Nucleic Acids

The Central Dogma of Molecular Biology

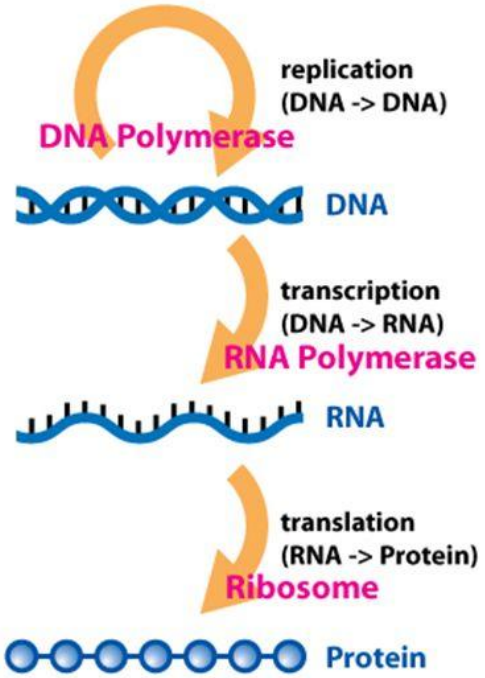
- Information is transferred from DNA to RNA to protein

  DNA -> RNA -> Protein

- Proteins create traits

- This is called **gene expression**

- This process is found in all organisms



Synthesis and degradation of nucleic acids strands

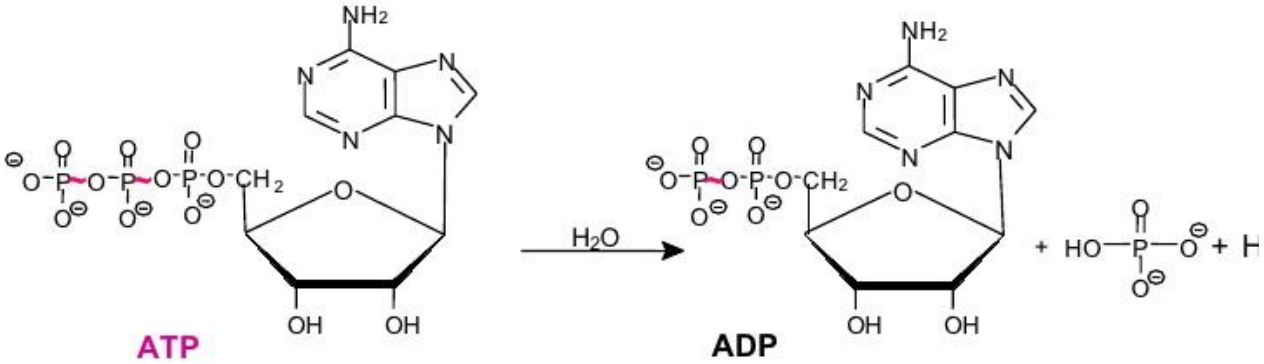
- Polymerized nucleic acid strand has higher free energy than a mixture of monomers
- Therefore nucleic acid could be degraded (hydrolyzed) with no additional energy needed.
- In order to synthesize a nucleic acid strand from monomers additional chemical energy is required. This energy comes in a form of a high-energy (macroergic) phosphate bond.

ATP

The term „high-energy compound“

(also „macroergic compound“ or „energy rich compounds“)

The most important is ATP



Two stages of ATP hydrolysis

ATP provides energy in two reactions:

$ATP + H_2O \rightarrow ADP + P_i$ $\quad \Delta G^{0'} = -30{,}5$ kJ/mol

$ATP + H_2O \rightarrow AMP + PP_i$ $\quad \Delta G^{0'} = -32{,}0$ kJ/mol

Reactions are catalyzed by enzymes

Similarly GTP, UTP a CTP can provide energy

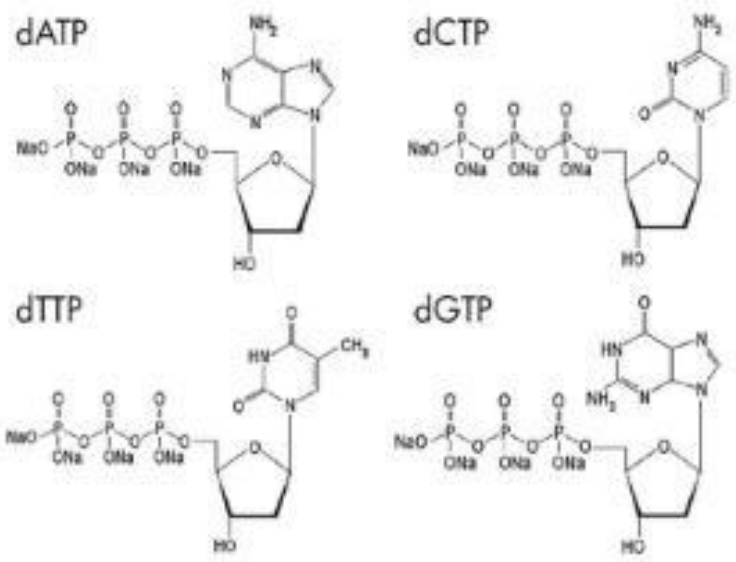
ATP in cells

- Life expectancy of an ATP molecule is about 2 min.
- It must be permanently synthesized
- Momentary content of ATP in a human body is about 100 g, but 60-70 kg is produced daily
- Adenylate kinase maintains the equilibrium between ATP, ADP a AMP

$$ATP + AMP \rightleftarrows 2\ ADP$$

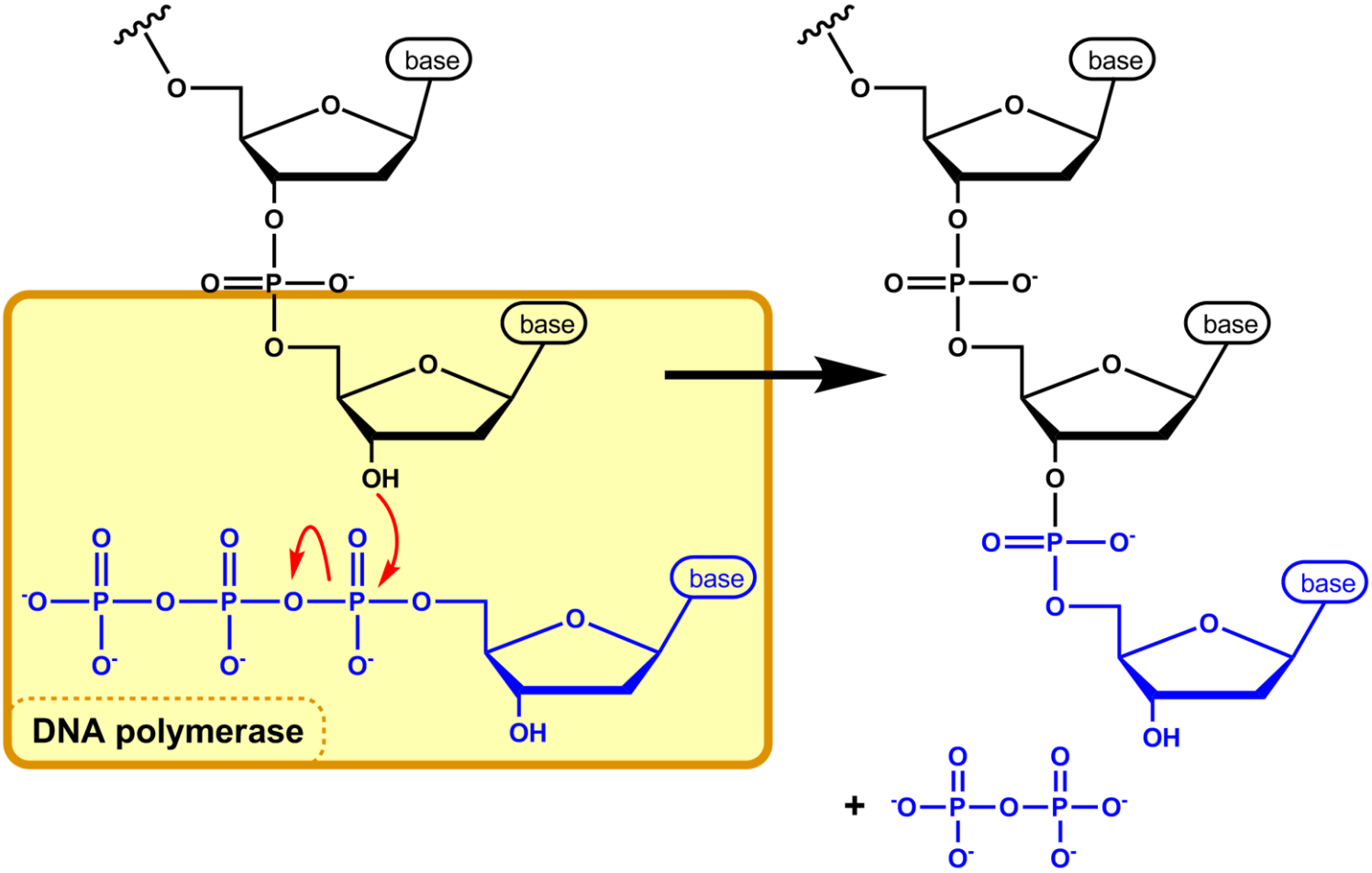
ATP is a universal "fuel" in the cell used in the majority of the reactions that require additional energy

- Any nucleotide or deoxynucleotide could be phosphorylated yielding a triphosphate macro-ergic derivative :



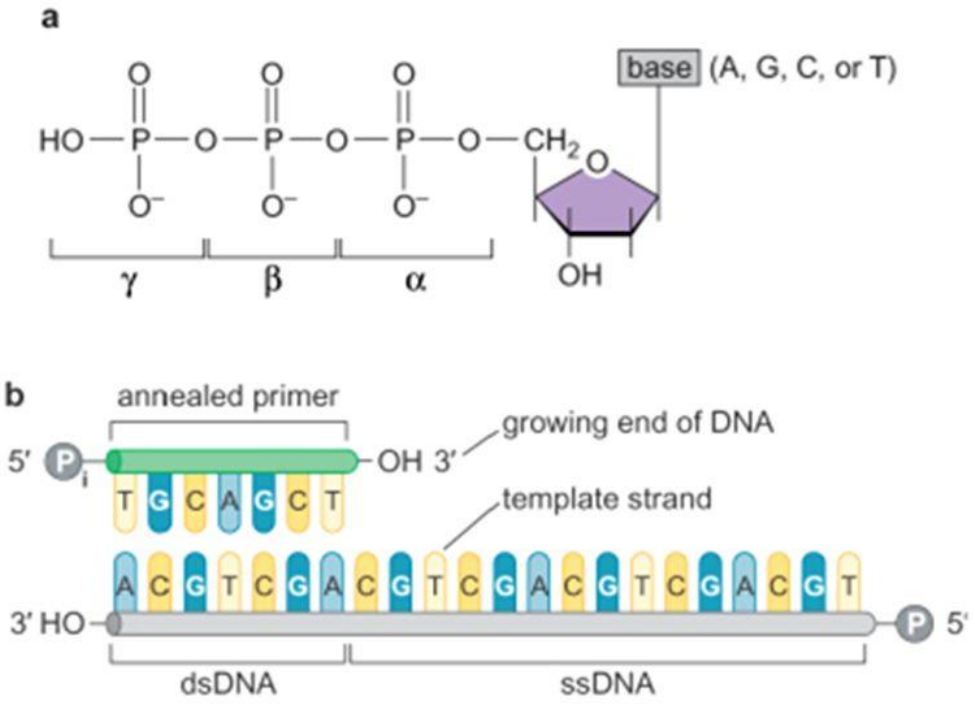
- Specialized enzymes maintain pool of NTP and dNTP in the cell at concentrations needed for new DNA and RNA synthesis.

Addition of new monomer to the growing DNA (RNA) strand



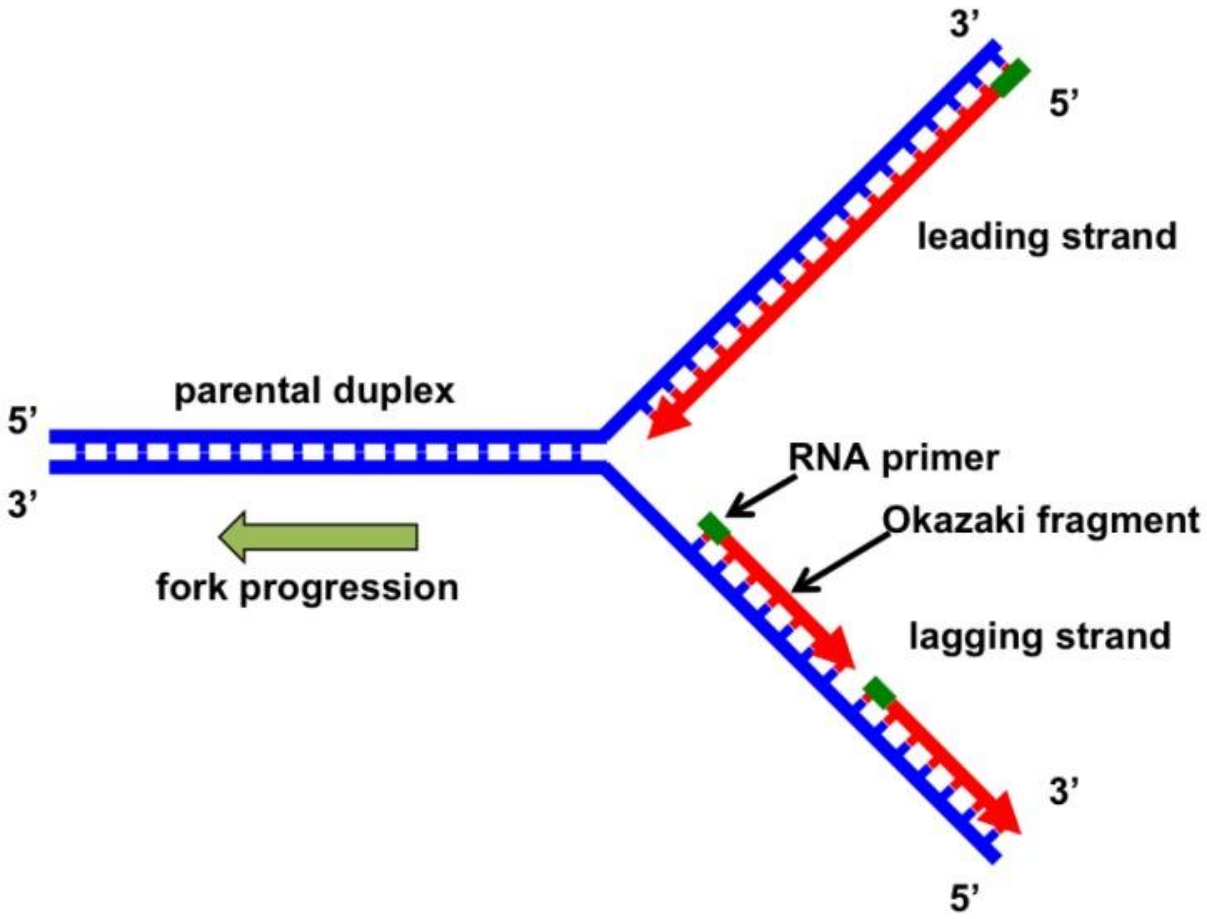
- There are many enzymes that can catalyze polymerization of DNA or RNA strand
- In the processes of DNA replication and transcription into RNA new nucleic acid strand is copied from a template NA that has complimentary sequence to the new strand.
- Some enzymes can extend NA strand without a template

Substrates required for DNA synthesis

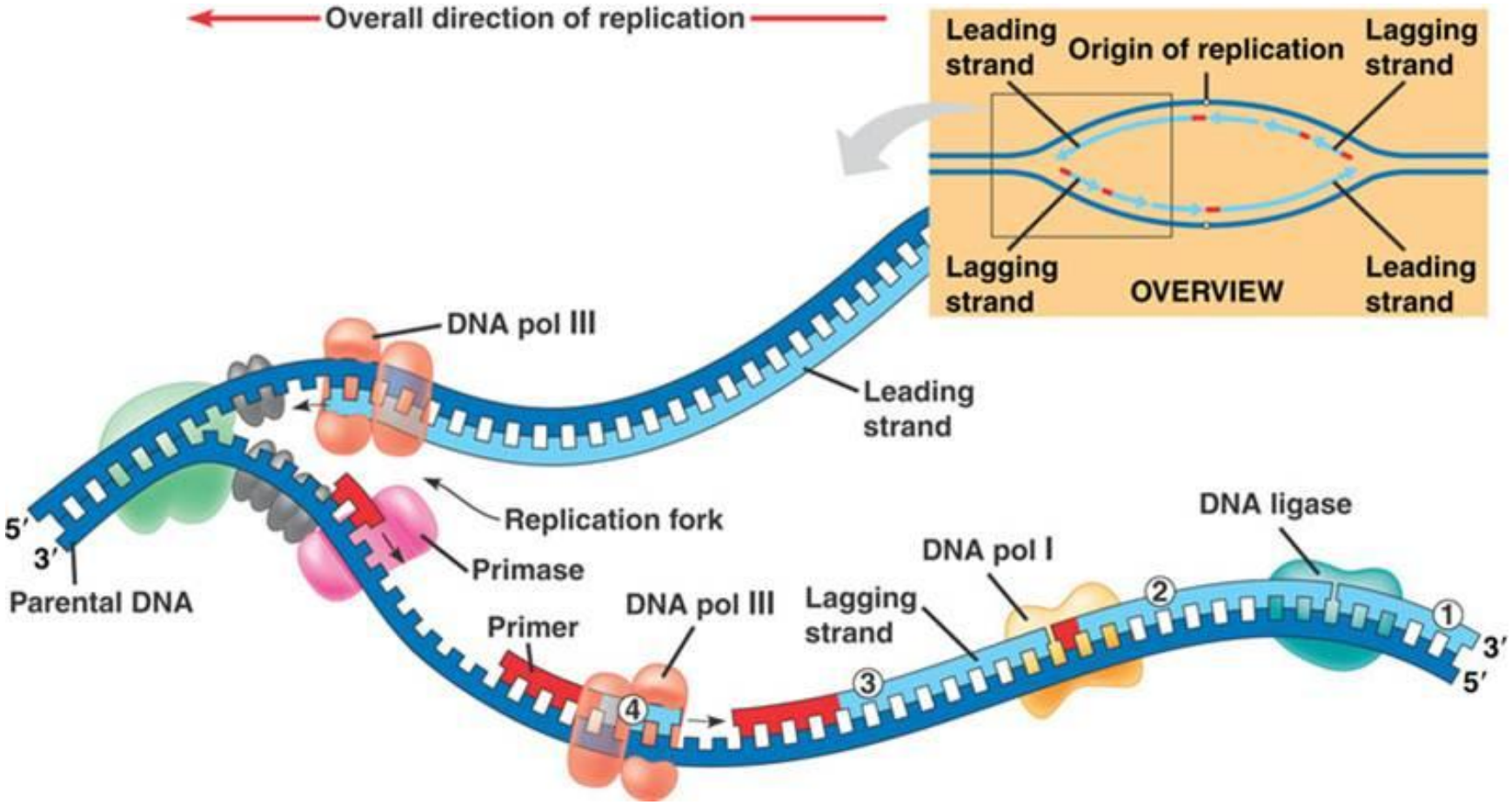


Newly synthesized NA strand grows from in the 5’ to 3’ direction

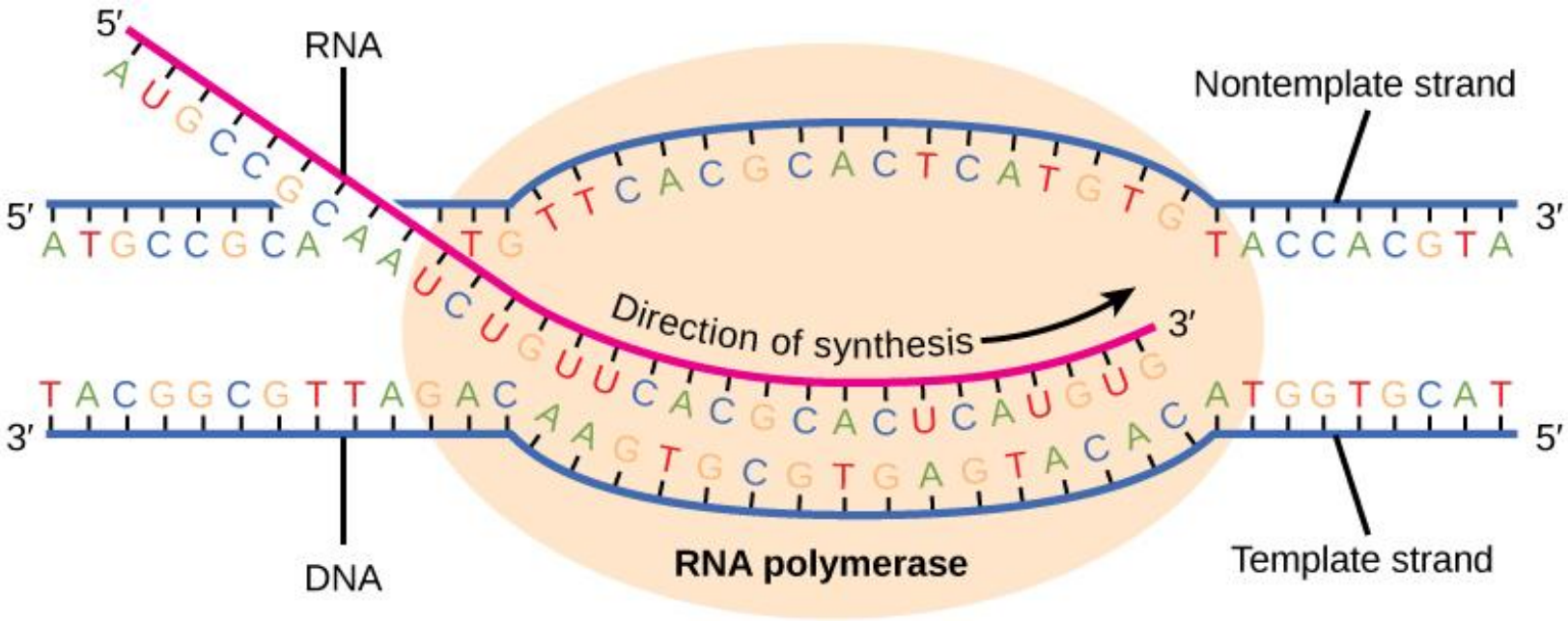
DNA replication



DNA replication



Transcription



Transcription