



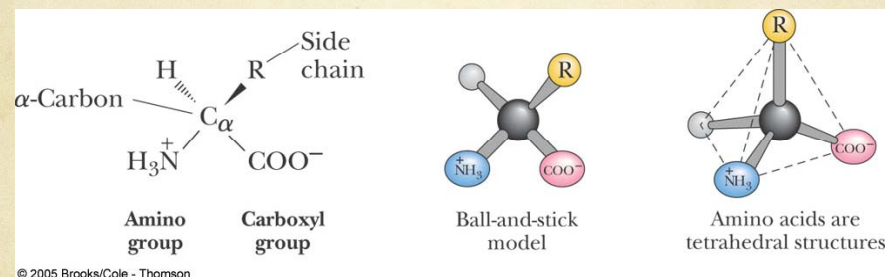
蛋白質的結構與功能

蘇士哲博士

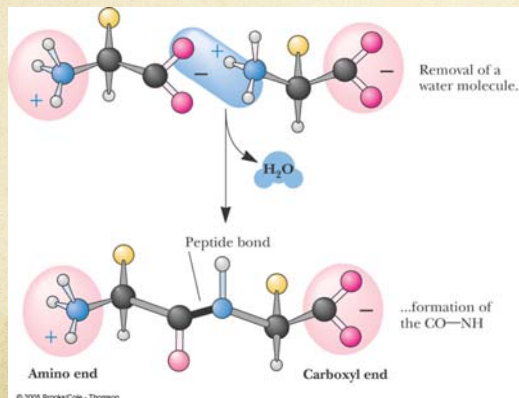
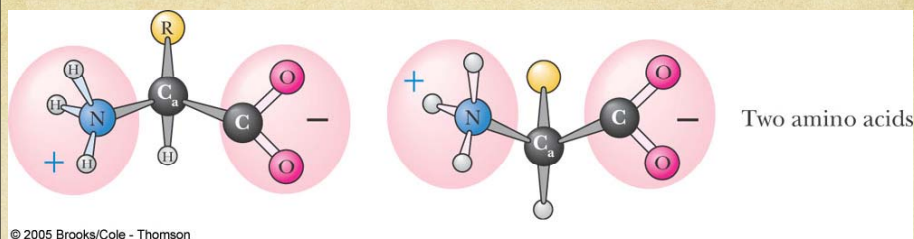
清華大學 生物資訊與結構生物所

胺基酸：蛋白質的組成單位

從 DNA 到蛋白質

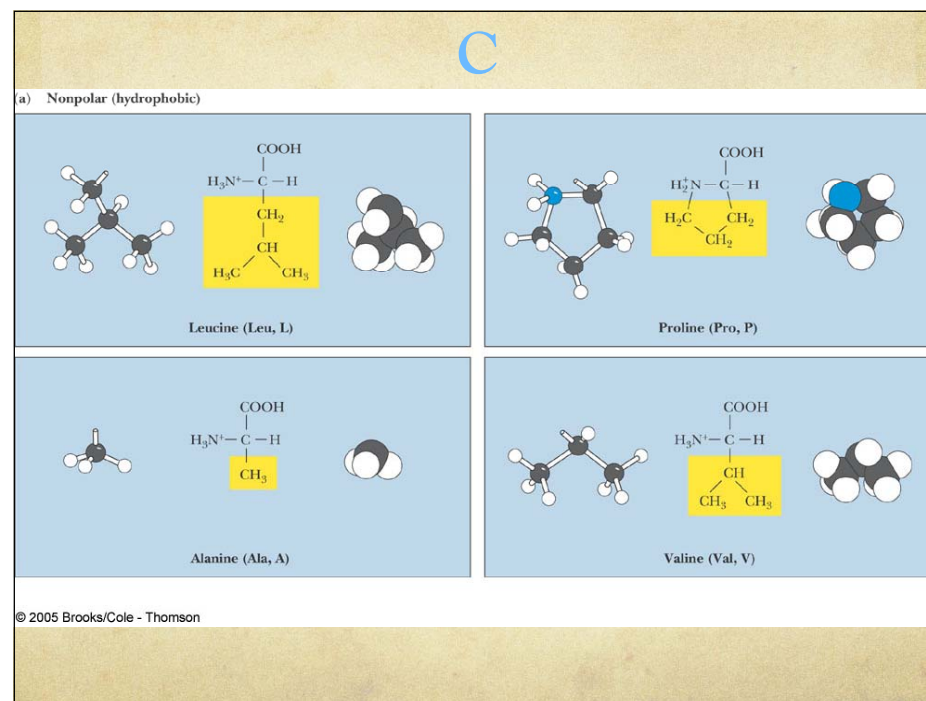


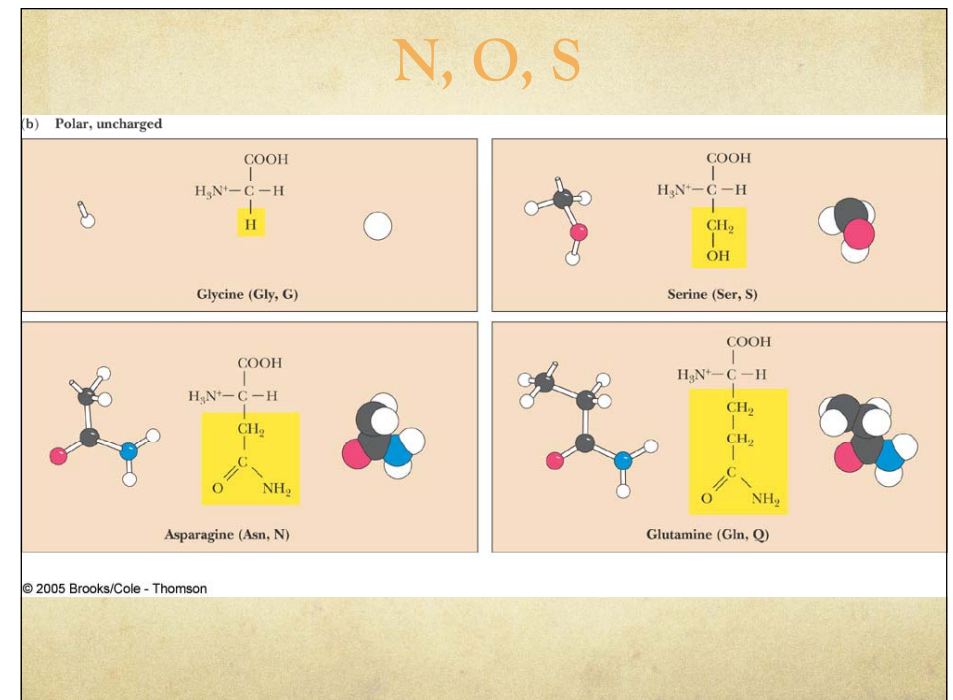
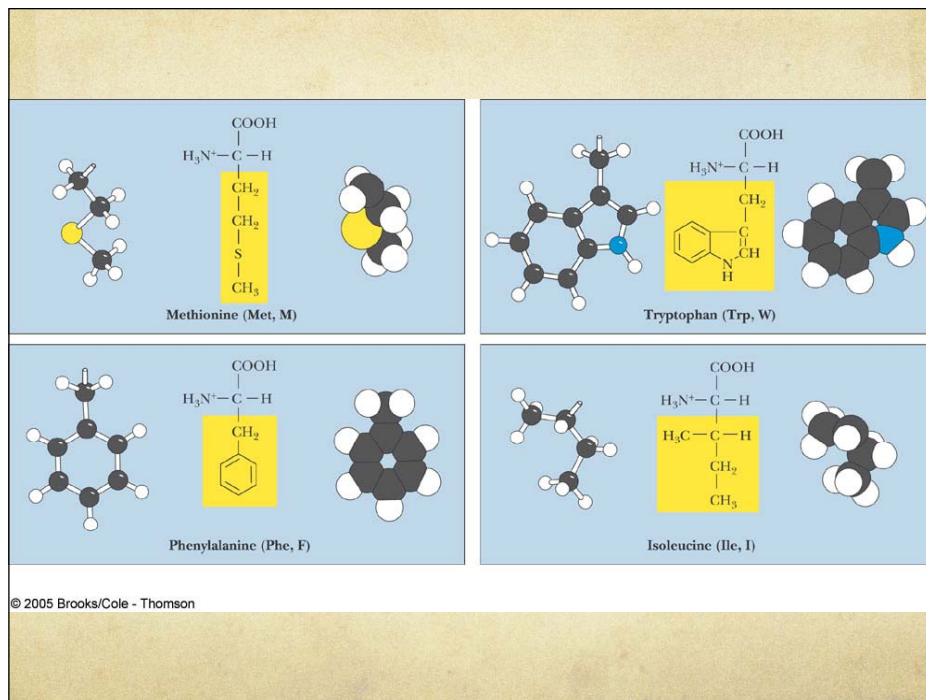
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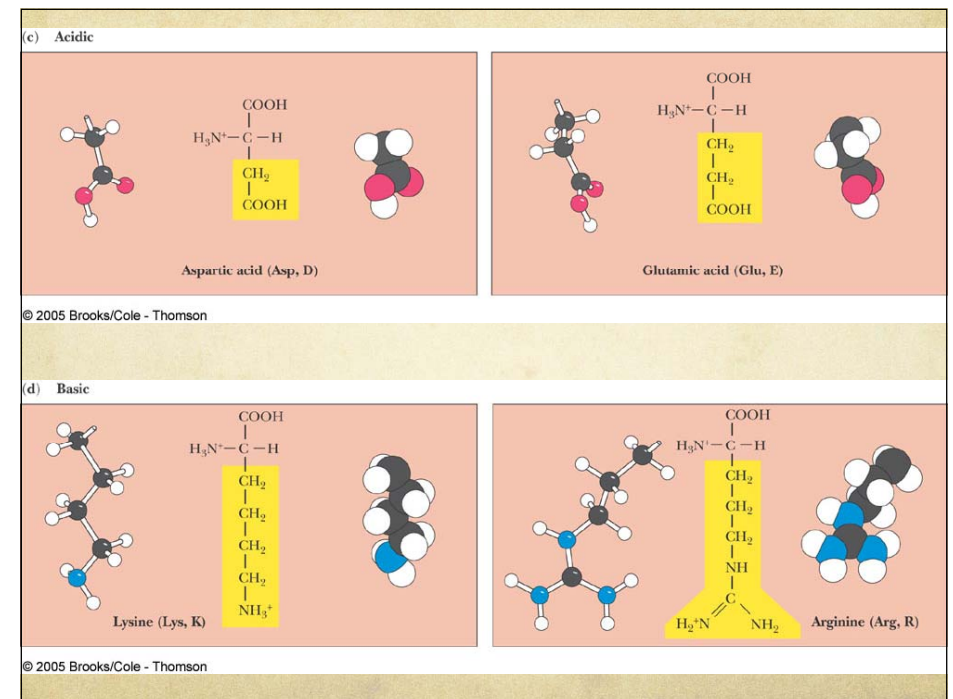
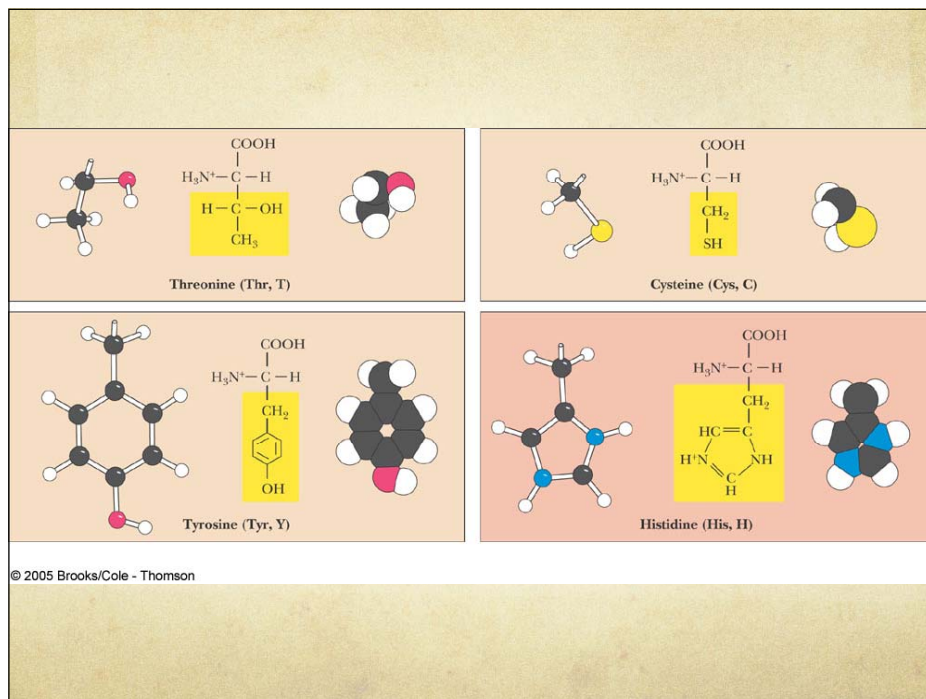
Five elements:
H, C, N, O, S

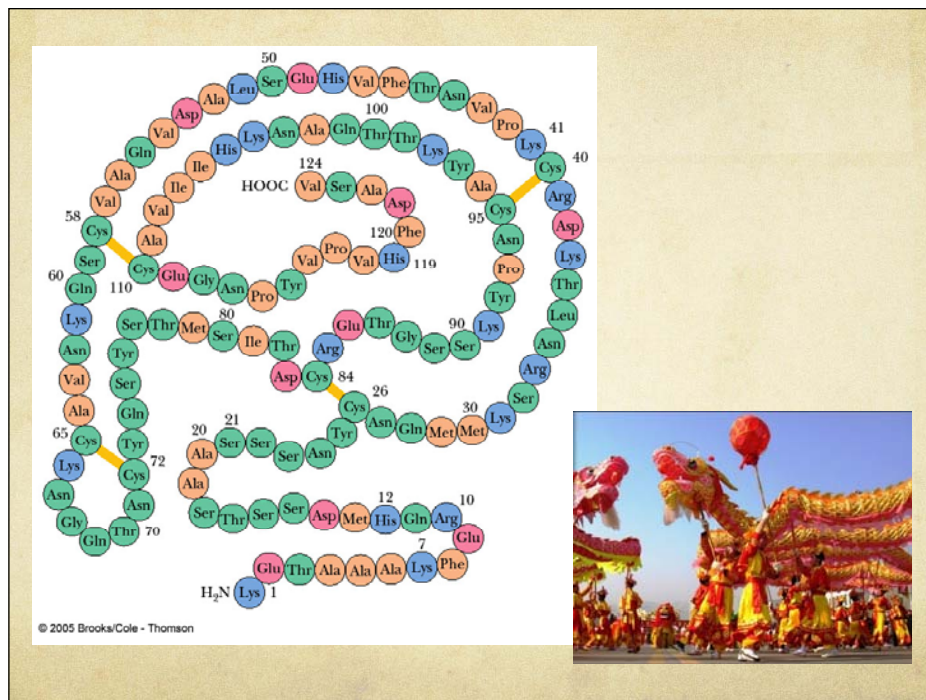
1 + 1 + 1 + 1
(..... NCC + NCC + NCC)





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蛋白質骨架的運動與結構

蛋白質是一串胺基酸組成的序列

ADFRTGSCVNMILKPYTRWQWSDFGHKLMAN
T

一級到二級結構

primary structure
(amino acid sequence)

secondary structure
(α -helix)

tertiary structure
(folded individual peptide)

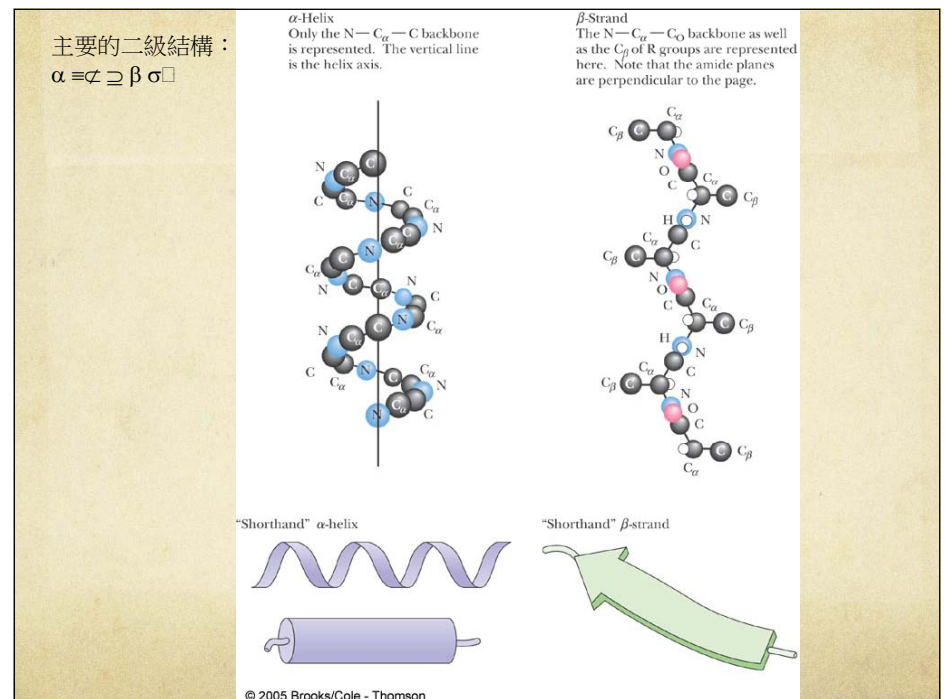
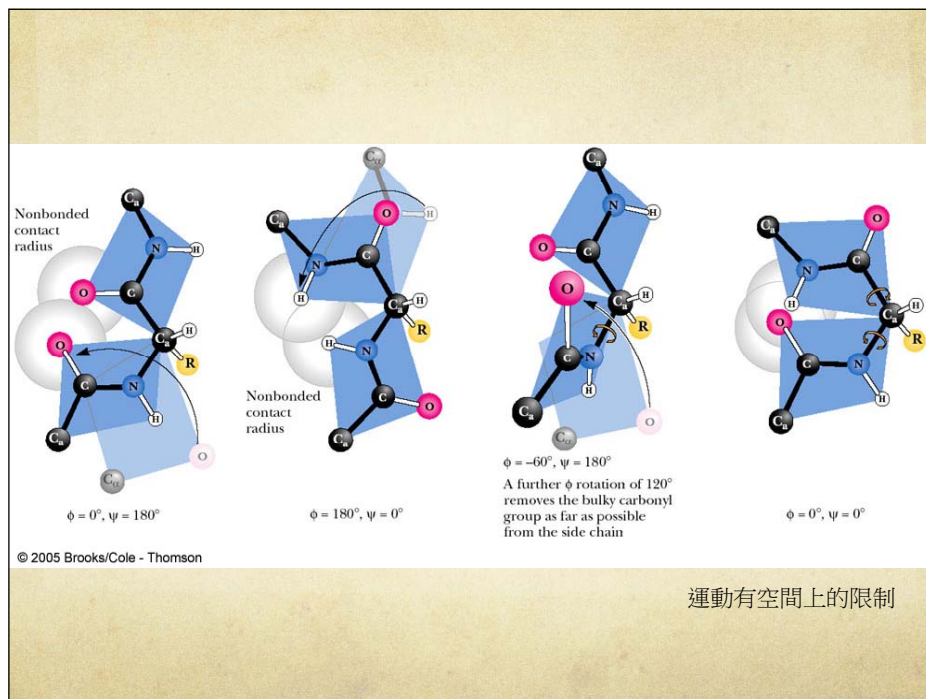
quaternary structure
(aggregation of two or more peptides)

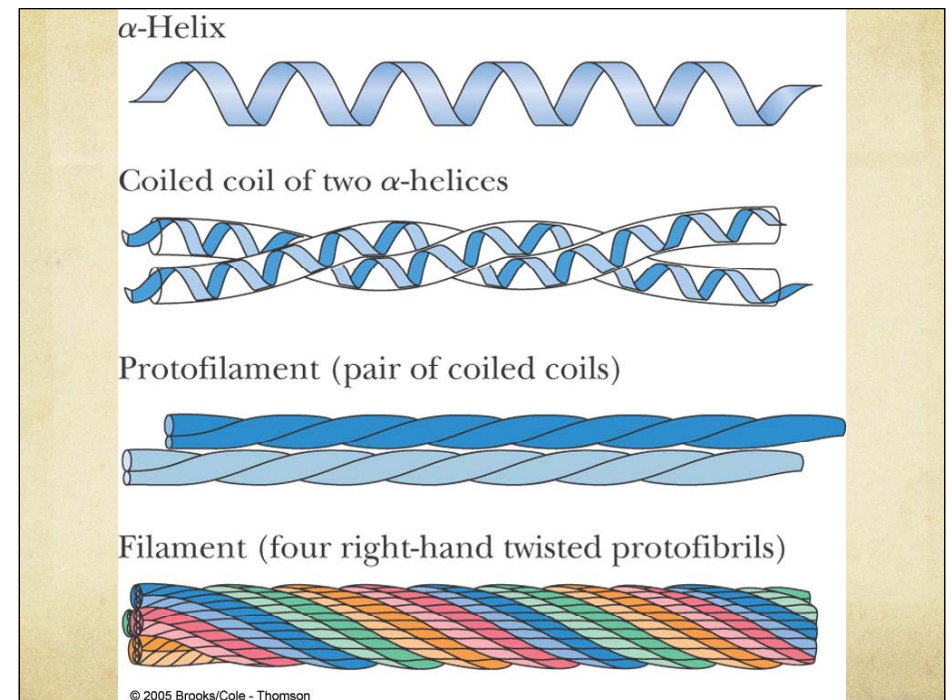
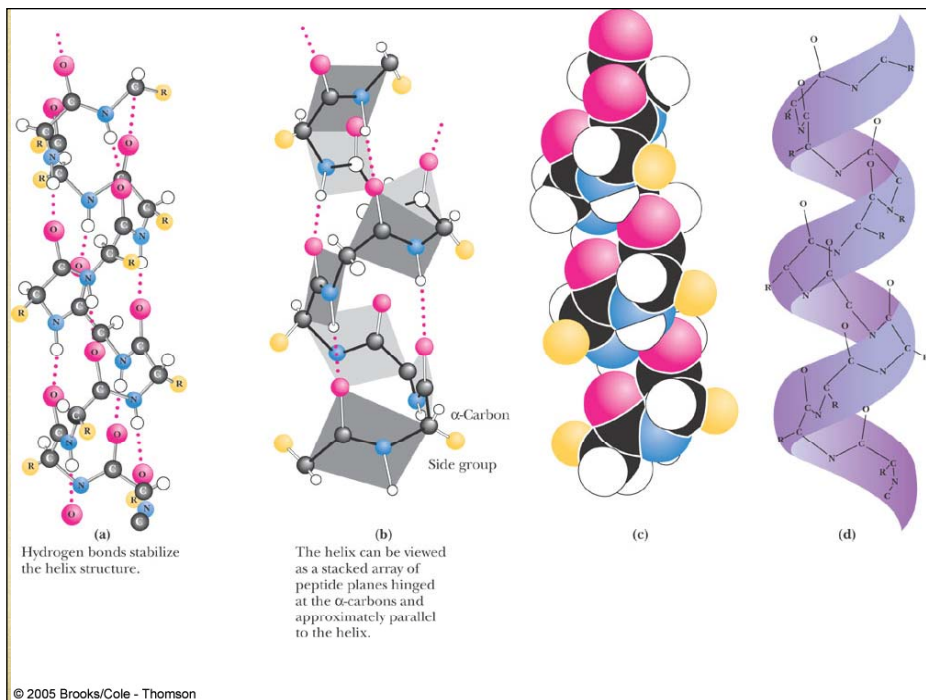
Amide plane

$\phi = 180^\circ, \psi = 180^\circ$

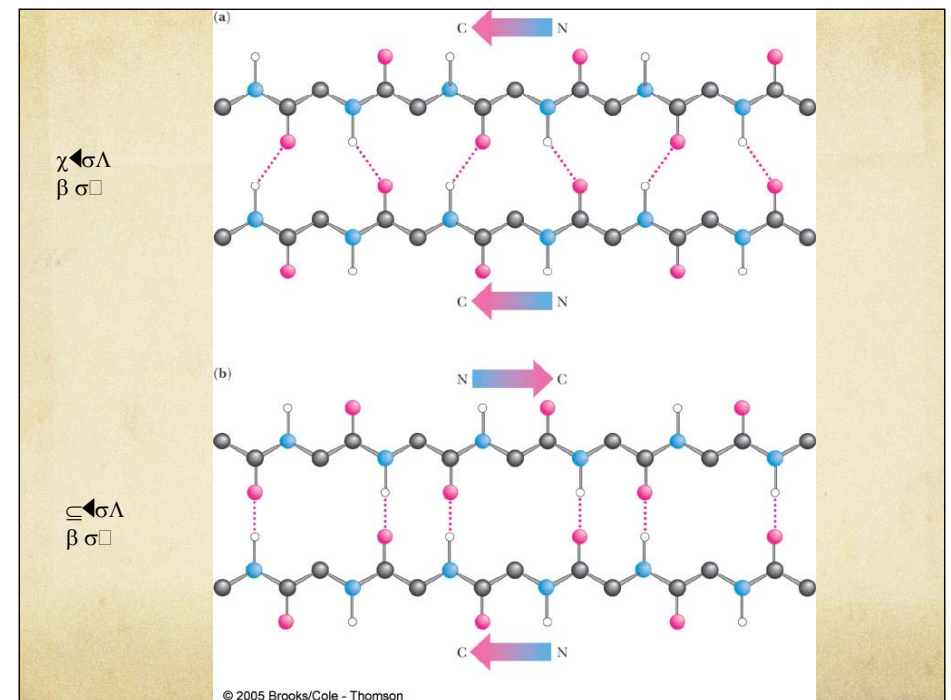
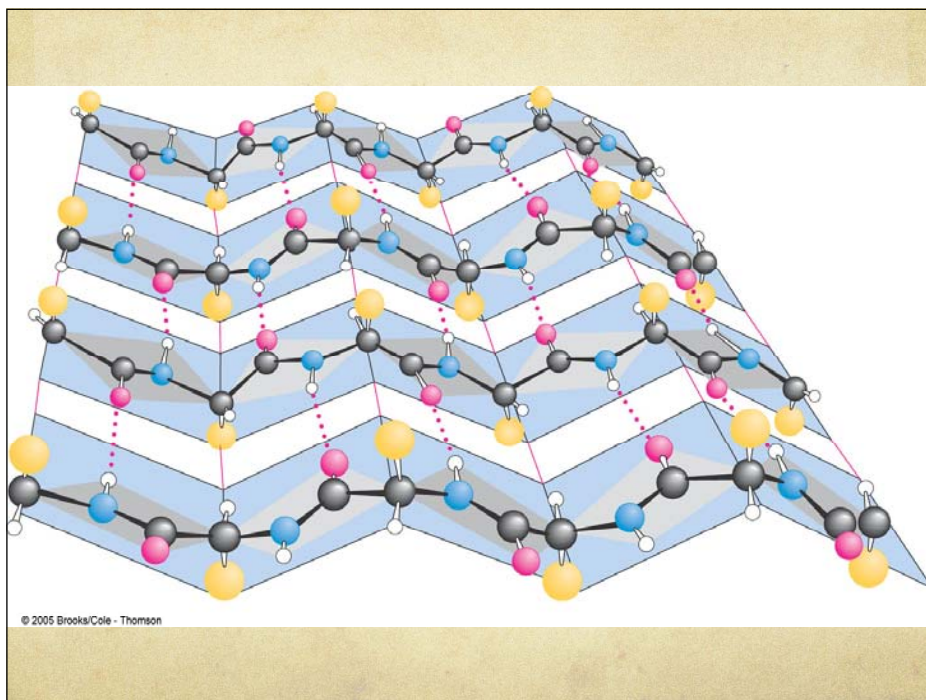
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二極結構組成蛋白質三級結構



β -Hemoglobin subunit

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(a)

© 2005 Brooks/Cole - Thomson

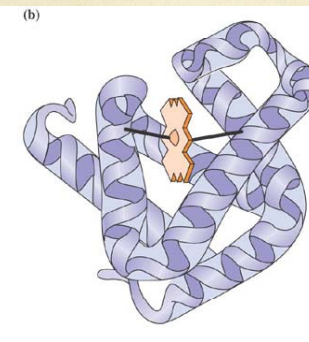
蛋白質的結構範例

各式各樣的蛋白質結構

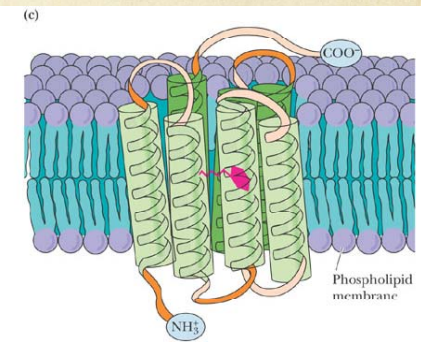


Collagen, a fibrous protein

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Myoglobin, a globular protein



Bacteriorhodopsin, a membrane protein

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Insulin



Cytochrome c



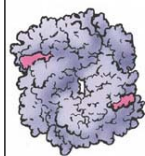
Ribonuclease



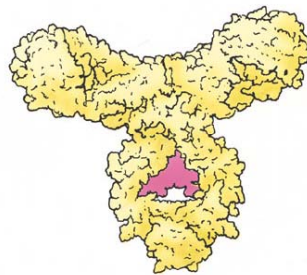
Lysozyme



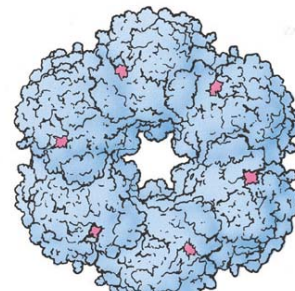
Myoglobin



Hemoglobin

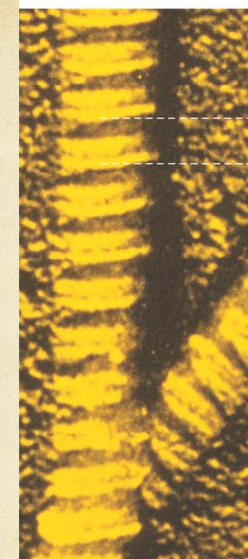


Immunoglobulin



Glutamine synthetase

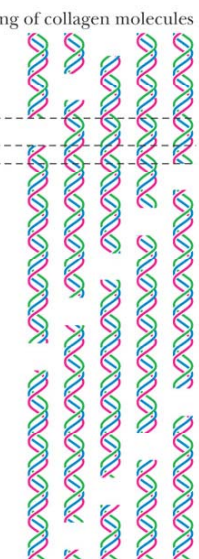
© 2005 Brooks/Cole - Thomson



Packing of collagen molecules

Hole zone
 $0.6d$

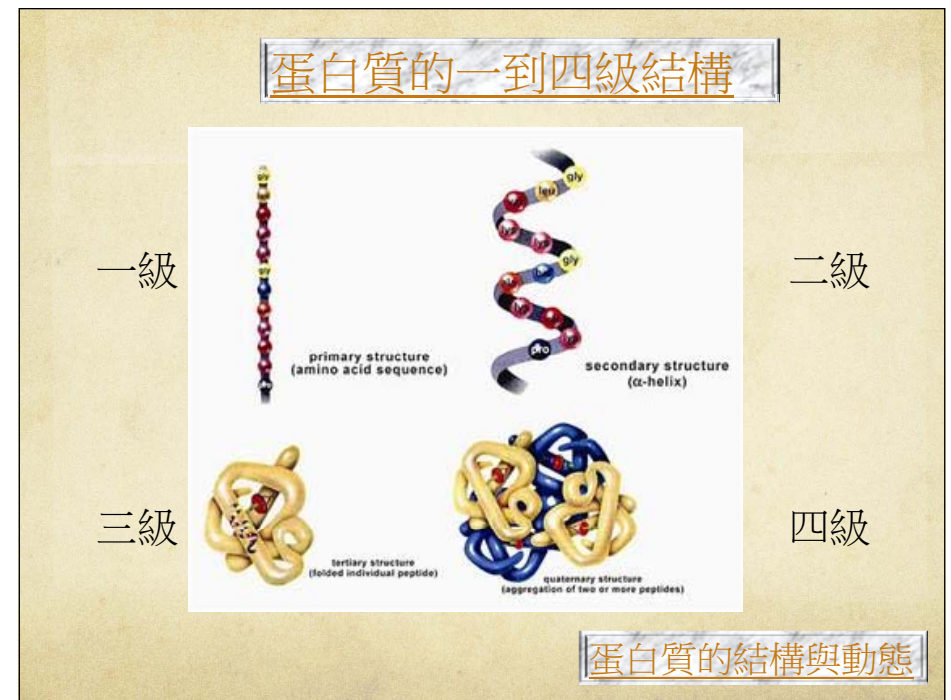
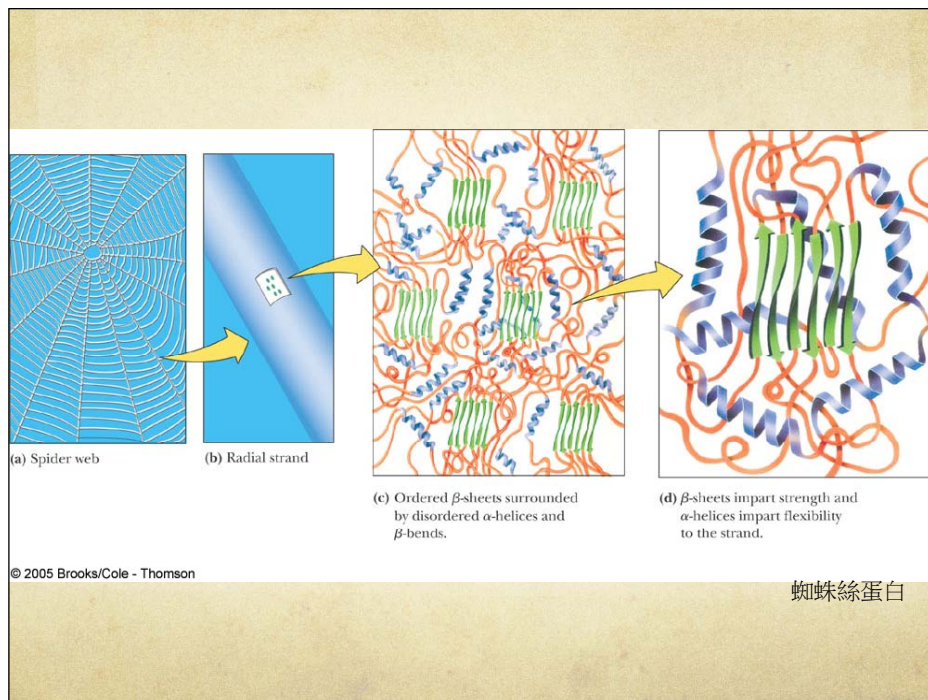
Overlap zone
 $0.4d$



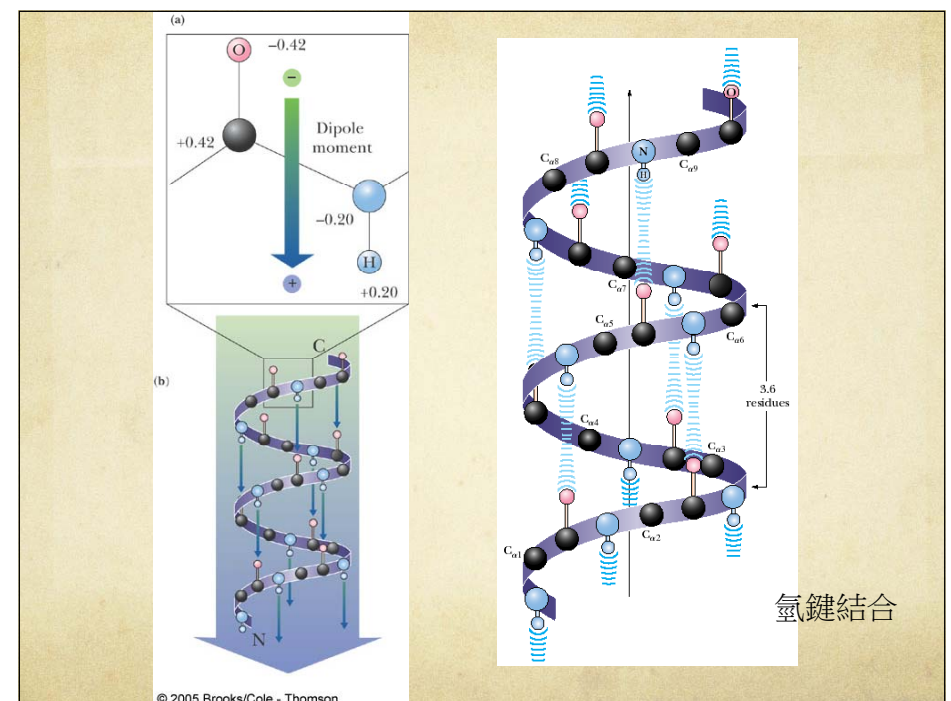
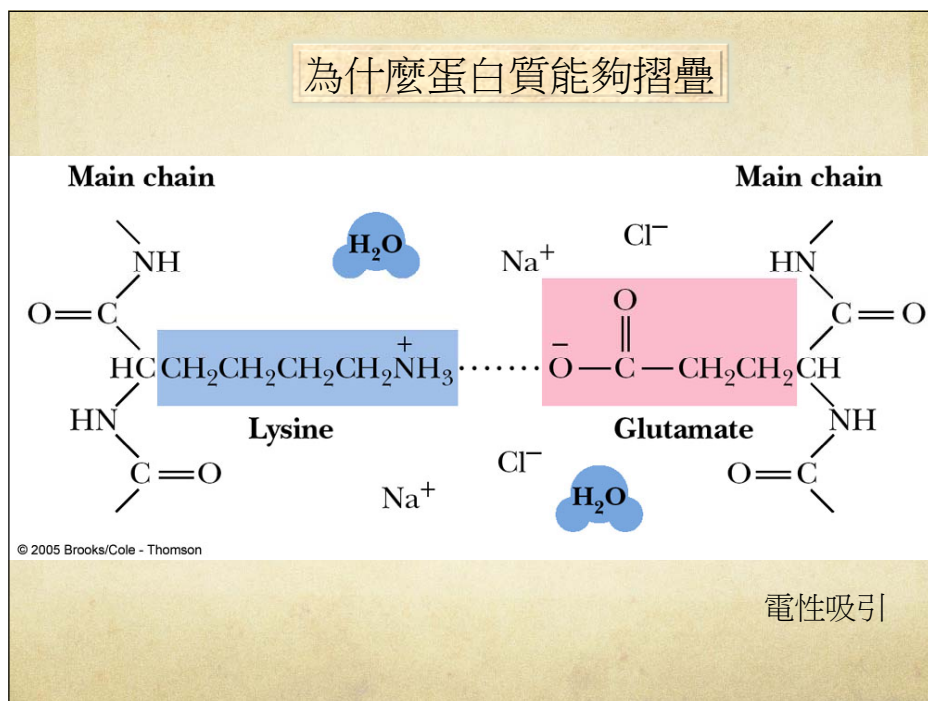
許多具三級結構的蛋白質組成
更大的聚合物，四級結構

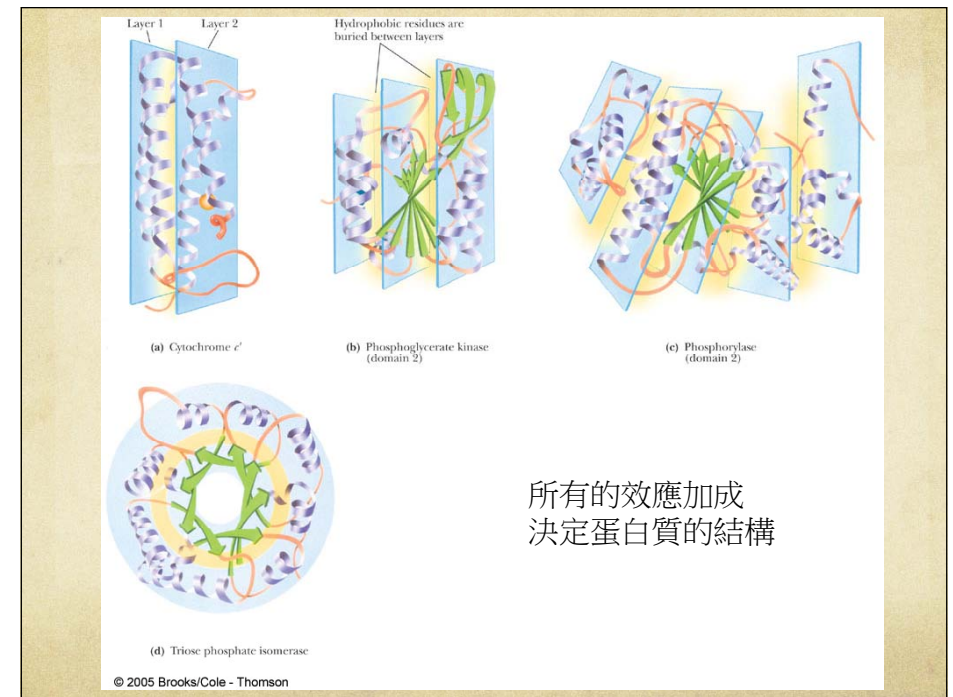
膠原蛋白

© 2005 Brooks/Cole - Thomson

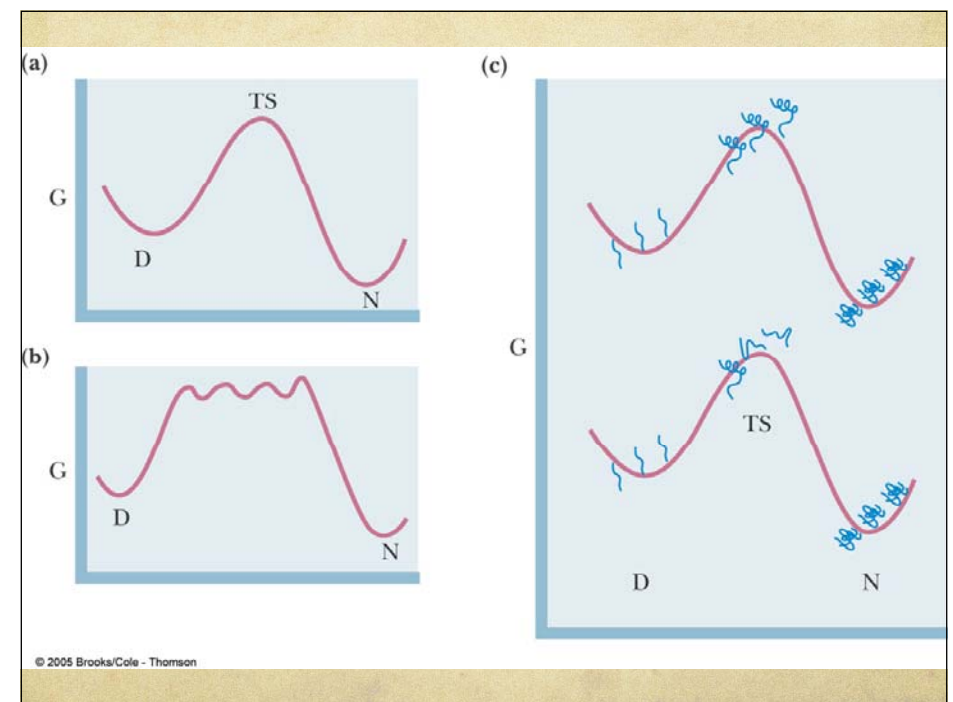
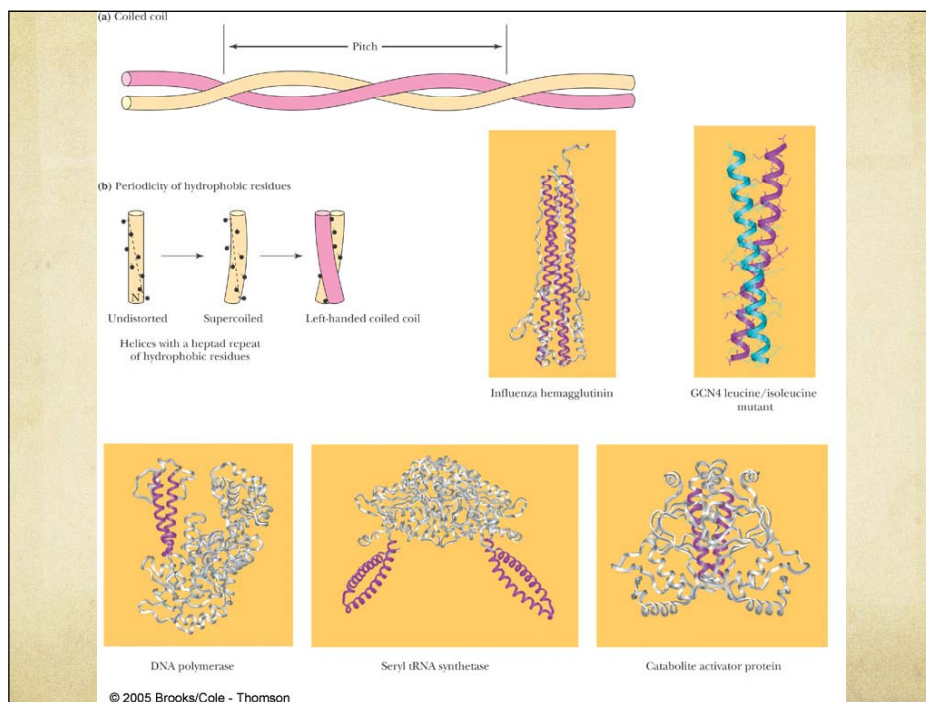


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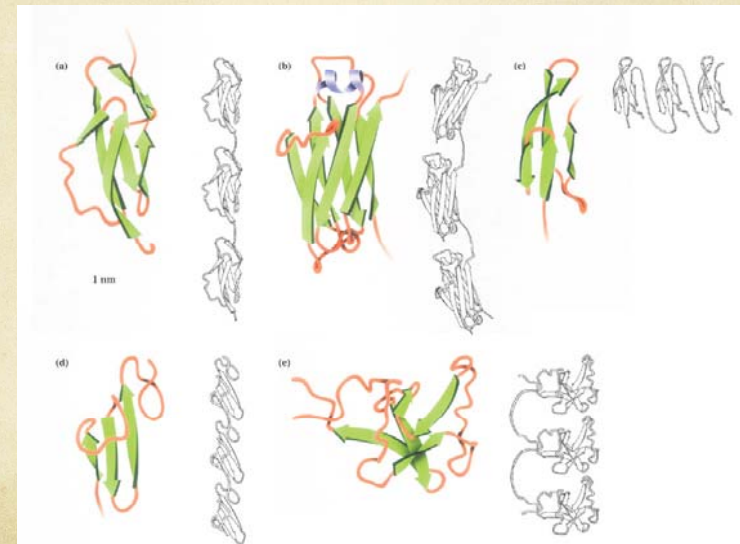
蛋白質的折疊(I)

蛋白質的折疊(II)



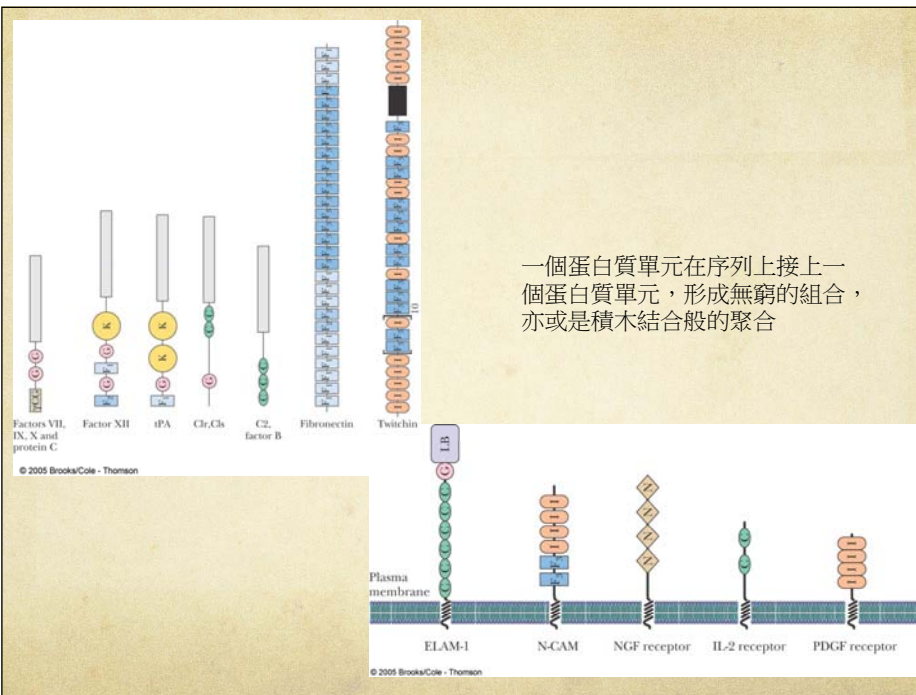
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蛋白質結構還能排列組合的更複雜

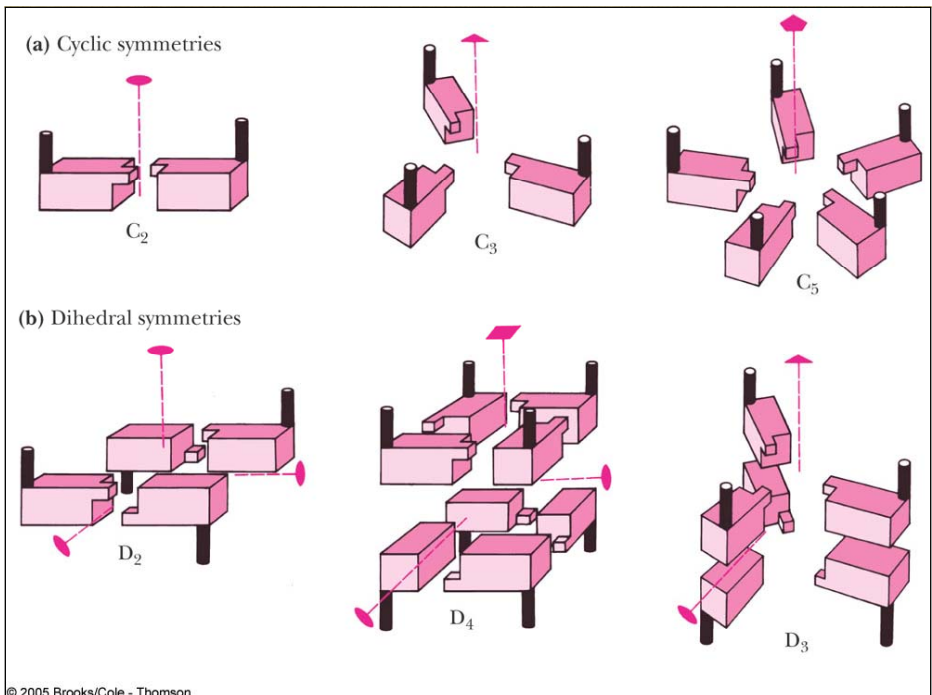


© 2005 Brooks/Cole - Thomson

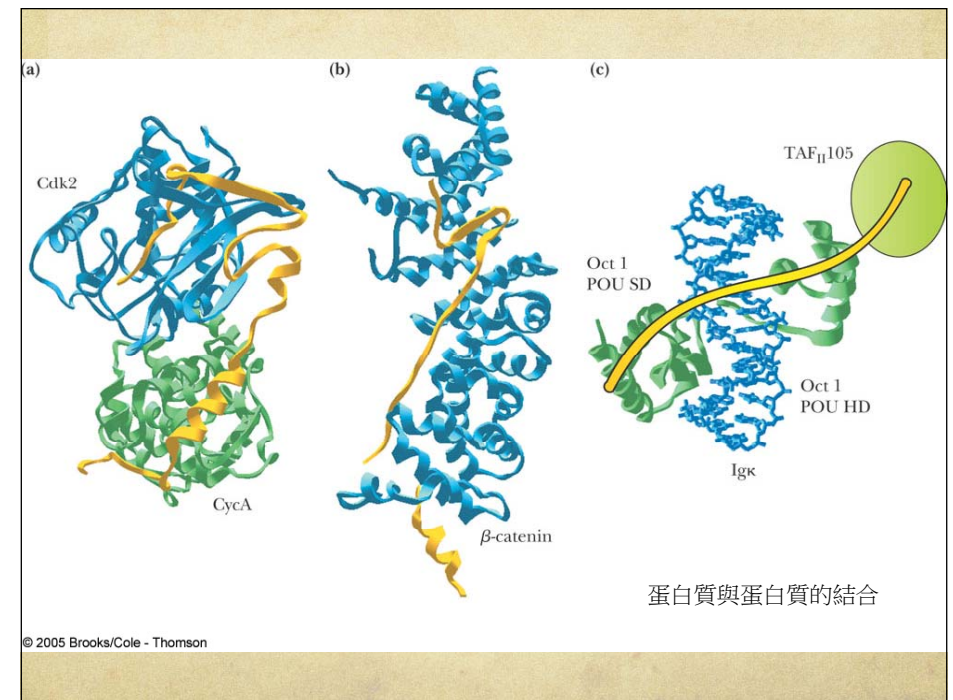
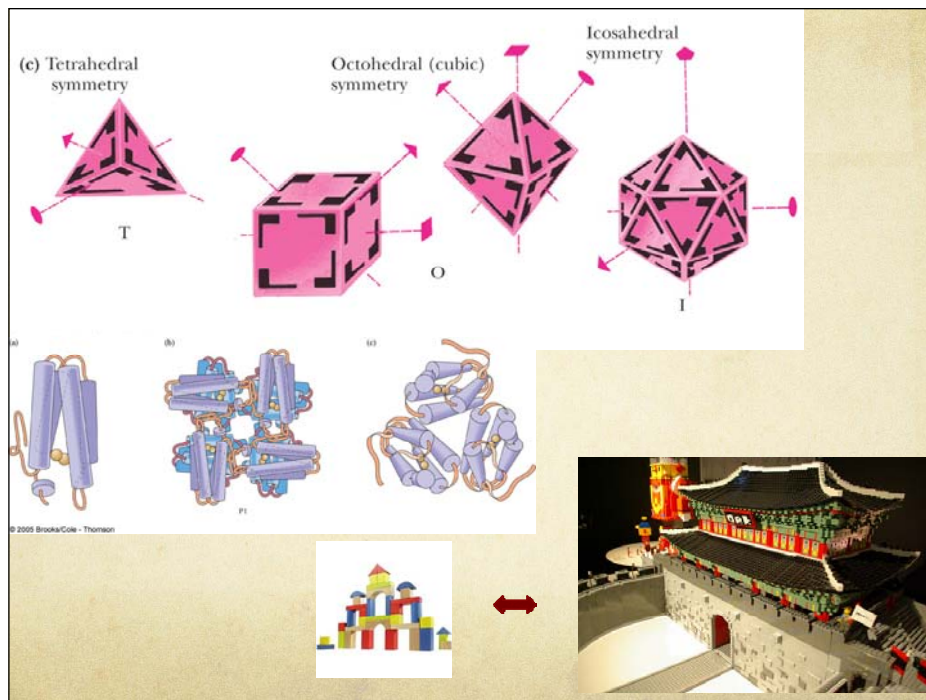
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最 Cool 的蛋白質結構

No. 3

No. 4

No. 5

第五名：?

第四名：?

第三名：?

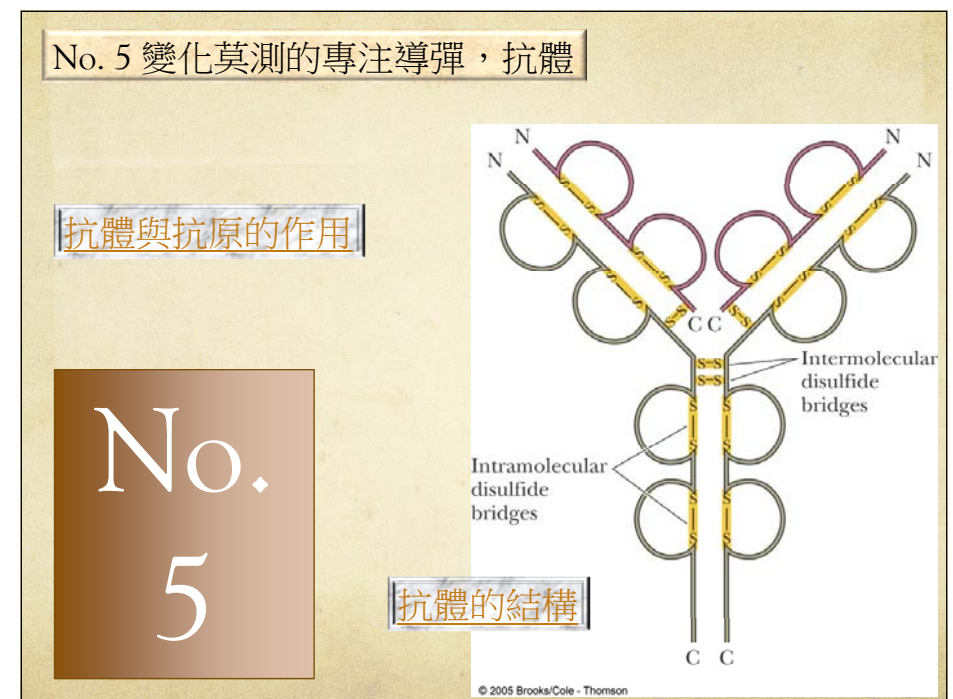
第二名：?

第一名：?

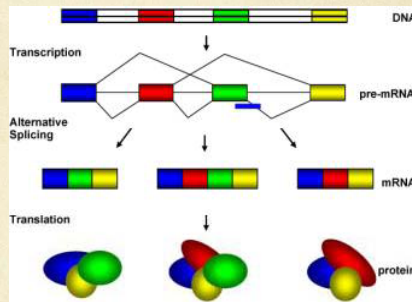
No. 2

No. 1

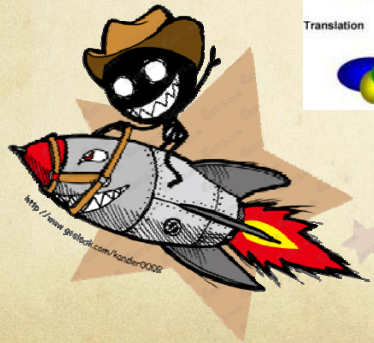
The slide shows a ranking of protein structures. The top row contains 'No. 3', 'No. 4', and 'No. 5'. Below these are five question marks representing the names of the structures. The bottom row contains 'No. 2' and 'No. 1'. The text '最 Cool 的蛋白質結構' (Most Cool Protein Structure) is at the top.



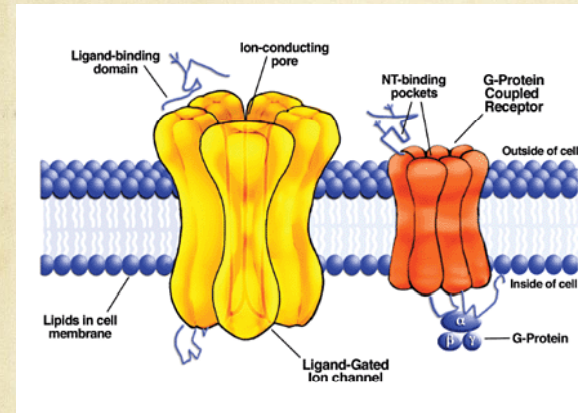
抗體變化莫測的祕密：Alternative Splicing



成千上萬種抗體



No. 4 敬忠職守的守門員，細胞膜通道



神經突觸的蛋白質通道

腸壁上的蛋白質通道

No.
4

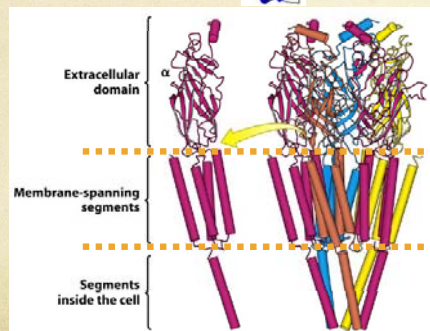
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眼鏡蛇神經毒

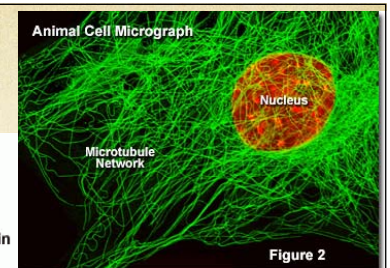
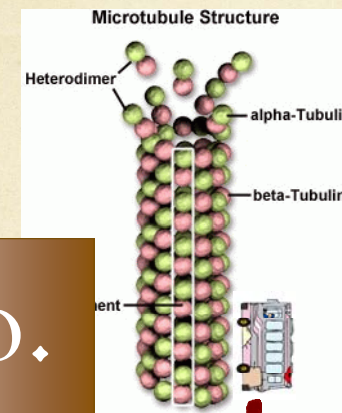


乙醯膽鹼受體

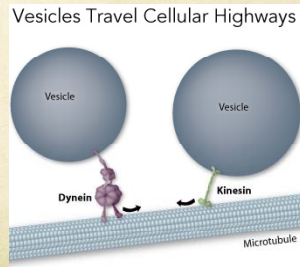
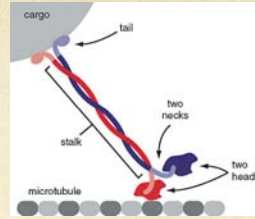
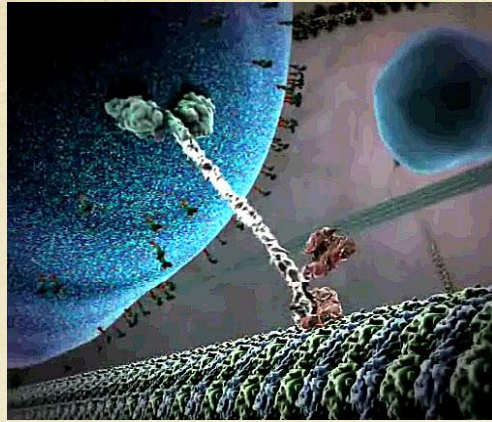
細胞膜



No. 3 蛋白拖車向前衝



No.
3



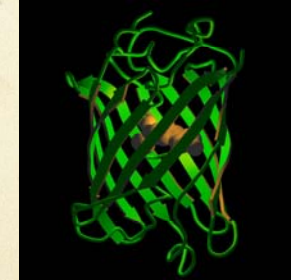
<http://learn.genetics.utah.edu/content/begin/cells/vesicles/>

No. 2 不用打燈籠也找得著，螢光蛋白

No.
2

轉植動物標定

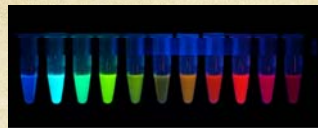
細胞組織標定



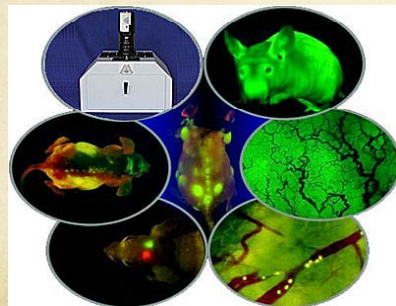
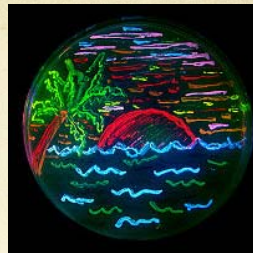
GFP: 綠色螢光蛋白



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GFP 的花花綠綠兄弟姊妹



© The Nobel Foundation. Photo: Ulla Montan

2008 Nobel 化學獎

No. 1 自己學壞也帶壞別人的蛋白質，PRION

枯魯症 (kuru) 及庫賈氏病
(Creutzfeldt-Jakob disease, CJD)



狂牛症
羊搔癢症

No.
1

1976 Carleton Gajdusek 及 Baruch S. Blumberg, 1997
Stanley Prusiner, Nobel 生理獎

突變造成結構的改變



結構改變誘導結構的改變

蛋白質即有感染力
無法消除毒性或被分解
不會從體內消失
症狀緩慢出現
無法檢測無法醫治



巨觀上造成神經系統病變

研究已擴及
老人痴呆症及巴金森病

最 Cool 的蛋白質結構

第五名：變化莫測的專注導彈，抗體

第四名：敬忠職守的守門員，細胞膜通道

第三名：蛋白拖車向前衝

第二名：不用打燈籠也找得著，螢光蛋白

第一名：自己學壞也帶壞別人的蛋白質，
PRION