

- C1. All of these processes are similar in that a segment of genetic material has been transferred from one bacterial cell to another. The main difference is the underlying mechanism whereby this transfer occurs. In conjugation, two living cells make direct contact with each other, and genetic material is replicated and transferred from one cell to another. In transduction, a virus infects a cell, makes new virus particles that contain some genetic material from the bacterium, and then these virus particles are transferred to a new bacterial cell. Finally, in transformation, segments of DNA are released from a dead bacterium and later taken up by a living cell.
- C2. It is not a form of sexual reproduction whereby two distinct parents produce gametes that unite to form a new individual. However, conjugation is similar to sexual reproduction in the sense that the genetic material from two cells are somewhat mixed. In conjugation, there is not the mixing of two genomes, one from each gamete. Instead, there is a transfer of genetic material from one cell to another. This transfer can alter the combination of genetic traits in the recipient cell.
- C3. If neither cell has a selective growth advantage, we would expect that the F^+ cells would eventually overrun the population. This is because a mating starts with an F^- and F^+ cell and ends with two F^+ cells. Therefore, F^+ cells can convert F^- cells into F^+ cells but the opposite cannot occur.
- C4. An F^+ strain contains a separate, circular piece of DNA that has its own origin of transfer. An *Hfr* strain has its origin of transfer integrated into the bacterial chromosome. An F^+ strain can transfer only the DNA contained on the F factor. If given enough time, an *Hfr* strain can actually transfer the entire bacterial chromosome to the recipient cell.
- C5. The role of the origin of transfer is to provide a starting site where two important events occur. The DNA is nicked and one strand begins its transfer into a recipient cell. The direction of transfer in *Hfr*-mediated transfer will determine the order of transfer of the genes. For example, if the origin is between gene *A* and *B*, it could be oriented so that gene *A* will be transferred first. Alternatively, it could be oriented in the opposite direction so that gene *B* will be transferred first.
- C6. Sex pili promote the binding of donor and recipient cells and provide a passageway for the transfer of genetic material from the donor to the recipient cell.
- C7. Originally, there may have been a segment of the normal bacterial chromosome that was accidentally excised to form a circle. F factors have their own origin of replication and carry bacterial genes.
- C8. Though exceptions are common, interspecies genetic transfer via conjugation is not as likely because the cell surfaces do not interact correctly. Interspecies genetic transfer via transduction is also not very likely because each species of bacteria is sensitive to particular bacteriophages. The correct answer is transformation. A consequence of interspecies genetic transfer is that new genes can be introduced into a bacterial species from another species. For example, interspecies genetic transfer could provide the recipient bacterium with a new trait such as resistance to an antibiotic. Evolutionary biologists call this horizontal gene transfer, while the passage of genes from parents to offspring is termed vertical gene transfer.
- C9. Briefly, the lytic cycle involves the production of new viruses. The phage takes over the synthetic machinery of the cells to make many more additional virus particles. Eventually, the cell lyses to release these new particles. The lysogenic cycle involves the integration of the viral DNA into the host cell's chromosome. This integrated DNA is called a prophage. It will replicate whenever the host chromosome is replicated. At a later time, a prophage can be induced to progress through the lytic cycle.
- C10. Cotransduction is the transduction of two or more genes. The distance between the genes determines the frequency of cotransduction. When two genes are close together, the cotransduction frequency would be higher compared to two genes that are relatively farther apart.
- C11. Most of the P1 phages would contain P1 genetic material. However, an occasional phage contains a piece of the bacterial chromosome.
- C12. If a site that frequently incurred a breakpoint was between two genes, the cotransduction frequency of these two genes would be much less than expected. This is because the site where the breakage occurred would separate the two genes from each other.
- C13. The steps that occur during transformation are described in Figure 6.12. A competent cell is able to take up DNA from the environment. Several factors affect competency including temperature, ionic conditions, and nutritional growth conditions.
- C14. The transfer of conjugative plasmids such as F factor DNA.

- C15. One advantage of the uptake of DNA is that it could be used as a nutritional source. The bacterial cells could use the nucleotides for their own growth and metabolism. The integration of DNA into the bacterial chromosome (i.e., transformation) has the advantage of possibly giving the bacterium a new trait that might be beneficial to its survival. For example, if a bacterium that cannot metabolize lactose is transformed with *lac*⁺ genes, the transformed bacterium can survive in a medium containing lactose as the sole carbon source for growth.
- C16. A. If it occurred in a single step, transformation is the most likely mechanism because conjugation does not usually occur between different species, particularly distantly related species, and different species are not usually infected by the same bacteriophages.
- B. It could occur in a single step, but it may be more likely to have involved multiple steps.
- C. The use of antibiotics selects for the survival of bacteria that have resistance genes. If a population of bacteria is exposed to an antibiotic, those carrying resistant genes will survive and their relative numbers will increase in subsequent generations.
- C17. The term refers to the outcome when two mutations are combined in a single individual. If two defective mutations combined in a single individual result in a nondefective phenotype, complementation has occurred. This is because the two mutations are in different genes, and the corresponding wild-type versions are dominant. If complementation does not occur, this means that the defective mutations are in the same gene. When combined in the same individual, complementation cannot occur because the individual does not have a normal (functional) copy of the gene.
- C18. The term *allele* means alternative forms of the same gene. Therefore, mutations in the same gene among different phages are alleles of each other; the mutations may be at different positions within the same gene. When we map the distance between mutations in the same gene, we are mapping the distance between the mutations that create different alleles of the same gene. An intragenic map describes the locations of mutations within the same gene.
- C19. Perhaps the mutations are at exactly the same spot (i.e., the same nucleotide) in the gene. For example, if a gene is composed of 500 nucleotides, perhaps two different strains both have a mutation at nucleotide number 377 (from one end of the gene).