rather skips ahead. PRR is RecA dependent.

Post-transcriptional regulation- Regulation of the gene product at any step after the RNA has been transcribed.

Post-translational regulation- Regulation of the protein's activity after it has been translated.

Primary mutation- The mutation which leads to the defect that is reversed by a suppressor or pseudorevertant.

Primer – A small stretch of linked nucleotides. In the case of DNA synthesis, this small stretch consists of ribonucleotides that DNA polymerase can attach deoxyribonucleotides to.

Primosome - The initiator complex consisting of DnaA, DnaB, and DnaC, whose activities at *ori*C (specifically at the DnaA boxes of *oriC*) result in the separation of the double-stranded DNA molecule so that DnaG can prime DNA replication.

Probe- A molecule that is tagged in some manner so that it can be easily detected and is used to identify a molecule of interest. For example, a gene of interest can be tagged and used in a

colony blot to detect the plasmids that carry the gene of interest. Probes can be tagged with radioactivity, fluorescent dyes or enzymes, to name a few.

Promoters - A sequence of DNA found adjacent to the coding region of a gene that RNA polymerase containing a sigma factor recognizes and binds to, subsequently initiating mRNA transcription. The promoter sequence contains two highly conserved motifs at –10 and –35.

Promoter recognition- The first step in the synthesis of RNA. RNA polymerase recognizes the promoter and binds to it.

Proofreading- DNA polymerases contain enzymatic activities that allow them to recognize a mispaired nucleotide and remove it before moving on and adding more bases. See editing.

Prophage – The phage DNA that is maintained in a silent state inside of a bacterium.

Protease - An enzyme that degrades proteins by catalyzing the breakage of a peptide bond between the amino (NH_2) group of one amino acid and the carboxyl (COOH) group of another amino acid.

Protein or polypeptide– Macromolecules composed of a chain of amino acids that are used for many different purposed in the cell. The amino acid sequence of a protein is specified by the cell's DNA. Proteins are used for building and tearing down molecules, transporting nutrients into the cell, for all major processes such as transcription and translation and for generating energy.

Protein fusion- Fusion of a gene of interest to a reporter gene such that all signals needed for transcription and translation come from the gene of interest. The protein that is produced contains a stretch of amino acids from the gene of interest linked to a stretch of amino acids from the reporter gene.

Proteome – All the proteins present in a cell at any given time or under some specific condition.

Proteomics - The study of which of the proteins in a cell are on at what time and under what condition.

Pseudo-*pac* sites – Sites in the chromosomal DNA molecule that are used to package chromosomal DNA into the heads of generalized transducing phage.

Pseudorevertant- A mutation which reverses the phenotype of another mutation.

Pyrimidine dimers – A type of lesion that forms when the DNA molecule is exposed to ultraviolet light. Examples of dimers include, 6-4 pyrimidine-pyrimidone and cyclobutane dipyrimidine. Pyrimidine dimers can be repaired by photoreactivation, UvrABC endonuclease excision repair or tolerated by Post Replicative Repair.

Quorum-sensing system- A system that detects a change in the number of cells in a given volume and relays this information to the inside of the cell. Once the signal has been internalized, it affects the regulation of genes whose products allow the cell to adapt to the environment.

R factors – Plasmids that can carry many antibiotic resistance genes as well as the genes needed for conjugation.

Raw sequence- The base sequence of a piece of DNA that simply lists the order of the A's, C's, G's and T's.

Rearrangements- Mutations that result from the scrambling of DNA bases without loss of any base pairs.

Recipient cells- Cells in a genetic cross that are receiving the DNA from the donor cell. For example, in a transduction, the transducing phage is grown on the donor and used to infect the recipient cells/

Recessive – A mutation that does not exhibit any phenotypes when it is placed in a cell with a wild type copy of the same gene.

Reciprocal – In homologous recombination, DNA is exchanged between two DNA sequences. In a reciprocal cross, the information from one DNA sequence is moved to a second DNA sequence concomitantly with the DNA sequences from the second molecule being moved to the first DNA sequence. No DNA sequences are lost in a reciprocal cross, they are simply rearranged.

Recombinase - The enzyme responsible for the exchange of DNA in a site specific recombination event.

Regulatory protein – A protein whose function is to regulate or control expression of genes. Expression can be controlled negatively through the repression of gene expression or positively through the activation of gene expression.

Regulon - A group of operons or a subset of genes in a group of operons whose expression is coordinately regulated by a global regulatory mechanism.

Replication fork – The region in a replicating molecule where the replication machinery is adding nucleotides to a growing DNA chain.

Replicative transposition – A mechanism for transposition where one strand of the transposon is cleaved and ligated to one strand of the new insertion site. Extensive DNA replication across the entire transposon by DNA replication enzymes restores the duplex DNA.

Replicon- An independently replicating DNA molecule that is stably maintained in a population of cells. Plasmids are referred to as replicaons.

Reporter gene – A well-characterized gene that is used to monitor the expression level of another less well characterized gene. The reporter gene is placed 3' to the DNA of the promoter to be studied and expression of that promoter is examined by following the amount and timing of appearance of the protein from the reporter gene.

Repression- Control of gene expression by preventing a gene from being expressed.

Resolvase – The enzyme encoded by some transposons to resolve a cointegrate structure into two DNA molecules that contain one copy of the transposon each. Resolvase carries out a site-specific recombination reaction to resolve the cointegrate.

Response regulator protein - One of two proteins that make up a two component regulatory system. The response regulator protein is activated, usually by phosphorylation, in response to signals received from a membrane bound sensor kinase protein (the second component of this system). A response regulator protein is often a transcriptional activator, whose ability to activate gene expression is controlled by the signals it receives from the corresponding sensor kinase protein.

Restriction- The process by which DNA is cut at a specific sequence by an enzyme known as a restriction endonuclease.

Restriction endonucleases or restriction enzymes – Proteins produced by many different species of bacteria that recognize foreign DNA sequences and cleave the foreign DNA on both strands at a DNA sequence specific for each restriction enzyme. Bacterial restriction systems are a primitive immune system in that they protect bacteria from foreign DNA coming into the cytoplasm. There are three types of restriction enzymes (Type I, II, and III). The three categories are based on the number of proteins that make up the enzyme, the cofactor requirements, if the proteins form a complex and the nature of the

sequence that is recognized by the enzyme. Commercially useful restriction endonucleases (Type II) recognize and cleave the short specific sequence of DNA.

Restriction site- The site in the DNA that is cleaved by a restriction enzyme.

Revertant – A mutant cell that regains its wild-type phenotype by a second mutation. Revertants can be either a reversal of the mutant base pair back to the wild-type base pair (true revertant) or a second mutation that compensated for the first mutation (pseudorevertant or suppressor).

Reversion-The process of reversing the phenotype of a mutant bacterium.

Ribosomal RNA – RNA molecules that are used to build a ribosome. Ribosomes are the large complex of RNA and proteins that translate mRNA into proteins.

Ribosome binding site or Shine-Dalgarno sequence- The bases in the mRNA where the ribosome binds to begin translating the mRNA into protein.

RNA – Ribonucleic acid is a macromolecule that is comprised of a sugar-phosphate backbone and the four bases uracil, adenine, thymine and guanine.

RNA polymerase - The enzymes responsible for transcribing DNA into RNA. The holoenzyme consists of the subunits: $\beta\beta'\alpha_2\sigma$, with the σ factor acting as the specificity factor, directing RNA polymerase to initiate transcription from specific promoter sequences

Rolling circle replication – The process by which phage make one long piece of DNA that contains multiple phage genomes. Phage use rolling circle replication to make DNA molecules that they can package into phage heads.

Same sense or silent mutation - A base pair substitution that changes the nucleotide sequence encoding a polypeptide but fails to result in a change in the amino acid sequence.

Selectable marker – A gene in a vector that makes a gene product that confers a positive or selectable phenotype on cells that contain the vector. The selectable marker is used to select out of a mixed population cells that contain the vector.

Selection- The environmental conditions used to allow only some cells in a population to grow.

Selective agar – Growth media used to identify specific cells and exclude the growth of other cells. For example, selective agar is used to select transductants from a mixture of bacteria and transducing phage particles.

Semiconservative replication – During DNA replication, both strands of the DNA molecule serve as templates for the synthesis of new complementary strands. The newly synthesized complementary

strands (also called daughter strand) will hydrogen bond with its corresponding template strand (also called parental strand). Thus, each DNA molecule will consist of a parental and a daughter strand.

Sensor-kinase protein - One of two proteins that make up a two component regulatory system. The sensor protein is a cell membrane bound kinase that autophosphorylates in response to a specific environmental signal. It transfers this phosphoryl group to a response regulator protein so that the regulator may activate or repress express of the appropriate genes.

Septum – The septum is the structure that is build between two dividing cells to wall them off from each other. The septum is mainly composed of membranes and peptidoglycan.

Shine-Dalgarno sequence- Another name for a bacterial ribosome binding site. The site in a mRNA where the ribosome binds to initiate translation.

Short patch repair-Repair of a ultraviolet light induced dimmer by excision of the dimmer from the DNA by UvrABC and synthesis across the gap by DNA polymerase I.

Short sequence repeats (SSR)- Repeated DNA sequences that can be used for illegitimate recombination. The SSR can be as short as 3-8 bp.

Shuttle vectors- Vectors that can replicate and be maintained in two different species. One of the species is usually *E. coli*, where it is easy to manipulate DNA, and the other can be other bacteria, yeast or even mammals.

Siblings- Cells in a culture which are derived from each other and all contain the same mutation(s).

Sigma factor – The specificity determinant of RNA polymerase. This subunit directs core RNA polymerase to promoters during initiation of transcription.

Signal transduction – The mechanism by which two component regulatory systems (sensor-regulator pairs) function. It involves the transferring of signals, usually in the form of phosphory groups so that environmental signals outside of the cell can influence gene expression inside the cell.

Silent mutation- A mutation that does not confer a phenotype on the cell that carries it.

Similar sequences- When comparing two or more sequences, similar amino acids are found at a given position. Similarity usually refers to amino acid sequences because some amino acids have similar properties and are interchangeable. For example, valine and alanine both have hydrophobic characteristics.

Site-specific recombination – Recombination between two specific sequences in DNA that requires a unique set of proteins to carry out the cleavage and joining reactions. For example, recombination between *attP* in λ and *attB* in the chromosome is a site-specific recombination reaction.

SOS mutagenic repair - A DNA repair regulon that responds to extensive DNA damage. SOS genes are repressed by the transcriptional repressor, LexA. Upon extensive DNA damage, LexA is cleaved, fully activating the expression of the SOS genes whose gene products are needed to repair the damaged DNA.

Southern blotting- A techniques first described by E. M. Southern to detect homologies between two DNA molecules when the sequence of the two DNA molecules is not known. One of the DNA's is electrophoresed on a gel and transferred to a filter. The DNA strands are separated after the DNA has been transferred on the filter. The second sequence is tagged and incubated with the filter. The tagged DNA will bind to the filter only where a homologous DNA sequence has been attached to the filter.

Specialized transducing phage – A phage that can carry a specific segment of chromosomal DNA as part of its genome. The segment of chromosomal DNA is the same in every phage particle.

Specialized transduction – Movement of a specific fragment of chromosomal DNA from one bacterium to another. The fragment of DNA is usually incorporated and replicated as part of bacteriophage DNA. Because of this, the specific fragment of chromosomal DNA can be amplified by growing a large number of the phage.

Spore- The storage form of some bacteria that are made in the developmental pathway called sporulation. Spores contain a bacterial genome surrounded by a tough protective coating. In some species, spores can survive for decades.

Sporulation - A process that results in the formation of a dormant spore that is resistant to chemicals, heat and physical agents and which contains an entire copy of the bacterial chromosome. Only some bacteria are capable of sporulation.

Staggered ends or sticky ends- The linear ends of a dsDNA molecule that contain a few single-stranded nucleotides. Many restriction enzymes leave staggered ends.

Stem loop structures – Found in nucleic acid molecules when single stranded regions find intramolecular complementary bases to pair with to form regions of double strandedness. Also called hairpin structures or secondary structures. The base pairing that forms is a result of noncovalent, hydrogen bonding between complementary nucleotides within the same single stranded molecule. Stem loop structures can be found at the ends of genes to signal where transcription stops.

Sticky ends or staggered ends- The linear ends of a dsDNA molecule that have some single-stranded bases on their ends. Restriction enzymes that cleave the DNA asymmetrically at their recognition site produce sticky ends on the DNA. The sticky end can have either a 5' overhang or a 3' overhang.

Suicide vectors – Phage vectors that can infect a specific bacterium but not replicate or produce offspring.

Supercoiling –DNA that is highly twisted on itself and compacted.

Superinfection- The process of a phage infecting a cell that is already lysogenic for the phage. In most cases, the incoming phage cannot replicate.

Suppressor- A mutation that reverses the phenotype of another mutation.

Surface exclusion- The process of a cell containing an F preventing mating with another cell that contains an F. Cells that contain an F produce at least two proteins to indicate the presence of the F. TraS inhibits DNA transfer and TraT inhibits mating pair formation.

Target DNA – The DNA that the transposon is moving into.

Target immunity – The inability of a transposon to transpose near a copy of itself. Only some transposons have this property. Immunity can extend over at least 175 kilobases for some transposons.

Tautomer - An alternative form (a structural isomer) of a base in which a spontaneous transient rearrangement of bonds results in the electrons being distributed differently among the atoms.

T-DNA – The piece of the Ti plasmid that is moved into the plant cells. The T-DNA enters the plant nucleus where it is integrated into the plant nuclear genome.

Temperate phage – A phage that is capable of both lytic and lysogenic growth.

Template – A chain of nucleotides that is used in a polymerization reaction to produce a complementary DNA or RNA strand.

Temperature sensitive- A secondary phenotype of a mutation that causes the mutant gene product to not function at increased temperatures.

Terminal redundancy – The ends of the DNA of certain phage genomes that have overlapping sequence homology. If the sequence of the genes is ABCDE, terminally redundant molecules would have the sequence ABCDEAB. The overlapping sequence homology, or terminal redundancy allow the ends of the phage DNA to circularize by homologous recombination.

Terminator- The sequence at the end of a gene that tells RNA polymerase to quit transcribing. Terminator have step loop structures.

Theta replication – The bidirectional replication of a circular DNA molecule where initiation of replication starts at a single *ori*. Structures that look like the Greek letter theta are produced.

Three factor crosses – Examining the behavior of three genes in a single genetic cross.

Ti plasmids – Plasmids that are found in *Agrobacterium tumifaciens* and are responsible for the formation of crown gall tumors in plants. There are many different versions of the Ti plasmid, each having subtle differences. All are capable of inducing tumors in plants.

Topoisomerase - An enzyme that eliminates or introduces either underwinding or overwinding of a double stranded DNA molecule. It catalyzes single (type I) and double (type II) strand breaks changing the relative positions of the DNA strands, and then ligating the breaks. It differs from a nuclease in the way it creates these breaks or reseals them. Topoisomerses use the process of transesterification rather than hydrolysis to break or reseal a phosphodiester bond between two nucleotides.

Transcription – The synthesis of RNA using a DNA template, RNA polymerase and the precursor, ribonucleoside 5'-triphosphates.

Transcription fusion or **Operon fusion** – A fusion of the DNA from a promoter that is under study to a reporter gene. The signals needed for transcription come from the promoter under study and the signals needed for translation are provided by the reporter gene.

Transdimer synthesis – A tolerating mechanism used to replicate damaged DNA. The specificity of the polymerizing DNA polymerase III is relaxed so that any nucleotide can be place across from a lesion in the template strand.

Transducing particles- Bacteriophage particles that contain bacterial chromosomal DNA instead of (generalized transducing phage) or in addition to (specialized transducing phage) phage DNA.

Transductants – Bacteria that have received a piece of chromosomal DNA from a transducing phage.

Transduction - The process of using a bacteriophage to move pieces of chromosomal DNA from one bacterial cell to another.

Transfer RNA – tRNA is a macromolecule that is used in the process of translating a messenger RNA into a protein. tRNA serves as a bridge between the mRNA and the amino acid specified by the tRNA.

Transformants - Bacterial cells that have taken up free DNA. The transformed DNA, if it contains an origin of replication(*ori*), can exist independently from the chromosome. If it does not have an *ori*, yet contains sequences homologous with the chromosome, it can undergo homologous recombination.

Transformasome – A membrane-enclosed compartment that contains a 30-50 kb dsDNA fragment. Transformasomes are used by some bacteria to move free DNA from the environment into the cytoplasm.

Transformation - A process by which bacterial cells acquire free (naked) DNA from their environment. Some bacteria are naturally competent to take up free DNA and others can be physically manipulated to take up free DNA.

Transition - A base substitution mutation where a purine replaces a purine (an A for a G or vice versa) or a pyrimidine replaces a pyrimidine (a C for a T or vice versa).

Translation – The synthesis of protein from a mRNA template.

Translational fusion or **Protein fusion** – A fusion of the DNA from a promoter that is under study to a reporter gene. The signals needed for both transcription and translation are provided by the promoter under study.

Translational regulation- Regulation of transcription of a mRNA into a protein.

Translocation- A mutation that results from base pairs being moved to a new site on the chromosome.

Transposable element – Another name for a transposon.

Transposase – A protein encoded by a transposon that is required for movement of the transposon. Transposase actually breaks the DNA backbone at the donor site between the transposon and the adjacent DNA and joins it to the DNA at the new insertion site.

Transposon – A segment of DNA that is capable of moving itself from one piece of DNA to another piece of DNA.

Transversion - A base substitution mutation where a purine replaces a pyrimidine (a G for a T) or a pyrimidine replaces a purine (C for a G).

True revertant- A reversal of the phenotypes of a mutation by changing the mutated base back to the wild-type base.

Two component signal transduction - A process that consists of at least two proteins, one which is the sensor kinase and the other which is the reponse regulator protein. The sensor kinase senses specific changes in the environment and then communicates the change biochemically (usually in the form of a phosphate) to the response regulator. The response regulator alters the expression of the genes whose products respond to the environmental change.

Two factor crosses - Examining the behavior of two genes in a single genetic cross.

Uptake signal sequence (USS) - A short and specific sequence of nucleotides that must be present in free DNA in order for it to be taken up by certain bacteria during natural transformation.

Unidirectional DNA synthesis – DNA synthesis from the origin that proceeds in only one direction at a time.

Vector – A molecule that has been manipulated in vitro for cloning genes. Vectors must contain an origin of replication and frequently contain multiple cloning sites and a selectable marker. Many different features can be included, depending on the final species the vector will be used in and the uses it will be put to.

Very short patch repair-A repair mechanism that recognizes and repairs T-G mismatched bases in a specific sequence. VSP is a three step process by which Vsr endonuclease recognizes the mismatch and cleaves the phosphodiester backbone next to the mismatch and removes the mismatch. DNA pol I adds back the correct base.

Viable cell count – A way to measure the number of cells in a culture. The culture is diluted and a known amount of it is plated on solid growth media known as an agar plate. The agar plate is incubated until colonies are formed and the number of colonies are counted. Each colony represents one cell in the original culture.

Virulence factors –Factors that allow pathogenic (disease causing) bacteria to invade or colonize other, usually eukaryotic, cells.

Virus- A protein coated nucleic acid molecule that can infect sensitive cells, transporting the nucleic acid into the cytoplasm. Once there, the nucleic acid is used to make more of the virus. The progeny viruses leave the cell and go on to infect other cells. Viruses that infect bacteria are called bacteriophage.

Wild type – Wild type or WT refers to a gene or a protein sequence that contains no known mutations and is present in most members of a species.

XGal (5-bromo-4-chloro-3-indoyl-β-D-galactoside) – A chemically synthesized derivative of lactose that can be used to indicate when cells are producing active β-galactosidase. When intact XGal is colorless and when XGal has been cleaved by β-galactosidase, a blue colored indigo dye is produced.