DNA Replication:

1. Prokaryote vs. Eukaryote
   1. Prokaryote (no nucleus; bacterium)- Commonly *E. Coli*
      1. Cyclical DNA because strand is shorter
      2. One point of replication
      3. Creates a replication fork and replication bubble
         1. *Replication Fork:* physical sites of replication
         2. *Replication Bubble:* Shape that forms through the replication process
   2. Eukaryote (contains nucleus)
      1. Linear because strand is longer
      2. Multiple origins of replication
         1. *Origin of Replication:* DNA replication starts here and proceeds in both directions
      3. Creates a replication fork and replication bubble
2. Proteins
   1. *Helicase:* Unwinds double helix and separates complementary strands
   2. *Binding Proteins:* Keeps strands separated
   3. *Topoisomerase:* Relieves strain caused by unwinding and avoids a supercoil
   4. *RNA Primase:* adds RNA primer
   5. *DNA Polymerase III:* adds dNTPs (nucleotide base pairs) to lagging strand (works on Okazaki Fragments)
   6. *DNA Polymerase I :* replaces RNA primer with DNA on leading strand (also found in lagging strand)
   7. *Ligase:* forms bonds to connect the fragments of DNA (in both leading and lagging strands)
   8. *Telomerase*- elongates the ends of chromosomes (in immortal cells, such as cancer cells and in gametes-sperm and egg cells)
      1. Aging occurs because of the shortening of chromosomes without telomerase
3. The Process
   1. Steps
      1. Helicase separates complementary strands
      2. Binding proteins keep strands separated
      3. Topoisomerase relieves the strain caused by unwinding done by helicase
      4. RNA primer is added
      5. DNA polymerase III comes in after the RNA primer and adds nucleotides
      6. Once reaching next primer DNA polymerase III detaches
      7. RNA primer jumps back for lagging end, jumps forward for leading end to prime the DNA strand
      8. DNA polymerase I replaces the RNA primer with DNA
      9. DNA ligase forms bonds to connect the fragments of DNA
   2. *Deoxynucleotides* (dNTPs)
      1. dATP, dCTP, dGTP, dTTP
      2. Can only be added to the hydroxyl group (-OH) at the 3’ end
      3. Negative charges of phosphate groups repel each other
      4. Deoxyribonucleoside triphosphates (3 phosphate groups)
4. *Telomeres*
   1. the ends of linear chromosomes that are lost with each cell division because the RNA primer can only jump backwards until it falls off the DNA strand
   2. Therefore telomerase adds gibberish to the end of the DNA strand which nds and lets the RNA jump back and finish replicating the DNA strand
5. Important to Note
   1. DNA replication occurs during S-Phase
      1. Finally fully replicated by G2 Phase
   2. DNA unwinds in two directions- leading and lagging
   3. Primers are required for DNA Polymerase
   4. 10-12 base pair long primers are synthesized by Primase
   5. Each strand grows 5’ to 3’
      1. Chain grows at 3’ end (new nucleotides are added to 3’ end
         1. New nucleotides are added to the RNA primer by DNA polymerase
      2. Can’t add to the end with a phosphate (5’ end)
   6. Due to this reason we have a *lagging strand*
      1. The RNA primer must jump back towards the 5’ end and works towards the 3’ end
         1. Thus creating *Okazaki fragments* (short pieces of new DNA and RNA primer
   7. Leading ends do not have this problem because DNA polymerase is always adding to the 3’ end

Questions:

1. Which enzyme splits apart the two DNA strands at the beginning of replication.
   1. Telomerase
   2. DNA Polymerase I
   3. DNA Polymerase III
   4. Helicase
   5. Ligase
2. What stage does DNA Replication occur during?
   1. G1-Phase
   2. G2-Phase
   3. M-Phase
   4. S-Phase
   5. Anaphase
3. In what direction does DNA replication proceed?
   1. 5’ to 3’
   2. 3’ to 5’
   3. Both 3’ to 5’ and 5’ to 3’
   4. 5’ to 5’
   5. None of the above
4. What does Ligase do?
   1. add dNTPs
   2. unwinds the DNA strand
   3. forms bonds to connect the fragments of DNA
   4. Makes RNA primase
   5. changes charge of phosphates to allow replication in 5’ to 3’ direction
5. Which of the following is correct regarding Eukaryotic and Prokaryotic cells?
   1. Prokaryotes are animal and plant cells, contain linear DNA, and have no nucleus
   2. Eukaryotes are bacteria, contain circular DNA, and have a nucleus
   3. Eukaryotes contain linear DNA inside a nucleus
   4. Prokaryotes contain no DNA
   5. Prokaryotes are plant cells with circular DNA and Eukaryotes are animals cells with linear DNA

Essay Topics:

1. Why do Okazaki Fragments exist?
   1. DNA replication starts in a 5’ to 3’ direction
   2. Replication cannot go backwards from the origin of replication
   3. Fragments of DNA are created by RNA primers and extended by DNA Polymerase III
   4. DNA Polymerase III jumps back and proceeds 5’ to 3’ until it hits the previous RNA Primer and then the process continue
2. What is the importance of Telomerase?
   1. Definition of Telomeres
   2. Definition of telomerase
   3. Prolonging length of Chromosomes
   4. RNA polymerase involvement
   5. Continuing DNA replication
   6. In cancer cells (makes them immortal) and gametes