PROCESS OF DNA REPLICATION

* MECHANISM OF POLYMERASE-III ACTIVITY

KEY POINTS

DNA POLYMERASE

New DNA is made by enzymes called DNA polymerases, which require a template and a primer and synthesize DNA in the 5' to 3' direction

LEADING STRAND

During DNA replication, one new strand is made as a continuous piece and is known as the leading strand

LAGGING STRAND

The other strand is made in small pieces and is known as lagging strand

The DNA polymerase can only add nucleotides to the 3' end of a DNA strand

ENERGY REQUIREMENT

The addition of nucleotides require energy. This energy comes from the nucleotides themselves, which have three phosphates attached to them (much like ATP). When the bond b.w phosphates is broken, the energy released is used to form a bond b.w the incoming nucleotide and the growing chain.

ORIGIN OF REPLICATION SITES

Replication always starts at specific locations on the DNA, which are called origins of replication and are recognized by their sequence.

REPLICATION BUBBLE

Specialized proteins recognize the origin, bind to this site, and open up the DNA. As the DNA opens, two Y-shaped structures called replication forks are formed, together making up what's called a replication bubble. The replication forks will move in opposite direction as replication proceeds.

SINGLE-STRAND BINDING PROTEINS

Proteins called ~~str~~ single-strand binding proteins coat the separated strands of DNA near the replication fork, keeping them from coming back together into a double helix

DNA POLYMERASE

DNA polymerases can only add nucleotides to the 3' end of an existing DNA strand. (They use the free -OH group found at the 3' end as a "hook", adding a nucleotide to this group in the polymerization reaction).

PRIMER

Primase makes an RNA primer, a short stretch of nucleic acid complementary to the template, that provides a 3' end for DNA polymerase to work on. A typical primer is about five to ten nucleotides long. The primer primes DNA synthesis i-e gets it started

EXTENSION

Once the RNA primer is in place, DNA polymerase "extends" it, adding nucleotides one by one to make a new DNA strand it's complementary to the template strand.

DNA polymerase can only make DNA in the 5′ to 3′ direction, and this poses a problem during replication. A DNA double helix is always anti-parallel; in other words, one strand runs in the 5′ to 3′ direction, while the other runs in the 3′ to 5′ direction. This makes it necessary for the two new strands, which are also antiparallel to their templates, to be made in slightly different ways.

LEADING STRAND

One new strand, which runs 5′ to 3′ towards the replication fork, is the easy one. This strand is made continuously, bcz the DNA polymerase is moving in the same direction as the replication fork. This continuously synthesized strand is called leading strand.

LAGGING STRAND

The other new strand, which runs 5′ to 3′ away from the fork, is trickier. This strand is made in fragments bcz, as the fork moves forward, the DNA polymerase (which is moving away from the fork) must come off and reattach on the newly exposed DNA. This tricky strand, which is made in fragments, is called the lagging strand.

OKAZAKI FRAGMENTS

The small fragments are called Okazaki fragments, named for the Japanese scientist who discovered them.

The leading strand can be extended from one primer alone, whereas the lagging strand needs a new primer for each of the short Okazaki fragments.