Nature of the genetic material

1. It must contain, in a stable form, information encoding the organism’s structure, function, development and reproduction
2. It must replicate accurately so progeny cells have the same genetic makeup
3. It must be capable of some variation(mutation) to permit evolution

DNA replication: the process in which the DNA within a cell makes an exact copy of itself

Semiconservative model: new double helix has 1 template + 1 new daughter strand

Mechanism

1. Enzymes unwind the parental double helix
2. Proteins stabilize the unwound parental DNA
3. The leading strand is synthesized continuously by DNA polymerase
4. The lagging strand is synthesized discontinuously. RNA polymerase synthesizes a short RNA primer, which is then extended by DNA polymerase
5. DNA polymerase digests RNA primer and replaces it with DNA
6. DNA ligase joins the discontinuous fragments of the lagging strand

Enzymes

1. Helicase——unwinds the double helix starting at a replication bubble
2. Single-strand binding proteins(SSB)——keep the strands from re-annealing
3. First subunit of DNA polymerase Ⅲ
4. Primase(RNA polymerase)——synthesize the RNA primer which “tell” the DNApolymerase where to start copying the DNA
5. Second subunit of DNA polymerase Ⅲ
6. DNA polymerase Ⅰ
7. DNA ligase

DNA replication requirement

1. H bonds between bases must be broken
2. Chain separation/unwinding
3. Available pools of 4 dNTPs: A=T, C=T
4. Enzymes: DNA helicase, primase, single-stranded DNA-binding protein, DNA polymerase

DNA polymerase ⅠⅡⅢ...

1. Polymerase catalyzes chain growth 5’ to 3’
2. Exonuclease removes mismatches 3’ to 5’
3. Exonuclease degrades double stranded DNA 3’ to 5’

Several types of activity in prokaryotic(bacteria)

PolⅠ:

1. Implicated in DNA repair
2. 5’ to 3’ activity (polymerase)
3. 3’ to 5’ exonuclease (proofreading)
4. 5’ to 3’ exonuclease (RNA primer removal)

PolⅡ:

1. Involved in repairation of damaged DNA
2. 3’ to 5’ exonuclease activity

Pol Ⅲ:

1. The main polymerase in bacteria (elongates in DNA replication)
2. 3’ to 5’ exonuclease proofreading ability

Eukaryotic DNA polymerases

Pol α：forms a complex with the Pri subunits concluding PriS(catalytic) and PriL(noncatalytic) and acting as a primase to synthesize an RNA primer, and Pol αelongating that primer with DNA nucleotides.

Pol β：implicated in repairing DNA, in base excision repair and gap-filling synthesis

Pol γ：

1. Replicates and repairs mitochondrial DNA
2. 3’ to 5’ exonuclease activity(proofreading)

Pol δ：

1. the main polymerase in lagging strand synthesis
2. 3’ to 5’ exonuclease activity(proofreading)

Pol ε：

1. the main polymerase in leading strand synthesis
2. 3’ to 5’ exonuclease activity(proofing)

Prokaryptes

1. Have a single origin of replication
2. Bidirectional replication with 2 forks→single terminus
3. 20 minuters

#DnaA is the initiator protein in DNA replication, and is essential for cell cycle

Eukaryotes

1. Have multiple origins of replication
2. Bidirectional replication with 2 forks
3. 1.4 h to 24 h or more

Why is replication necessary?

So both new cells will have the correct DNA

2. When does replication occur?

During interphase (S phase).

3. Describe how replication works.

Enzymes unzip DNA and complementary nucleotides join each original strand.