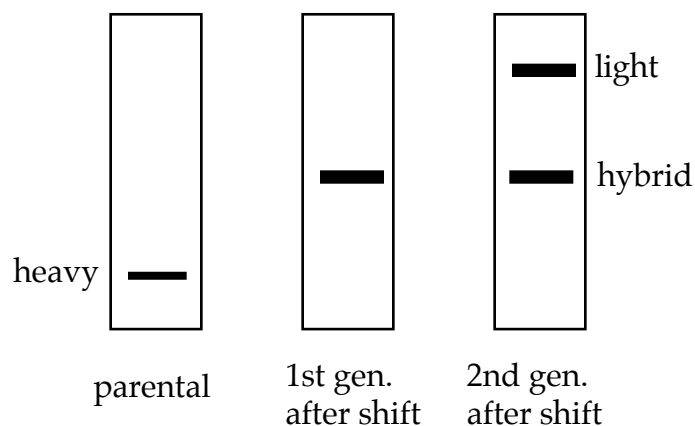
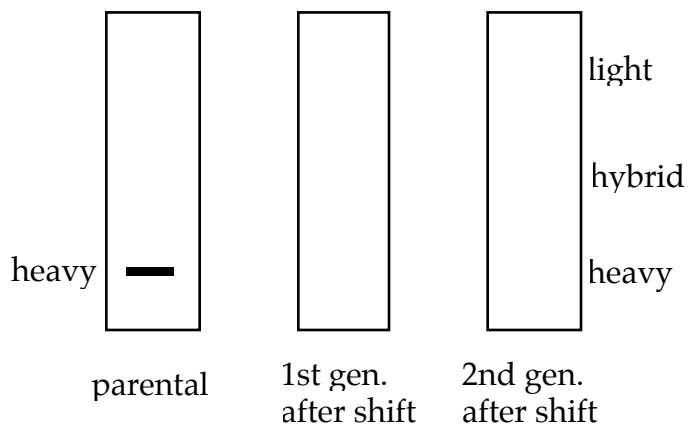


7.012 Replication Section Problem

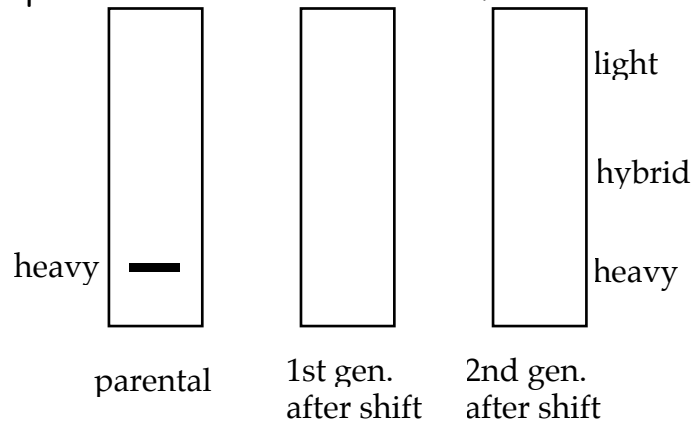
Meselson and Stahl demonstrated that *E. coli* replicates DNA in a semiconservative manner. This was shown by first growing *E. coli* in a medium containing ^{15}N for the first several generations, shifting the culture to one containing ^{14}N and then examining the density of the next generation of DNA. Their results are shown below.



a) On the diagram below, indicate what the results would be if a Martian organism replicates DNA in a conservative manner. Use a similar format as shown above.

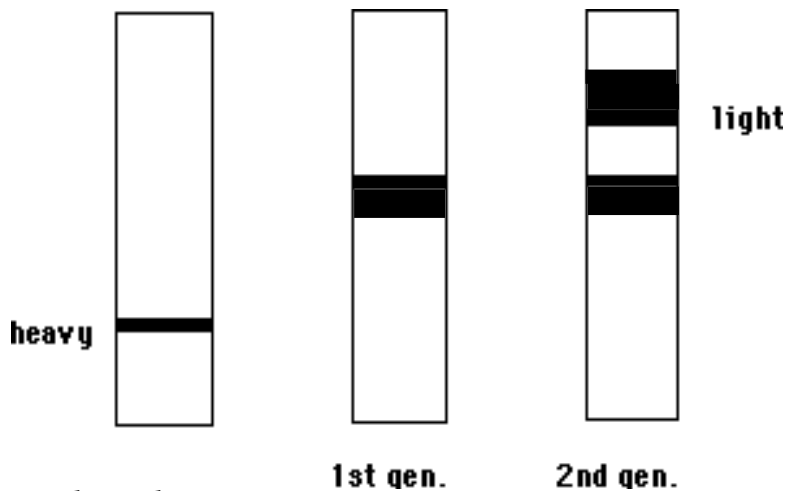


b) On the diagram below, indicate what the results would be if the Martian organism replicates DNA in a dispersive manner. Use a similar format as shown above.



c) An alien bacterium has been recovered from the atmosphere of *Ganymede*, a moon (the size of Mars!) of planet Jupiter. You have managed to isolate its genetic material, and find it to be similar to DNA in composition, except that it contains 6 types of "bases", that are of three different types: jovines, J and K, zeusines, Y and Z, and herenes, V and W. You find the "base" composition of a stretch of alien genetic material to be approximately 13% J, 20% K, 20% Y, 13% Z, 20% V and 13% W. Propose a structure for the alien genetic material.

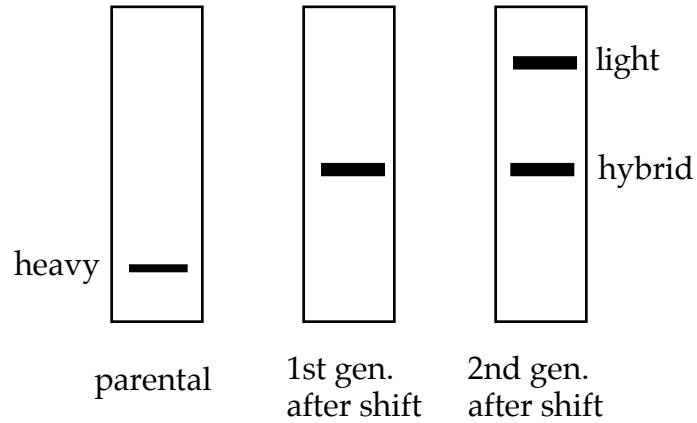
d) Curious as to how this alien organism replicates its genetic material, you grow it in heavy N^{15} for several generations (you have already determined that the alien bases contain nitrogen!) until all the genetic material is labeled and sediments at a new "heavy" position on a gradient. You then shift your culture to N^{14} containing medium, and examine the density of the next generations of genetic material. The results are shown below.



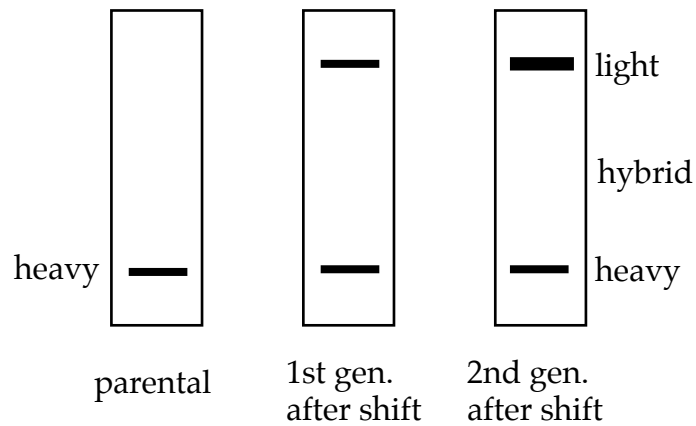
What can you say about how this alien genetic material replicates?

7.012 Replication Section Problem Answers

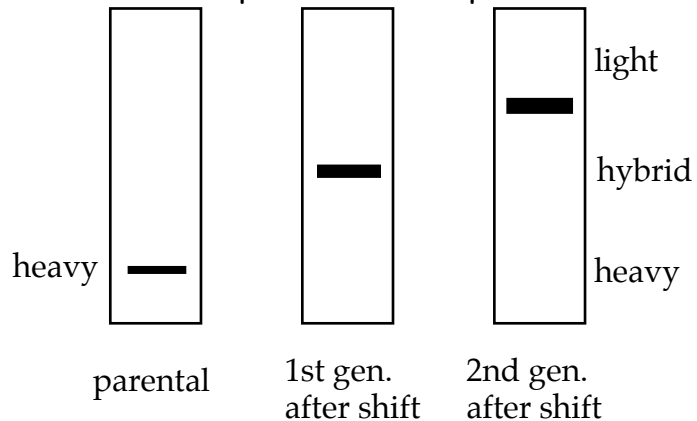
The results would be if DNA replicates in a semiconservative manner:



a) The results would be if DNA replicates in a conservative manner:



b) The results would be if DNA replicates in a dispersive manner:



c) By analogy to DNA, the alien genetic material is composed of three strands, held together by base triplets. J, Z and W form triplets, as do K, Y and V.

d) This is the equivalent of a Meselson-Stahl experiment. Since all the new genetic material produced after shifting the culture sediments at a new and lighter position, all the new molecules must contain some light N¹⁴ material, so replication cannot be conservative. Since the new molecules all sediment at the same position, replication is not dispersive; therefore it is semiconservative.

You can also deduce that replication requires just one strand of the triple helix to generate a whole new molecule, as illustrated below: The molecules in the first generation after shift all consist of one heavy strand and two light ones, and are only 1/3 as heavy. In the second generation, 1/3 of the molecules consist of a heavy strand and two light ones, while the other 2/3 are all light strands.

