On Achieving Clarity in Scientific Communication

Huan-Xiang Zhou

Department of Chemistry and Department of Physics
University of Illinois Chicago

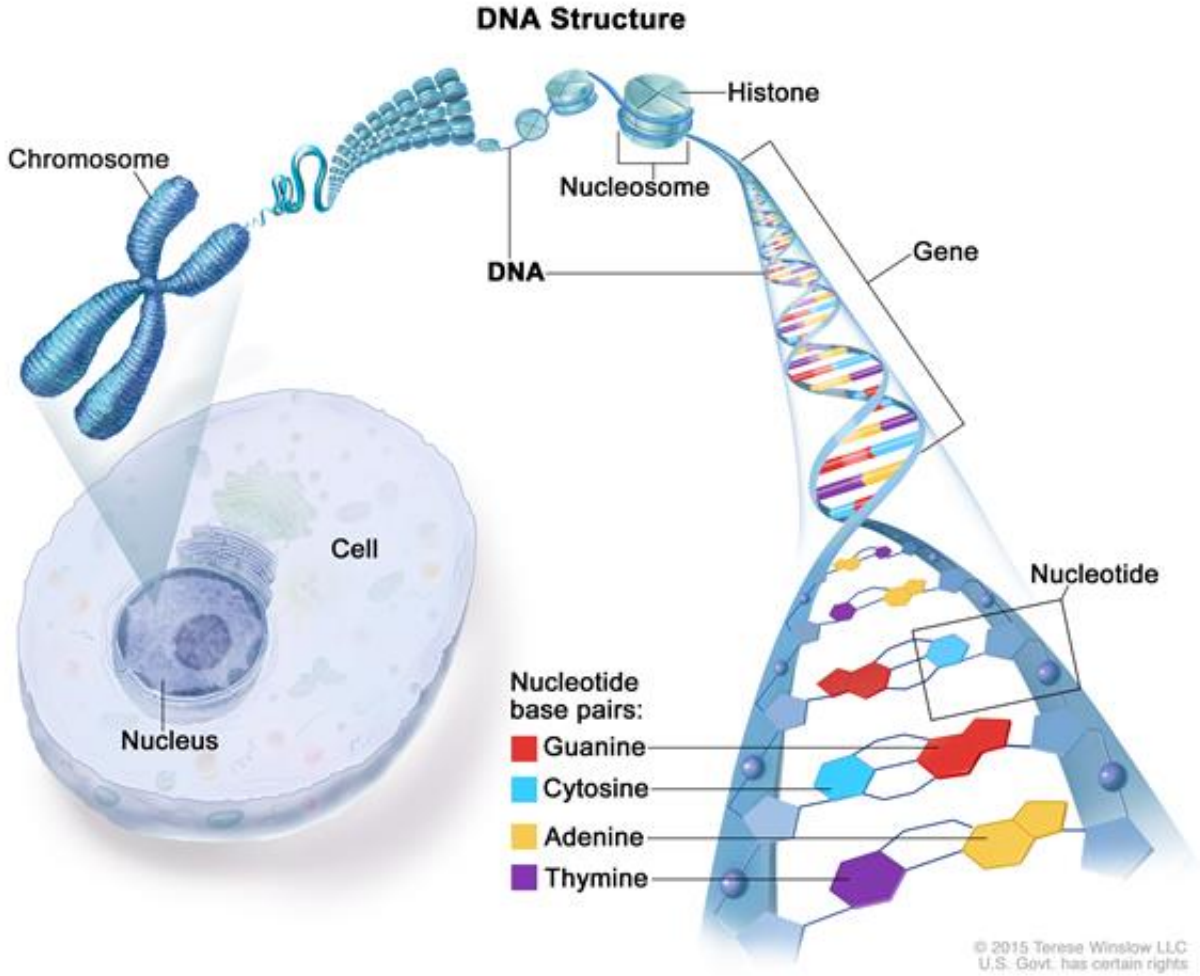
- Writing papers (and getting them published) and making presentations are the two most important means of communicating your research to others.
- No efforts should be spared in making your communication as effective as possible.
- The most important measure of effectiveness is clarity.

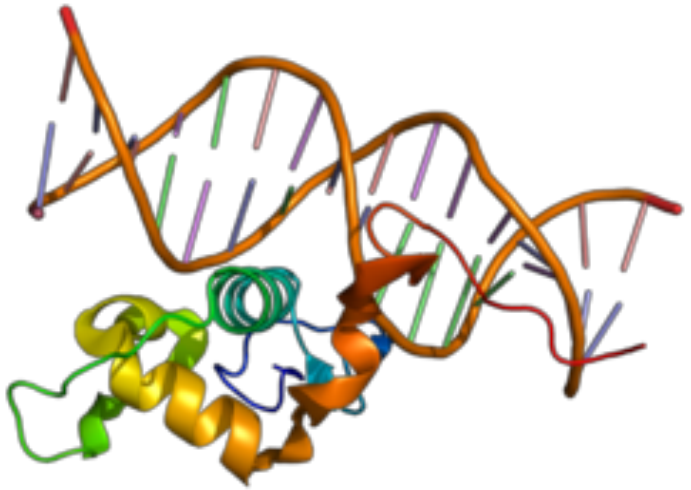
Each Paper Should Present One Message

This message should be repeated multiple times throughout the paper:

- Title
- Abstract
- Introduction: last sentence of first paragraph; last paragraph
- Results and Discussion
- Conclusion

Recognition of a Specific Piece of DNA by Protein





www.pnas.org/cgi/doi/10.1073/pnas.1101555108 PNAS | May 24, 2011 | vol. 108 | no. 21 | 8651–8656

Title

Rapid search for specific sites on DNA through conformational switch of nonspecifically bound proteins

Huan-Xiang Zhou[1]

Department of Physics and Institute of Molecular Biophysics, Florida State University, Tallahassee, FL 32306

Abstract

We develop a theory for the rapid search of specific sites on DNA, via a mechanism in which a nonspecifically-bound protein can switch between two conformations. In the "inactive" conformation, the bound protein has favorable, nonspecific interactions with the DNA, but cannot be recognized by the target site. In the "active" conformation, the protein is recognized by the target site but has a very rugged energy surface elsewhere on the DNA. The rate constant for protein binding to the specific site is calculated by an approach in which the protein, after reaching the DNA surface via 3D diffusion, searches for the target site via 1D diffusion while being allowed to escape to the bulk solution. Mindful of the pitfalls of many previous approximate treatments, we validate our approach against a rigorous solution of the problem when the protein has a fixed conformation. In the 1D diffusion toward the specific site, a conformationally switchable protein predominantly adopts the inactive conformation due to the favorable nonspecific interactions with the DNA, thus maximizing the 1D diffusion constant and minimizing the chance of escape to the bulk solution. Once at the target site, a transition to the active conformation allows the protein to be captured. This induced-switch mechanism provides robust speedup of protein-DNA binding rates, and appears to be adopted by many transcription factors and DNA-modifying enzymes.

Introduction 1st par.

Ever since the first demonstration that proteins can bind to specific DNA sequences (1, 2), numerous studies have been carried out to address the question of how a protein can readily find a short specific site on a long DNA (3–20). It is widely ac-

…

has been questioned (15). Here we present an approach for calculating the protein-DNA binding rate constant k_a that allows for proper coupling between 3D and 1D diffusion. We use this approach to treat the conformational switch of a nonspecifically bound protein, and demonstrate that it provides a robust mechanism for speeding up the search of specific sites.

…

two-state model, but with an unjustified specification of $\bar{n}$. Using our approach based on the position-dependent capture probability, we show that a DNA-binding protein can stay mostly in a fast diffusing "inactive" conformation until it encounters the specific site, whereupon interactions with the specific site induce it to quickly switch to the active conformation for recognition. This induced-switch mechanism appears to be adopted by many transcription factors and DNA-modifying enzymes.

Introduction last par.

Results and Discussion

…

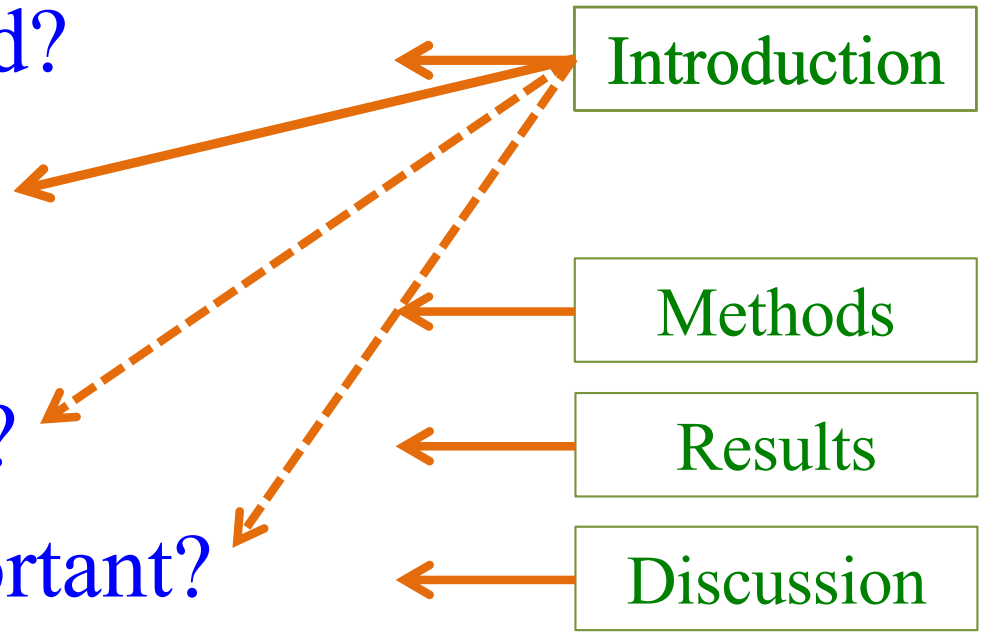
the accuracy of the k_a calculation. We finally use this approach to treat the conformational switch of a nonspecifically-bound protein, and find that adopting the fast diffusing inactive conformation during the approach to the specific site and then quickly switching to the active conformation via interactions with the specific site allow the protein to achieve significant speedup in k_a. Our results suggest that this "induced-switch" mechanism is adopted by many transcription factors and DNA-modifying enzymes.

Opening paragraph

…

A Paper Should Answer

- WHAT is that you studied?
- WHY did want to do it?
- HOW did you do it?
- WHAT is that you found?
- WHY is the finding important?



Five-sentence summary:

This paper is a study of aaa. We did the study because bbb. The study was done by ccc. We found ddd. This finding is important as it eee.

Same Idea Can be Used to Speed-Read Papers

How to use the shortest time to summarize a paper in one sentence, three sentences, five sentences?

Introduction Section

- It's crucially important that you have a thorough grasp of the literature in your subject area.
- In many ways the most important section
- State
  - the subject of your study ("study of aaa")
  - the motivation ("did the study because bbb")
- Summarize prior studies to provide the background for evaluating your study/finding: gap in knowledge; conflicting theories; experimental observations waiting for explanations
- Highlight the most important finding and explain why the importance

Discussion Section

- Explain how the finding of your study has changed/advanced the field
- Note caveats and alternative interpretations of results
- How your study will impact future studies
  - With the structure modeled or mechanism developed here, we can now design drugs

Divide b/w Introduction, Results, and Discussion

- The three sections represent the past, present, and future, respectively.
- Introduction presents what others and you have done in the past. All relevant past studies should be mentioned here.
- Results are what you've done at present.
- Discussion is about how your present work will influence the future.
  - Should contain no past studies that have not been introduced already.

Paragraphs

- Each paragraph talks about one point; the same point is covered in the same paragraph
- Each paragraph can be condensed into a single sentence
- In writing a section
  - first list the points to be covered
  - then order the points logically
  - finally expand each point into a paragraph
  - pay attention to transition between paragraphs; logical ordering helps

Sentences and Phrases

- Make sure that subject and verb agree
- “Evidence” is not countable and should be treated as singular
  - The evidence presented shows xxx; three lines of evidence suggest yyy
- When in doubt, use Google!
  - “to a lesser extent” 147 million hits vs. “to a less extent” 5.6 million hits

Words

- Strive to use precise words

  Initial: "… flexibility allows the protein to wrap around protrusions and indents of the target, giving rise to an intricate interaction surface …"

  Final: the bound state, flexibility allows the protein to wrap around protrusions and indents of the target, which gives rise to a convoluted interaction surface and high

- Words having several meanings can result in misinterpretation; use the word that can only be interpreted in the way intended
- Use spellchecker!

Presentation

- Purpose is to make your audience understand, not to impress the audience with complexity of your study
- Know your audience and present appropriate introductory materials to prepare your audience
- Simplify the presentation of your study so the audience has a chance to get it; leave out the gory details that you think may wow your audience
- Do not introduce a topic unless you're going to fully explain it; don't leave your audience wondering why that was brought up

Choose What to Include in Your Slides

- Choose carefully what to include and what not to include
- For anything you include, you should be ready to explain
- Sometimes you can say “I’m only going to explain one aspect of this slide or figure, and can explain other aspects if people ask”; or state “I’m not able to explain this other aspect”

Always Motivate

- Tell why you're going to present something before you present it
- Tell where you're heading before launching into a complicated exposition
- Start with a big picture before details
- It's OK to say this is a complicated subject and you're only going to give a basic idea but can explain technical details afterwards