What is Molecular Biology?
Molecular biology is the study of biology at a molecular level, especially DNA and RNA.

Molecular biology is the study of molecular underpinnings of the processes of replication, transcription, translation, and cell function. The central dogma of molecular biology where genetic material is transcribed into RNA and then translated into protein, despite being an oversimplified picture of molecular biology, still provides a good starting point for understanding the field.

Molecular biology chiefly concerns the understanding of the interactions between the various systems of a cell.

Molecular biology overlaps with other areas of biology and chemistry, particularly genetics (effect of genetic differences on organisms) and biochemistry (chemical substances and vital processes occurring in living organisms).

Molecular biology is the convergence of various, previously distinct biological and physical disciplines: biochemistry, genetics, cell biology, microbiology, virology and physics.
**Molecular biology** is the branch of biology that deals with the manipulation of DNA or RNA so that it can be sequenced, detected, modified, or expressed.

The techniques of molecular biology are applied to many fields

- Genomics
- Cell biology
- Microbiology
- Biotechnology
- Diagnostics
- Therapeutics
- Forensics
- Agriculture
Some core tools of molecular biology

- DNA purification
- Polymerase chain reaction
- Gel electrophoresis
- Restriction analysis
- DNA sequencing
- Bioinformatics
DNA structure and replication
DNA

- Deoxyribonucleic acid
- Macromolecule (average human chromosome has 5 cm of DNA)
- Contains genetic instructions for development and functioning of all known living organisms (with the exception of RNA viruses)
- Long-term storage of information
- Contains the instructions needed to construct RNA molecules and proteins
- DNA segments that carry this genetic information are called genes
- Other DNA sequences have structural purposes, or are involved in regulating the use of the genetic information.
DNA is normally double stranded

Two strands held together by H bonds between bases

A single strand of DNA has an orientation (5’ → 3’)

In double stranded DNA, the two strands have opposite orientation

There are four bases A (adenine), C (cytosine), G (guanine), T (thymine)

Specific base pairing
    - Base A always pairs with T
    - Base C always pairs with G

The sequence of one strand defines the sequence of the second strand. The two strands are said to be ‘complimentary’

Information is stored in the sequence of bases

Double stranded DNA resembles a ladder
    - Rails = sugar/phosphate
    - Rungs = base pairs (bp)

DNA building blocks = 4 nucleotides (phosphate/sugar/base)
DNA is a polymer of nucleotides

• DNA is a nucleic acid, made of long chains of nucleotides

![Diagram of DNA structure]

- DNA nucleotide:
  - Phosphate group
  - Nitrogenous base (A, G, C, or T)
  - Sugar (deoxyribose)

Polynucleotide

Sugar-phosphate backbone

3' END

5' END

Campbell et al. (2003) BIOLOGY concepts and connections.
3’ and 5’ ends of DNA movie

http://www.youtube.com/watch?v=p835L4HWH68
• Each strand of the double helix is oriented in the opposite direction.

Campbell et al. (2003) BIOLOGY concepts and connections.
• DNA has four kinds of bases, A, T, C, and G
In DNA replication, the strands separate
– An enzyme (polymerase) use each strand as a template to assemble the new strands
Figure 1-9 Simultaneous replication of both strands of the double helix. Both strands are read in the 3' to 5' direction. The lagging strand is read discontinuously, with the polymerase skipping ahead and reading back toward the replication fork on the lagging strand.
A SUMMARY OF DNA REPLICATION

1. Helicases unwind the parental double helix.

2. Single-strand binding proteins stabilize the unwound parental DNA.

3. The leading strand is synthesized continuously in the 5' → 3' direction by DNA polymerase.

4. The lagging strand is synthesized discontinuously. Primase synthesizes a short RNA primer, which is extended by DNA polymerase to form an Okazaki fragment.

5. After the RNA primer is replaced by DNA (by another DNA polymerase, not shown), DNA ligase joins the Okazaki fragment to the growing strand.

Overall direction of replication

http://www.tokresource.org/tok_classes/biobiobio/biomenu/dna_replication/index.htm
The DNA is transcribed into RNA, which is translated into the polypeptide.
Thank you
• RNA is also a nucleic acid
  – RNA has a slightly different sugar
  – RNA has U instead of T
phosphodiester linkage

example: DNA