Recitation Section 7
February 28-March 1, 2005

Molecular Biology—DNA as Genetic Material and DNA Replication

A. DNA as Genetic Material

Before people used words such as "genetic material," the concept behind this term was well established. In fact, an entire industry based in large part on this concept played an enormous role in the development of our civilization.

1. What is this industry? How was the concept of "genetic material" central, if not articulated, part of this industry?

After the work of Mendel was re-discovered, trying to understand what that "genetic material" was became a key part of scientific endeavor. While scientists did not discover what that substance was for some time, they fairly quickly formulated the three requirements that genetic material must satisfy.

2. What are those requirements? Why do they make sense?

3. Given what you now know about DNA structure, how does DNA satisfy these requirements?

In 1920s, Frederick Griffith experimented with smooth and rough *Streptococcus pneumoniae* bacteria. Griffith found that contrary to expectations, infecting a mouse with a mixture of live rough bacteria of type II (R_{II}) and heat-killed smooth bacteria of type III (S_{III}), killed the mouse. Griffith concluded that something was transferred in the course of the experiment from one type of bacteria to another, and as a result transformed the recipient bacteria. He named that substance "transforming principle." In fact, Griffith was able to isolate virulent bacteria from the dead mouse.

4. What was transferred in the experiment?

5. What type of bacteria was the recipient of the transforming principle, and what type was the "sender?"

6. How did the transfer enable the appearance of virulent bacteria?

7. Were all the bacteria of the recipient type transformed? Describe the probable process from co-infection to the death of the mouse.

B. DNA Replication

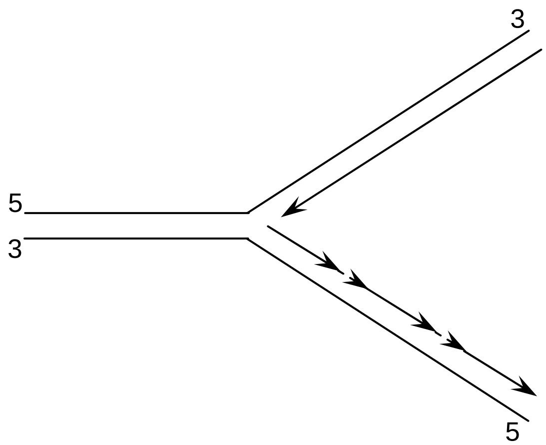
1. DNA replication is remarkably accurate. Do you think it would have been possible to evolve a more accurate polymerase? If so, would it have been evolutionarily advantageous? Why or why not?

2. We know that A pairs with T and C pairs with G. What is biochemically remarkable about these two pairs?

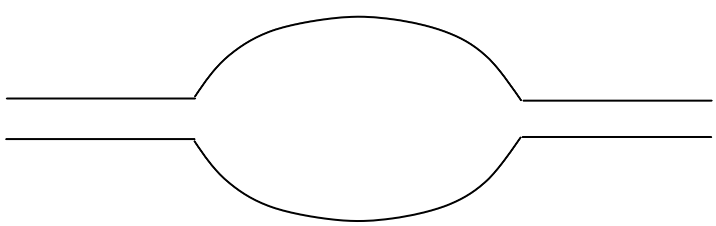
3. What enzyme is responsible for replicating DNA?

4. How does that enzyme know what base to put in next?

5. In lecture we saw the following drawing of the DNA replication fork:



How does this relate to the following diagram?



Which is a better representation of what actually happens during replication?

DNA is a long polymer of nucleotides that only differ in their nitrogenous bases. Yet it encodes a lot of information.

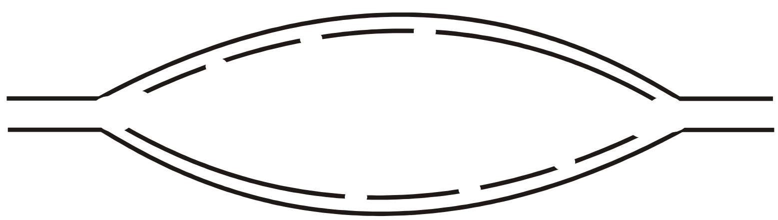
6. What are some of the types of information encoded in DNA?

7. How is it possible to reliably encode these many types of information in DNA?

DNA is organized into chromosomes. Bacteria generally have one circular chromosome, while eukaryotes have multiple linear chromosomes.

8. How does the process of DNA replication start? Is it same or different in bacteria and eukaryotes? (Hint: think about how much DNA needs to be replicated in each case, and how much time the cell needs to replicate it.)

9. Below is a schematic of a replication bubble that includes an origin of replication.



   i. indicate direction of DNA synthesis with arrows.
   j. label the ends of the original strands with 5' and 3'.
   k. indicate the origin of replication with an X.
   l. label the leading strands
   m. for each newly replicated strand, number the Okazaki fragments 1-3 in order of when they were created.

10. Using the schematics below, explain why base addition in DNA replication is strictly dependent on the presence of the 3' OH.

Figures removed due to copyright reasons.

Please see figure 9 and the left portion of figure 10 in http://hshgp.genome.washington.edu/teacher_resources/modules-view.htm

11. What energy source is used to power nucleotide addition reaction?

12. Speculate as to why performing polymerization 3'→5' might have been less energetically favorable for the cell overall.