

Spring 2008 MSAE E4990y  
Introduction to STM and AFM

Lecture 5  
Biological Studies  
February 6, 2008

Outline

- The Feynman Proposal
- Structure of DNA
- The polymerase chain reaction (PCR)
- Immobilizing DNA
- Imaging DNA
- Manipulating DNA

References: Sections 1.5.4.

The Feynman Proposal (1959)

What are the most central and fundamental problems of biology today? They are questions like: What is the sequence of bases in the DNA? What happens when you have a mutation? How is the base order in the DNA connected to the order of amino acids in the protein?...

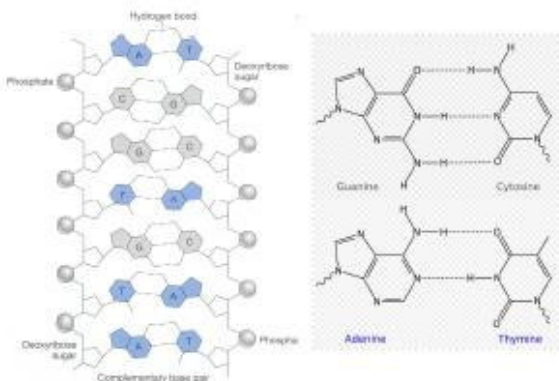
It is very easy to answer many of these fundamental biological questions; you just look at the thing! You will see the order of bases in the chain; you will see the structure of the microsome. Unfortunately, the present microscope sees at a scale which is just a bit too crude. Make the microscope one hundred times more powerful, and many problems of biology would be made very much easier.

Discovery of the Structure of DNA (1)



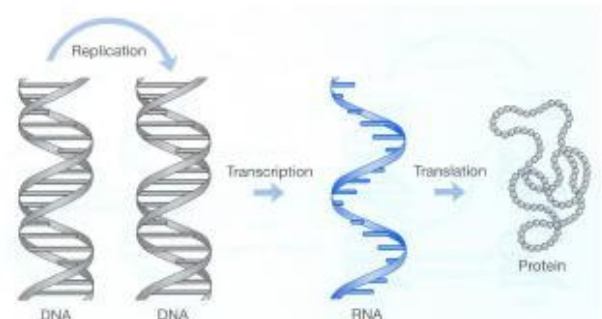
Francis H. C. Crick (1916 — 2004) James D. Watson (1928 —)

Discovery of the Structure of DNA (2)



(a) A "flattened" view of the double helix. (b) The base pairs.

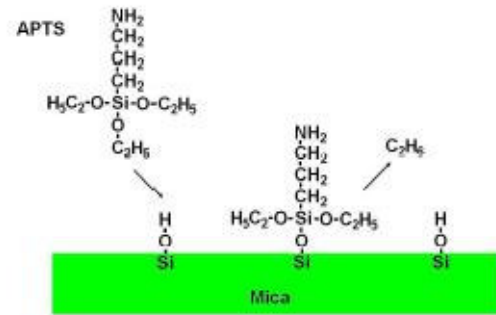
Crick's Central Dogma (1957)



## The Polymerase Chain Reaction (PCR)

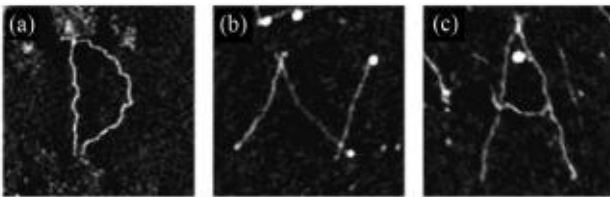
- Invented by Kary Mullis in 1985.
- A sequence of heating and cooling cycles with a DNA duplicating enzyme, polymerase.
- In the heating step, a DNA splits into two strings
- In the cooling step, each string picks up bases to become a double helix again.
- In each step, the number of DNA molecules doubles.
- With about 30 cycles, a single DNA molecule becomes one billion copies.

## Immobilization of DNA on silanated mica



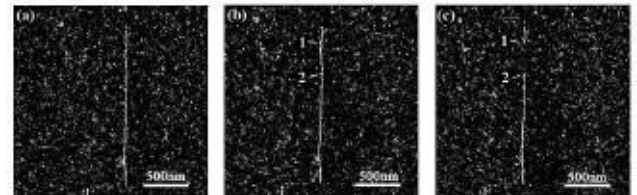
By reacting APTS with mica, a layer of amine group is formed with high activity.

## Imaging and manipulation of DNA using AFM



On top of APTS silanated mica, DNA can stay immobile during imaging, but can be pushed around by the AFM tip.

## Cutting and picking up a DNA segment using AFM



(a) The original DNA fragment. (b) The DNA fragment was cut at 150 nm and 450 nm locations. (c) The DNA segment is picked up by the FM tip.