



# Practical Tips on Teaching Biochemistry

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## 1. Choose the teaching tool which is best for you



Desktop PC or Notebook or  
**iPad Pro?**





## 2. Each lecture counts, especially first one and last one



# Passion

You have to teach every lecture with passion and take it very seriously



### *Comments from one of my students*



I love Biochemistry just because of Yang sir. After listening to his first lecture, I cannot wait for next one every week. When I am in bad mood, I just can't help shouting to myself: how much I want to listen to Biochemistry right now ! 😘



# How to give the first lecture?



- ✦ Give a brief welcome speech
- ✦ Ask one student to talk about how much he or she knows about Biochemistry
- ✦ Play one song called "**Biochemistry**"
- ✦ Emphasize the class disciplines and introduce the grading policy
- ✦ Invite a senior student who did best in biochemistry last semester to share the biochemistry-learning experiences
- ✦ Make a brief introduction about the recent biochemistry-related advances made by the Nobel laureates
- ✦ Introduce **the molecule or breakthrough of the year** related to biochemistry by *Science*
- ✦ Talk about what Biochemistry is, what biochemistry is about and what is the use of biochemistry
- ✦ Play three videos: the first is a news story about how a mother, a politics professor, treated her kids suffering from cystic fibrosis by self-studying biochemistry; the second one is also a story about how an undergraduate student diagnosed with chordoma from Duke university did his research about cancer in his spare time; the third one is "**the inner life of the cell**" created by Harvard university
- ✦ Give assignments



# Biochemistry



Biochemistry Biochemistry  
 I wish that I were wiser  
 I feel I'm in way over my head  
 I need a new advisor

My courses really shouldn't be  
 Such **metabolic misery**  
 Biochemistry Biochemistry  
 I wish that I were wiser

Biochemistry Biochemistry  
**Reactions** make me shiver  
 They're in my heart and in my lungs  
 They're even in my liver

I promise I would not **complain**  
 If I could store them in my brain  
 Biochemistry Biochemistry  
 I wish that I were wiser

Biochemistry Biochemistry  
 I'm truly in a panic  
 The **mechanisms** murder me  
 I should have learned **organic**

For all I have to memorize  
 I ought to win the **Nobel Prize**.  
 Biochemistry Biochemistry  
 I wish that I were wiser



A female test-genius from Class 2013 was sharing her biochemistry-learning experiences with her juniors



## How to give the last lecture?



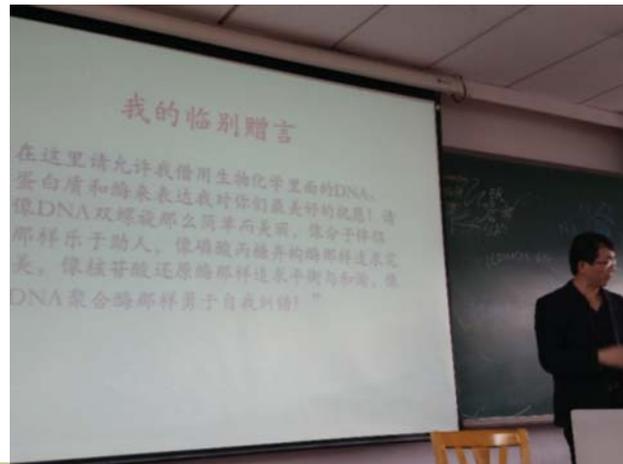
1. Don't start with a bang and end with a whimper
2. Be consistent with the first lecture
  - a. Play the song named “**Biochemistry Pie**”
  - b. Let students share their biochemistry-studying experiences
  - c. Speak of their “**favorite protein, favorite enzyme and favorite RNA**”
  - d. Replay the third video played in the first lecture and ask again how much students know about
3. Talk about the final exam
4. Give a farewell speech in a biochemical way



## My farewell speech



Here let me borrow DNA, proteins and enzymes from biochemistry, to express my best wishes to you! As simple and beautiful as the DNA Double Helix, as helpful as the molecular chaperone, as perfect as the triose phosphate isomerase, being in pursuit of balance and harmony as nucleotide reductase and self-correction just as DNA polymerase!



## 3. Keep your lecture up to date



### ★ Examples:

- a) Moonlighting proteins
- b) Pseudoenzymes
- c) CircRNA
- d) The fifth base and the sixth base of DNA
- e) **Bromine Is an Essential Trace Element for Assembly of Collagen IV Scaffolds in Tissue Development and Architecture (*Cell* 157, 1380–1392, June 5, 2014 )**
- f) A synthetic molecular system capable of mirror-image genetic replication and transcription. (*Nat Chem.* 8(7):698-704, July, 2016)



## 4. Diversify your teaching methods



- a) The bilingual teaching
- b) The multimedia teaching
- c) Problem-based teaching
- d) The elicitation method of teaching
- e) Limited Flipped classroom
- f) Oral lecture without the help of any other means even ppt slides



## Well-designed question examples



- a) Why don't sickle anemia and  $\beta$ -thalassemia affect fetus?
- b) Why can sickle anemia patients or carriers resist malaria?
- c) When a woman is pregnant, how will the 2,3-BPG level change in her body?
- d) Can rats or mice suffer from scurvy?
- e) Why is the catalytic efficiency of catalase so high and why is that of RuBP carboxylase just so-so?
- f) Why can the cystic fibrosis patients or carriers resist cholera?
- g) How can you do to create the trans-membrane proton gradient for *E. coli* in your intestine?
- h) How can TNT lose your weight?
- i) What happened if caffeine could inhibit the activity of cGMP phosphodiesterase?
- j) Why do primates catabolize purine with Uric acid as the end product?



## 5. Try to make your more interesting



- a) Arsenic and death of Wu dalang
- b) Cholera and death of Tchaikovsky
- c) Peter Mitchell built the lab in his home to seek evidences in support of the chemiosmotic theory
- d) German cows cause methane blast in Rasdorf
- e) Watching scary movies can lose weight
- f) How did Viagra which was originally developed to cure heart disease become a medicine to cure ED?
- g) How did adefovir which was originally developed to cure AIDS become a medicine to cure hepatitis B?
- h) Introduce the second law by predicting that a building where you are will collapse some day



## You can express I love you in a biochemical style!



Isoleucine

Leucine pyrrolysine valine glutamate

Tyrosine pyrrolysine selenocysteine





## *A Poem about how high fidelity of DNA replication is achieved*



- ✂ Replicative errors are no big deal,
- ✂ As long as editing is right.
- ✂ Even occurs one mistake,
- ✂ Repairing enzymes will fix it later.



## **6. Use analogy or comparison, make demonstrations and even play games**



### ☺ Comparison examples

- a) RNA and DNA
- b) Red muscle and white muscle
- c) White adipose tissue and brown adipose tissue
- d) Three energy storages: glycogen, fats and proteins
- e) Oxidative phosphorylation and photophosphorylation
- f) PKA and AMPK, PFK1 and PFK2、 CPT1 and CPT2, ACC1 and ACC2, CPS1 and CPS2
- g) Various signaling pathways
- h) Various metabolic pathways
- i) Bacteria, archaea and eukaryotes



## Analogy examples



- ☺ Titin—a great man knows when to yield and when not
- ☺ Prion —He that touches pitch shall be defiled
- ☺ Cyclin and CDK—Behind every active CDK there is a cyclin just like behind every successful man there is a woman
- ☺  $F_1F_0$ -ATP synthase—molecular cash printer, enzyme—molecular matchmaker, signal peptide—molecular zip code
- ☺ Phospholipid —yourself
- ☺ Glycolysis can be likened to cutting in the waist and phosphate pentose pathway can be likened to beheading.
- ☺ The enzyme and its suicidal inhibitor—the farmer and snake in the fable
- ☺ Why do the receptors of growth factors have to dimerize during action—You scratch my back and I'll scratch yours
- ☺ Function of citrate in the cytosol: one stone, four birds



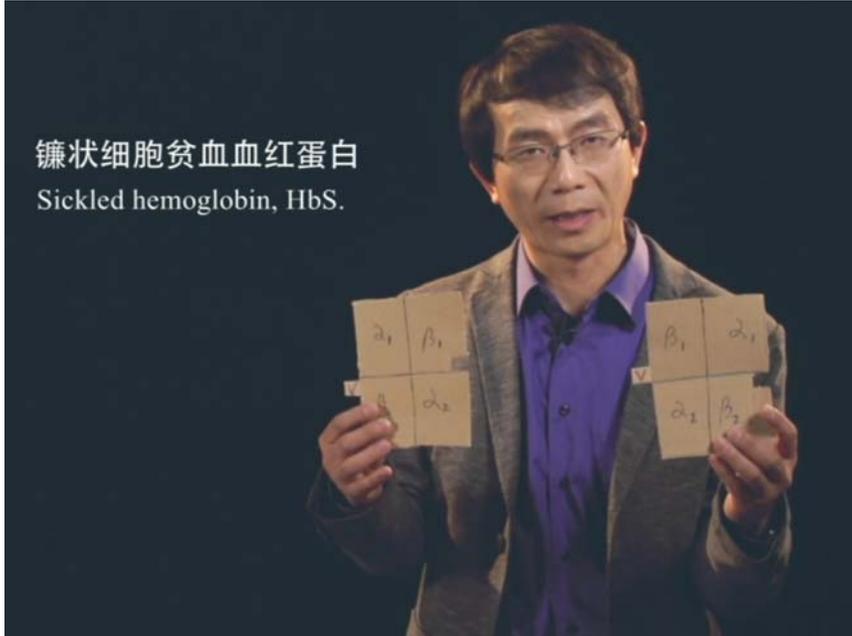
## Demonstration examples



- ☺ HbS polymerizes in the absence of oxygen
- ☺ How do chaperonin and proteasome work?
- ☺ The difference between single bond and double bond
- ☺ How do hydrophobic interactions form?
- ☺ How do adaptor proteins work?
- ☺ How do hormones act by their receptors?
- ☺ Lock and key model, the induced fit model and three-point attachment model
- ☺ How do pseudoknots form in the RNA?
- ☺ How do positive supercoil of DNA form?
- ☺ How does phosphoglycerate mutase work?



☺ How does HbS polymerize in the absence of oxygen



☺ How do chaperonin and proteasome work?

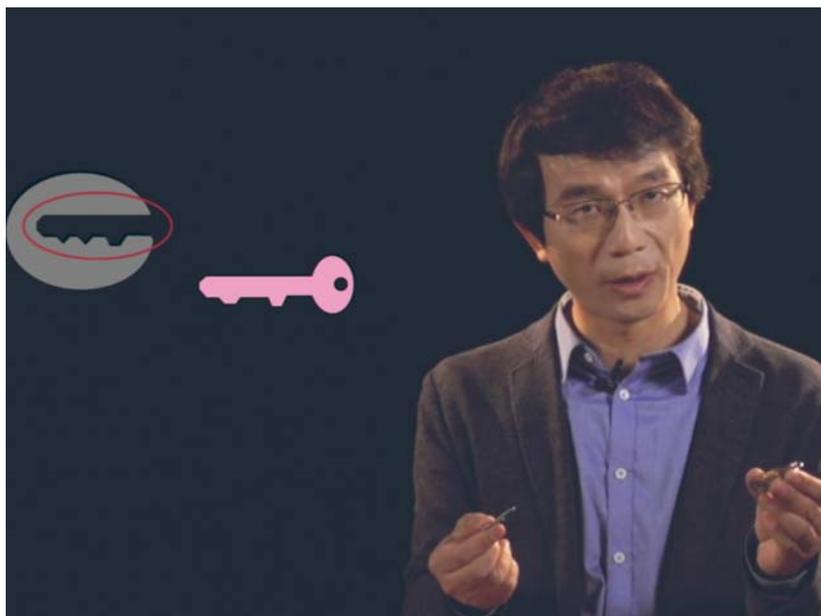




☺ How do hydrophobic interactions form?

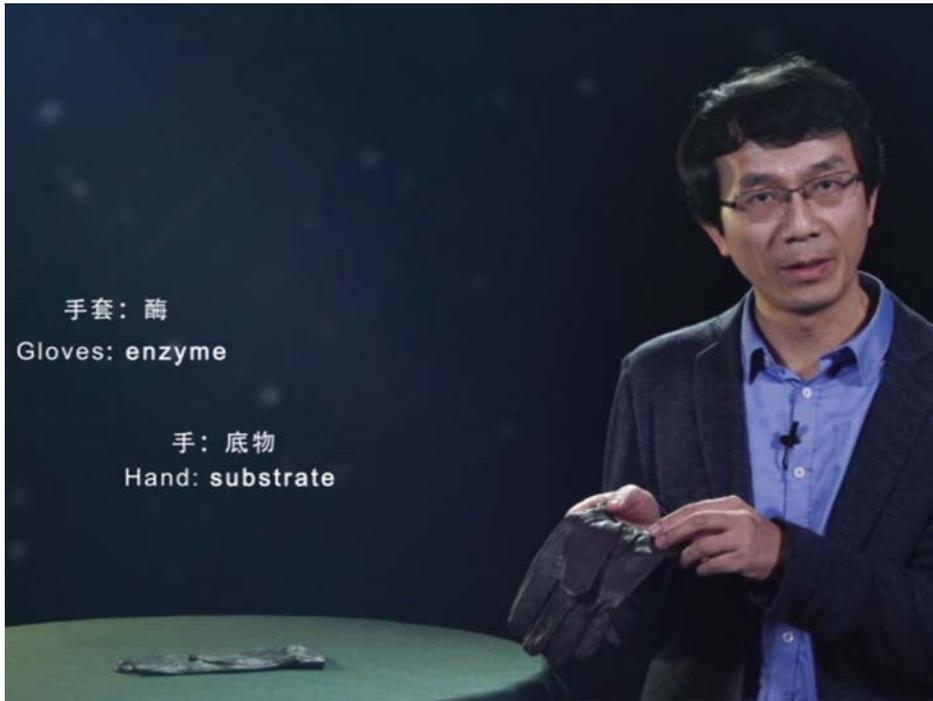


☺ Lock and key model





## ☺ The induced fit model



## ☺ Three-point attachment model





☺ How do pseudoknots form in the RNA?

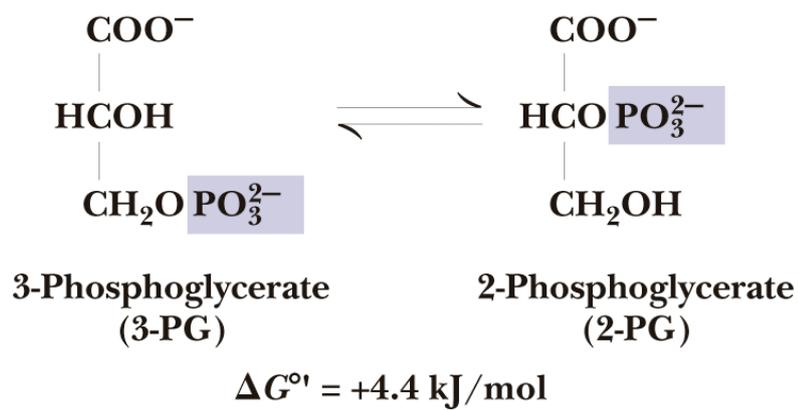
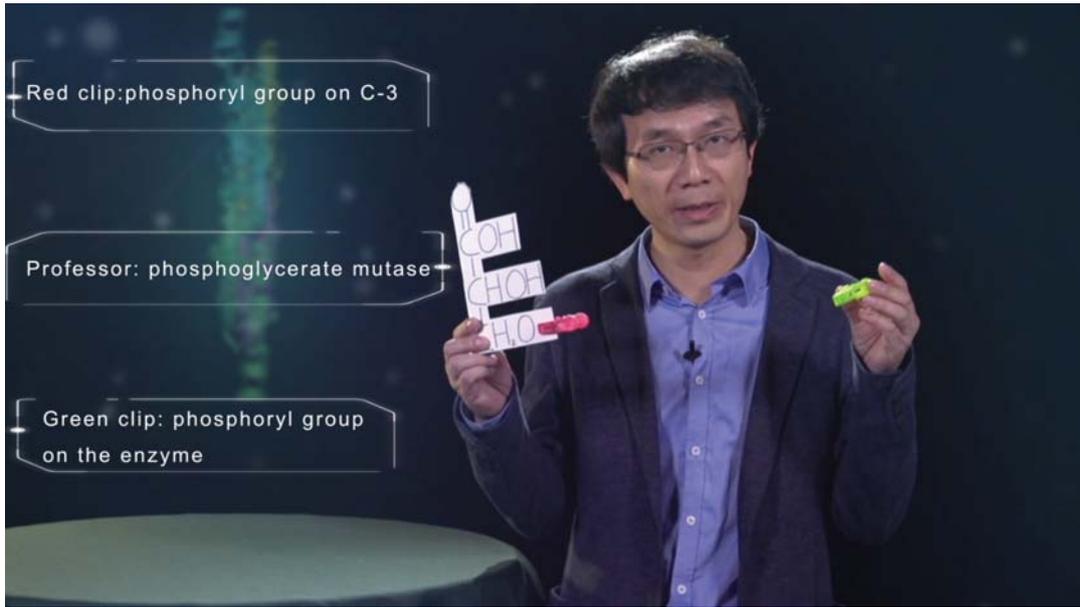


☺ How does positive supercoil of DNA form?





😊 How does phosphoglycerate mutase work?



The reaction catalyzed by phosphoglycerate mutase



## Playing games about the RTK signaling pathway



## 7. Introduce memorization tricks



### Examples

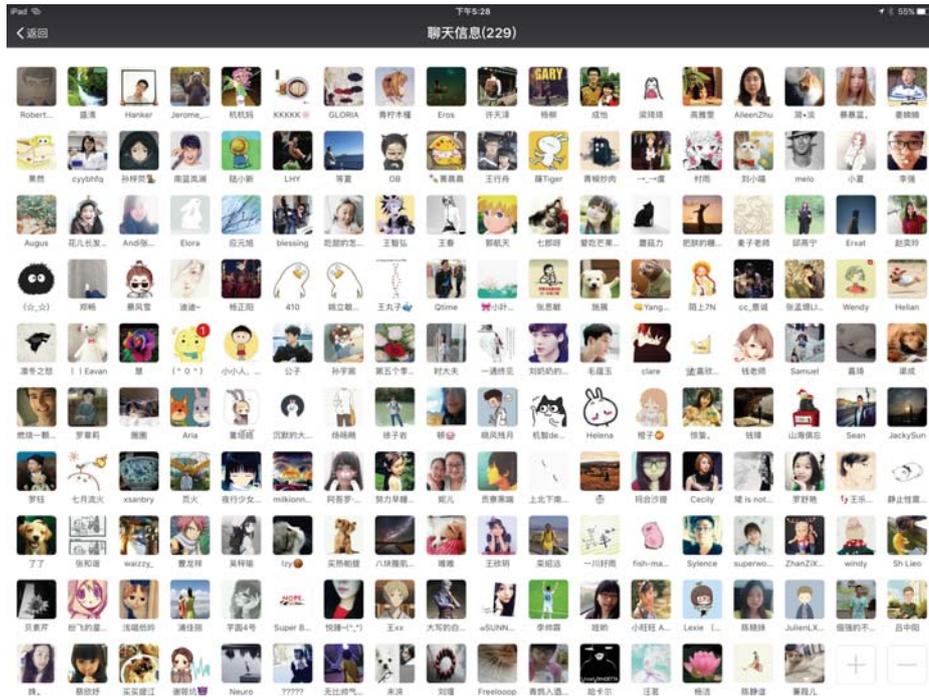
- ☺ Fat-soluble vitamins: coin a new word “**DAKE**”
- ☺ Three beta subunits in the different conformation of  $F_1F_0$ -ATPase: “**LOT**”
- ☺ Three different sites of ribonucleotide reductase: “**CAS**”
- ☺ Three tRNA-binding sites of ribosomes: “**APE**”
- ☺ Three antioxidizing vitamins: “**ACE**”
- ☺ Ketogenic and glucogenic amino acids: **TTTIP**
- ☺ The linkage of bases to ribose or deoxyribose: **911**
- ☺ Summary of Glycolysis and Krebs Cycle: **1234**
- ☺ The entryway to glycolysis of pentose or to Krebs cycle of propionate: **number game**



# 8. Take advantage of modern social media



## My wechat group named biochemistry paradise

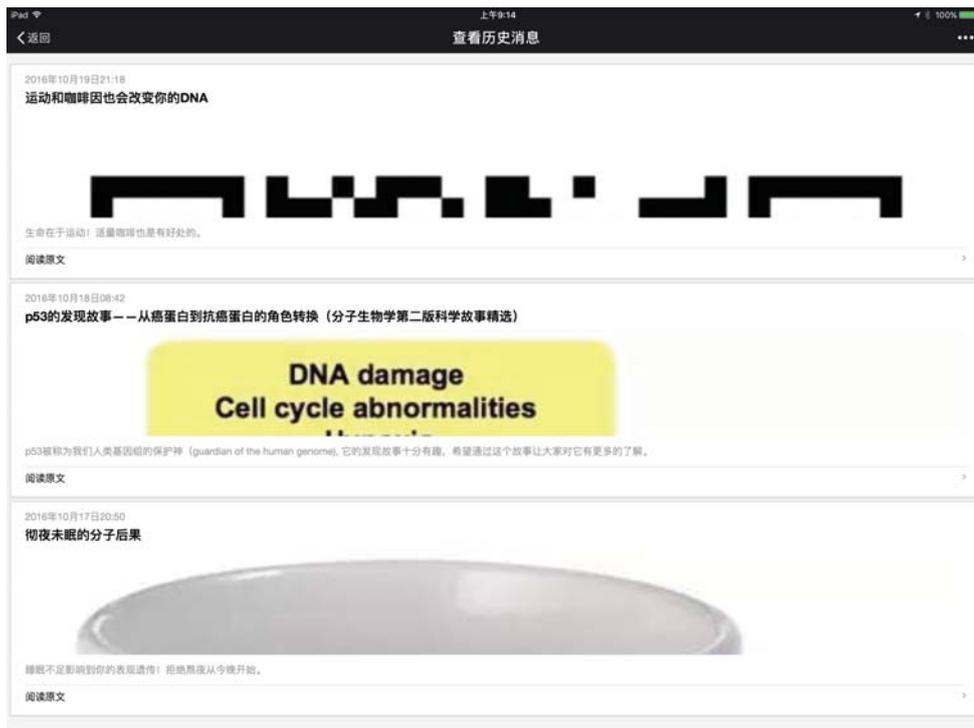


## My wechat public account number: iloveBIOCHEM



### Functions:

Spread and popularize the biochemical knowledge, focus and analyze hot issues about biochemistry, exchange biochemistry-related learning methods or experiences, hold the contest for biochemical knowledge and biochemistry-related short story writing. Make the learning of biochemistry easier and more interesting. Right here, there is no biochemistry crisis, only much fun!



## 9. Combine biochemical theory with practice



- a) Why is eating watermelon skin better for health?
- b) Why can't overnight leeks be eaten?
- c) How is trans-fat formed and why is it harmful to health?
- d) Why is eating raw eggs harmful to health?
- e) Why does the bean milk have to be boiled before being drunk?
- f) How do aspirin and nitroglycerin work as medicines?
- g) Can you read your physical report?
- h) Can Q10 and carnitine lose your weight?
- i) What is good or bad about the UV?
- j) Why can't wild mushrooms randomly picked and eaten?
- k) Is there anyone who can't be infected with HIV?



## ☺ My physical report



体检科室：检验科  
肿瘤标志物（男）  
检验时间：2015-10-29 检验人：成浩

指标名称	检查结果	单位	参考范围	提示
癌胚抗原测定 (CEA)	2.50	ng/ml	0~5	
甲胎蛋白测定 (AFP)	3.00	ng/ml	0~20	
总前列腺特异性抗原测定 (TPSA)	1.85	ng/ml	0~4	

检验备注：  
标本形态：

生化九项  
检验时间：2015-10-26 检验人：成浩

指标名称	检查结果	单位	参考范围	提示
丙氨酸氨基转移酶	23	U/L	5~40	
葡萄糖	5.94	mmol/L	3.90~6.10	
尿素	4.28	mmol/L	2.90~8.20	
肌酐	72	umol/L	59~104	
尿酸	387	umol/L	208~428	
甘油三酯	0.92	mmol/L	0.56~1.69	
总胆固醇	4.79	mmol/L	3.10~5.69	
高密度脂蛋白胆固醇	1.58	mmol/L	0.91~1.55	↑
低密度脂蛋白胆固醇	2.68	mmol/L	2.70~3.64	↓

检验备注：  
标本形态：

血细胞分析（静脉血）  
检验时间：2015-10-26 检验人：成浩

指标名称	检查结果	单位	参考范围	提示
白细胞计数值 (WBC)	5.7	$10^9/L$	4.00~10.00	
中性细胞比率 (NEUT%)	58.7	%	50.00~70.00	
淋巴细胞比率 (LYM%)	28.4	%	20.00~40.00	



## 10. Apply different methods to different parts of biochemistry



- Structural biochemistry: structure determines properties and function
- Metabolic biochemistry: biochemical logic
- Molecular biology: base-pairing rules, interaction of proteins and nucleic acids, internal cause and external cause



## The theory of internal cause and external cause



- a) Protein folding: internal cause- primary structure, external cause- molecular chaperone
- b) Sorting and targeting of proteins: internal cause-signal peptides, external cause-signal recognition particle or SRP
- c) Pre-mRNA splicing: internal cause- splicing signal, external cause- snRNPs



## Base-pairing is everywhere



- All double helices of RNA or DNA
- DNA replication, transcription, translation, reverse transcription
- snRNA-dependent Pre-mRNA splicing
- snoRNA-dependent rRNA processing
- gRNA-dependent mRNA editing
- Recognition of bacterial start codon
- RNAi, PCR, Southern blotting, Northern blotting, DNA chip, FISH, R-loop technique, genome editing



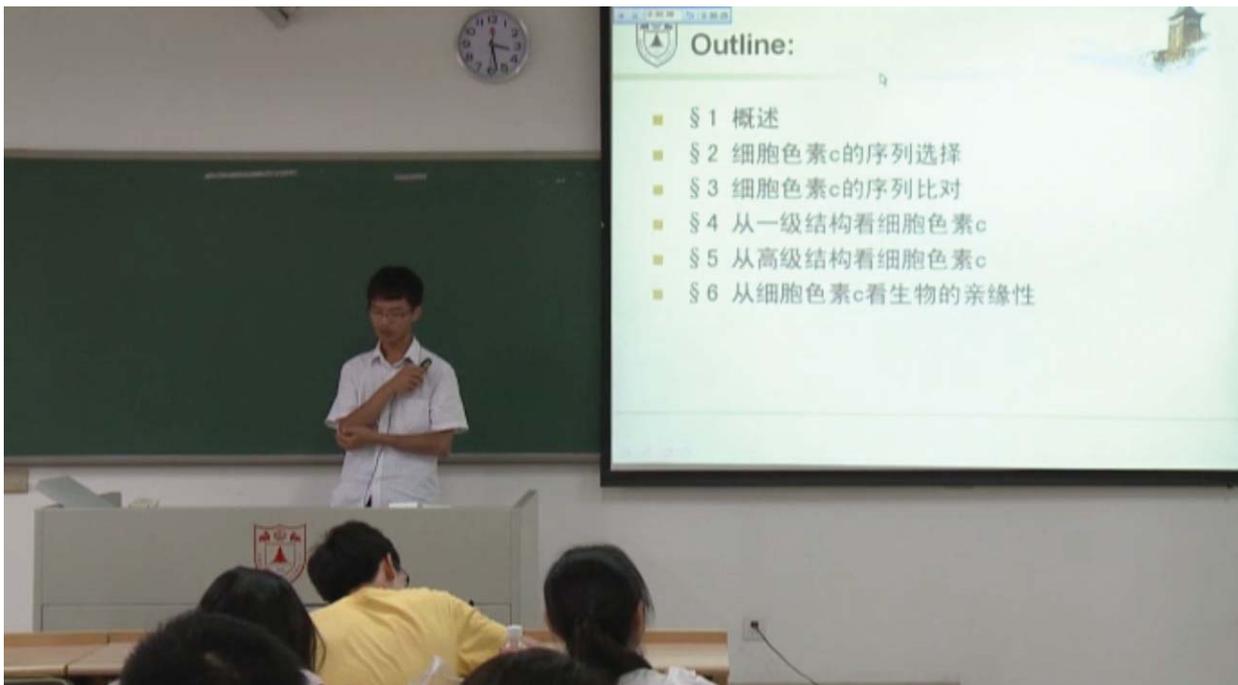
# 11. Carry out Extra-curricular activities



- ✓ Organize Video-taped Presentation
- ✓ Watch biochemistry-related videos
- ✓ Hold the Contest for biochemical knowledges or biochemical songs
- ✓ Write short biochemical stories
- ✓ Make wine and yogurt by fermentation
- ✓ Celebrate the birthday for the DNA double helix on every 4.25
- ✓ Promote education about AIDS on each 12.1



## A presentation about *cytochrome c*

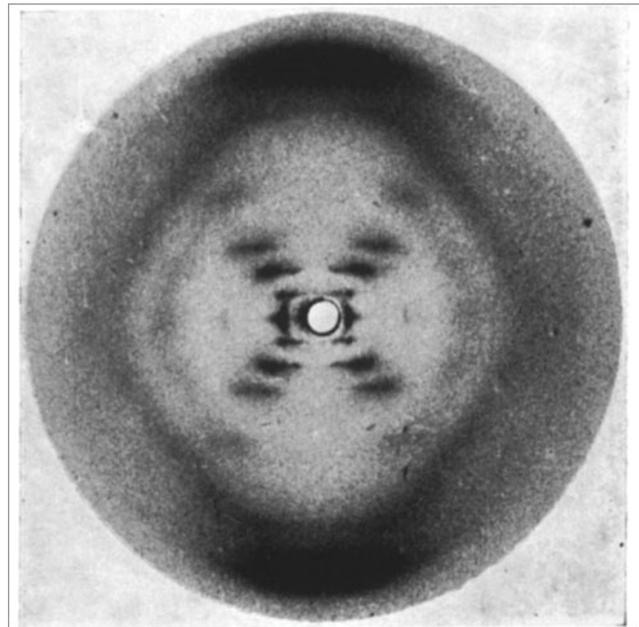
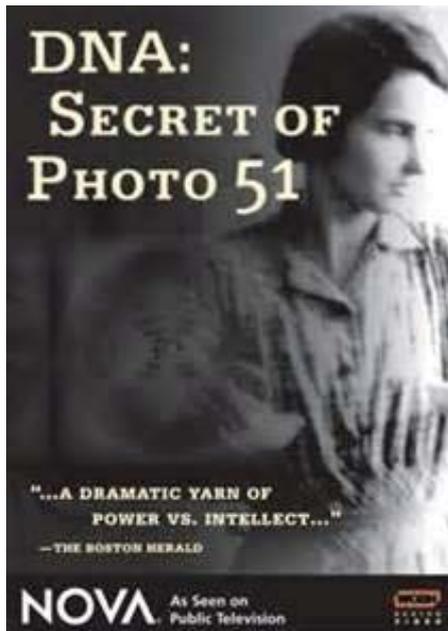




## A presentation about *pseudoenzymes*

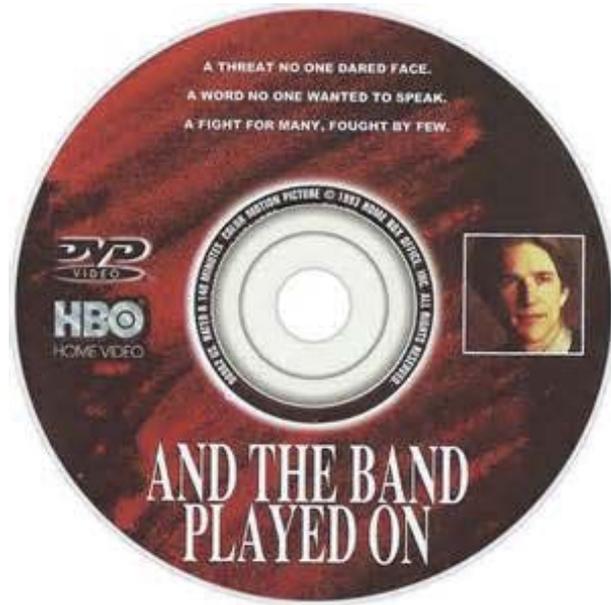
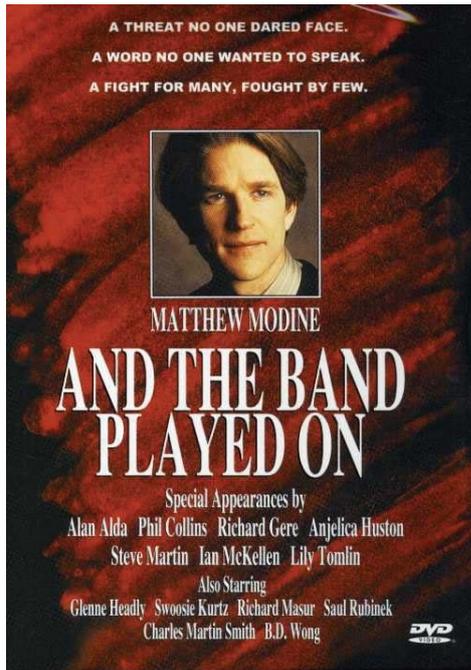


## A documentary film named *DNA : secret of photo 51*





## A film named *And the band play on*



## Celebrating the 60th birthday of DNA double helix





## Showtime for students to give wrong answers



## Treating the students who made the best presentation with dinner





# Acknowledgements



- There are a lot of people and organizations I want to thank
  - ✓ FAOBMB and CSBMB
  - ✓ Nanjing University
  - ✓ All of my students
  - ✓ My family



**You are welcome to study my structural biochemistry MOOC either on the coursera or on the Chinese university MOOC**





## Attending the 11th ceremony of being awarded the students' best-loved teachers



颁奖词：新竹高于旧竹枝，全凭老干为扶持。一堂堂生化课，杨sir凭借有趣的教学方法，清晰的逻辑体系，感染了每一位学生，激发了我们的兴趣。您严肃认真，却又不失风趣幽默；教学方式很传统，却从来不缺乏新意和乐趣。Robert Young，您爱学生一如爱苹果，上过您的课的同学都是您的粉丝！



杨老师是个非常感性的人，走红毯的他感觉没有学生在场很孤独。

获奖感言：我要说的很简单，我要感谢我所有的学生，不管是今天来还是没有来的，毕业的还是没有毕业的，在国内的还是国外的，感谢所有同学的支持！（主持人邀请老师兑现关于唱首歌的承诺：老师一天上了六节课，目前为止还是怕声音吼不上去）



## Attending the 12th ceremony of being awarded the students' best-loved teachers





*Thanks a lot!*

