

# Topics for the 5 min “Biophysics TED Talks”

*This is the list from 2015*

## ***Fundamentals/Introduction:***

What is life?  
The “family tree of life” – phylogeny and ribosomal RNA  
The DNA double helix  
DNA replication by DNA-polymerases  
DNA transcription by RNA-polymerases  
Translation: ribosomes in action

## ***Proteins:***

Natural and unnatural amino acids  
Protein secondary structure and circular dichroism (CD) spectroscopy  
Afinsen’s hypothesis and protein structure  
Levinthal’s paradox and protein folding  
Free energy and protein (un-)folding  
Chaperones: helping proteins fold  
Physics-based prediction of protein structure  
Knowledge-based prediction of protein structure  
Protein structure design  
The physical nature and biology roles of hydrogen bonds  
Molecular dynamics simulations

## ***Protein-ligand interactions:***

Protein-ligand interactions and drug design  
Basics of binding equilibria: affinity, free energy, and rates  
Binding cooperativity and allostery  
Modeling cooperative binding 1: Hill model  
Modeling cooperative binding 2: Monod-Wyman-Changeux model  
Modeling cooperative binding 3: Koshland-Némethy-Filmer model  
Measuring binding with temperature fields  
Why do molecules move in a thermal gradient?

## ***RNA***

Traditional roles of RNA in the central dogma  
RNA beyond the central dogma 1: Ribozymes  
RNA beyond the central dogma 2: RNA-interference  
RNA beyond the central dogma 3: Riboswitches  
RNA beyond the central dogma 4: The RNA world hypothesis  
Roles of ions in RNA folding  
Salt dependence of nucleic-acid protein interactions  
Poisson-Boltzmann theory  
SELEX: How to breed molecules  
The RNA world: finding RNA-based polymerases  
Questions to solve to understand the Origin of Life

## ***Polymer physics***

Freely-jointed chain (FJC)  
Excluded volume interactions à la Flory  
Small-angle X-ray scattering and the Guinier approximation  
Worm-like chain (WLC)  
Enthalpic stretching à la Odijk and DNA overstretching transition(s)

## ***Single-molecule experiments***

The Atomic Force Microscope (AFM)  
Unfolding proteins by AFM  
Receptor-Ligand bonds under force and force spectroscopy  
Optical tweezers  
Studying molecular motors using optical tweezers  
Magnetic tweezers  
DNA torque and twist in magnetic tweezers  
Powerspectra and the calibration of single-molecule instruments  
Sheet Illumination Microscopy for single molecule detection