

生命的起源

生物分子的介紹

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2004 Sep. 13

這是一個由人類所編撰出來的傳奇故事，雖然眾家傳說紛紜，但是我們只是希望能藉由其中的一個傳說，來人們協助了解基本的生物特性。

生命演化三部曲：

一、化學演化(Chemical Evolution)

原始的地球大氣層促使小型有機分子的誕生，而這些分子的累積，將地表的海洋“熬”成一“營養”豐富的有機湯(prebiotic soup)，這進而促使巨型有機聚合物分子的形成。

二、自我組織(Self Organization)

巨型有機聚合物分子發展出自我複製的能力為生命體起源的重要關鍵。

三、生物演化(Biological Evolution)

原始的生命基本單位-細胞的出現，誘發了物質與能源消耗的競爭，於是細胞逐漸演化出繁複的代謝過程以開發擷取不同的來源，這促成多細胞生命的產生。

生命起源的傳奇故事



1. 他們說這像說的形成

地球形成

2. 核苷酸聚合物助長自我的形成
3. 自我複製分子的自然選擇與淘汰

4. 特殊RNA分子催化生化反應

5. 訊息傳遞：由核苷酸聚合物到氨基酸的複雜物

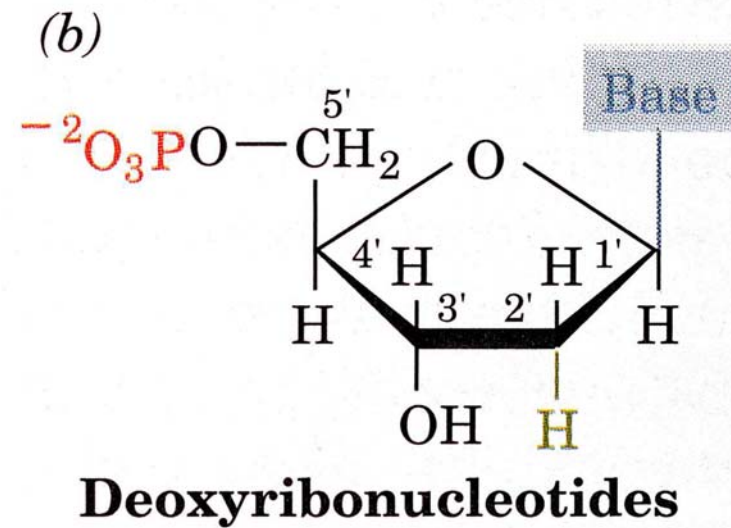
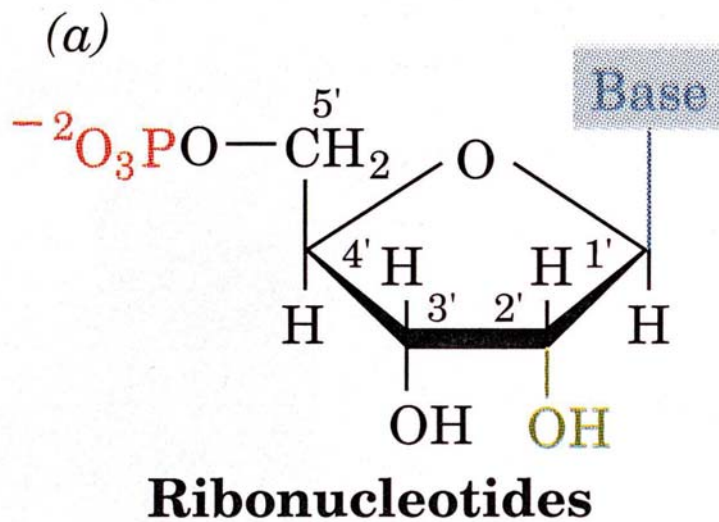
6. 真核細胞出現

多細胞生物崛起

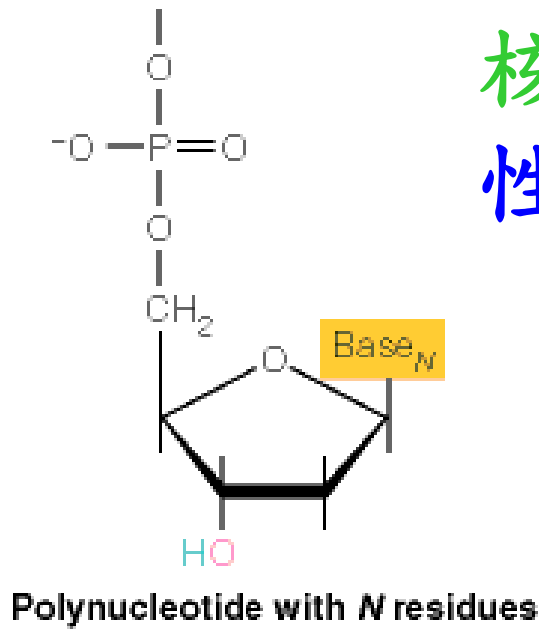
問題一：分子如何自我助長？

Nucleotides 核苷酸 *and Nucleic Acids* 核酸

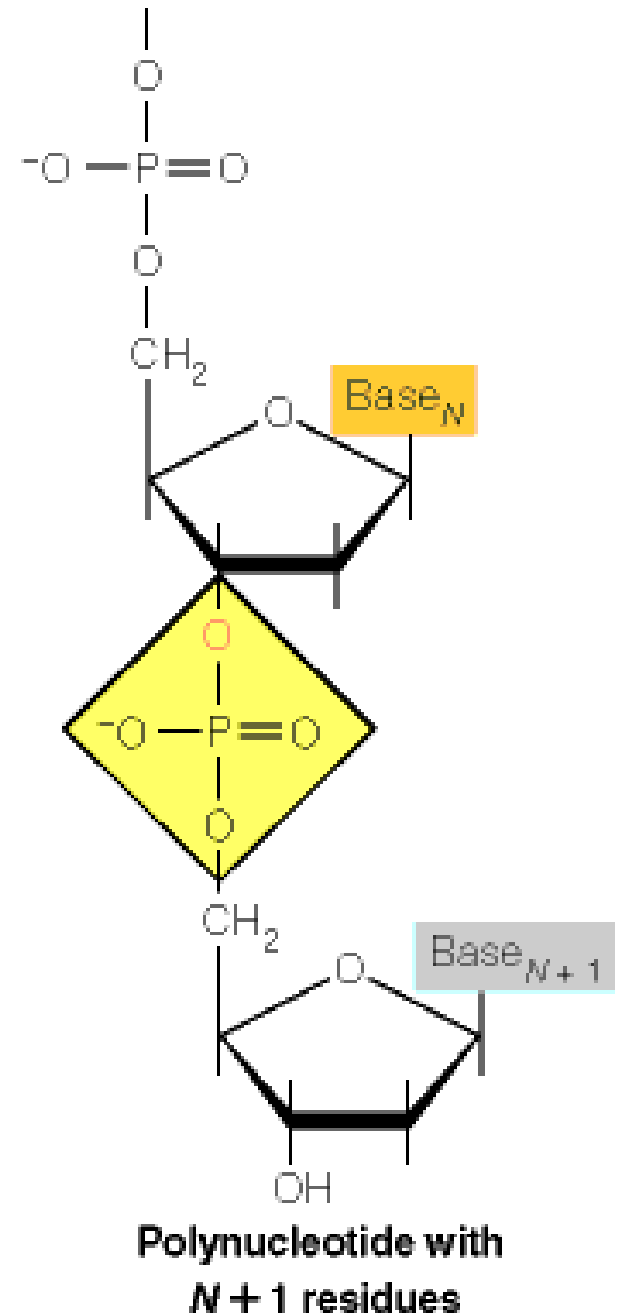
There two classes of nucleic acid: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). Structure of the monomer units of RNA and DNA are shown below:



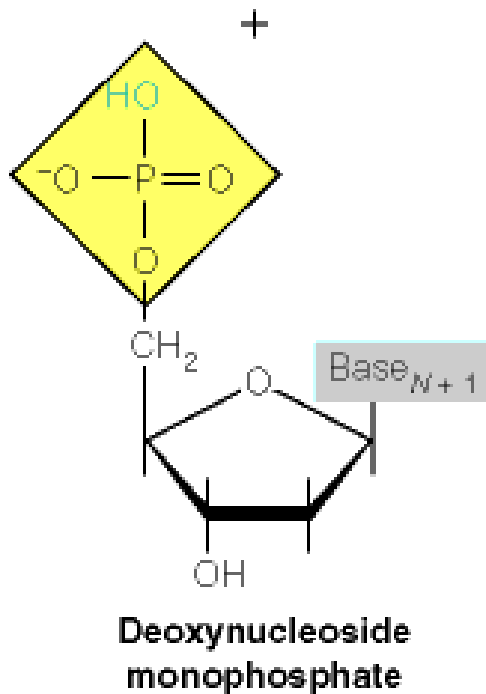
核酸分子形成線性聚合物之形式



dehydration

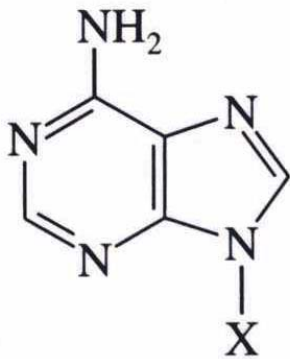


hydration

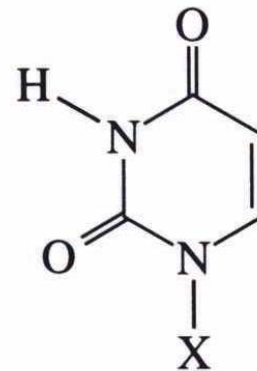


DNA has two purine, Adenine (A) and Guanine (G), and two pyrimidine, Cytosine (C) and Thymine (T).

RNA has the same bases excepts that Uracil (U) replace Thymine.



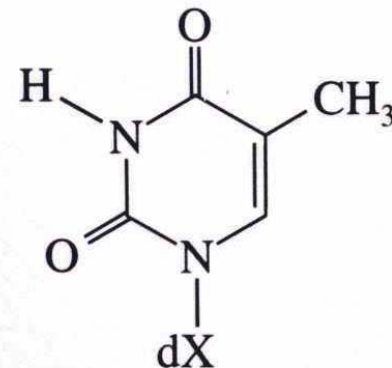
Adenine
Ade
A



Uracil
Ura
U

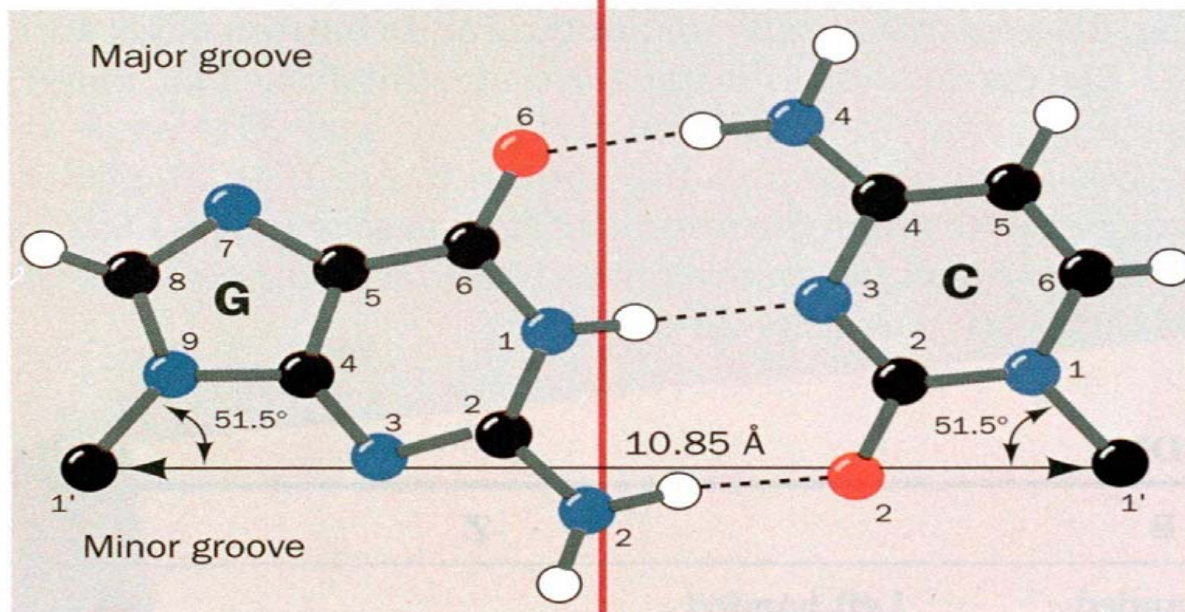
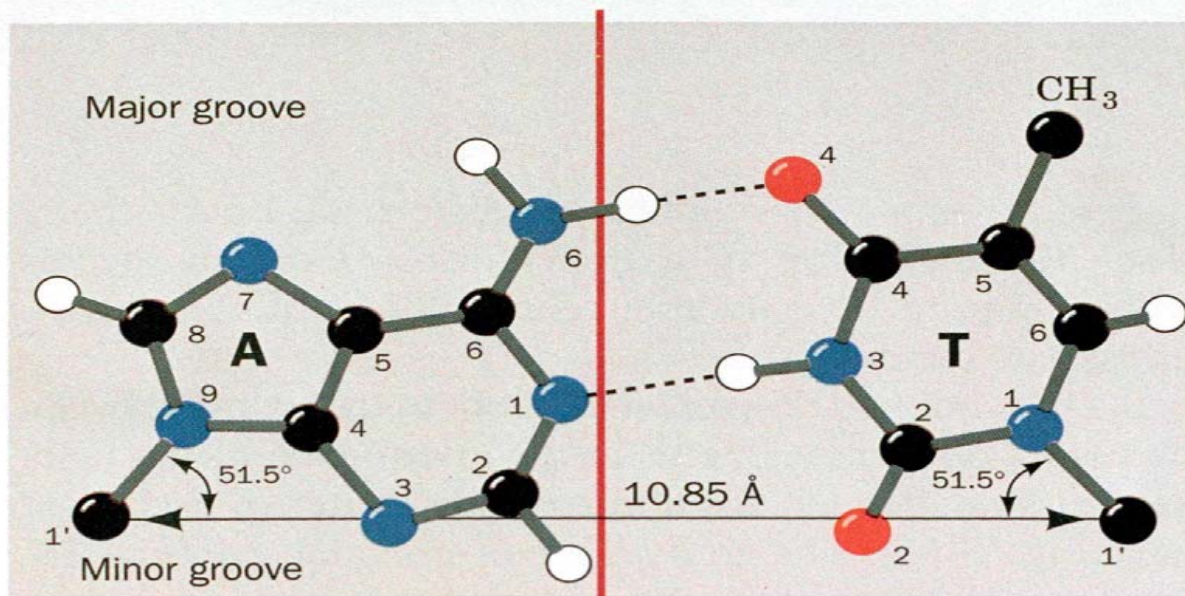


Guanine
Gua
G



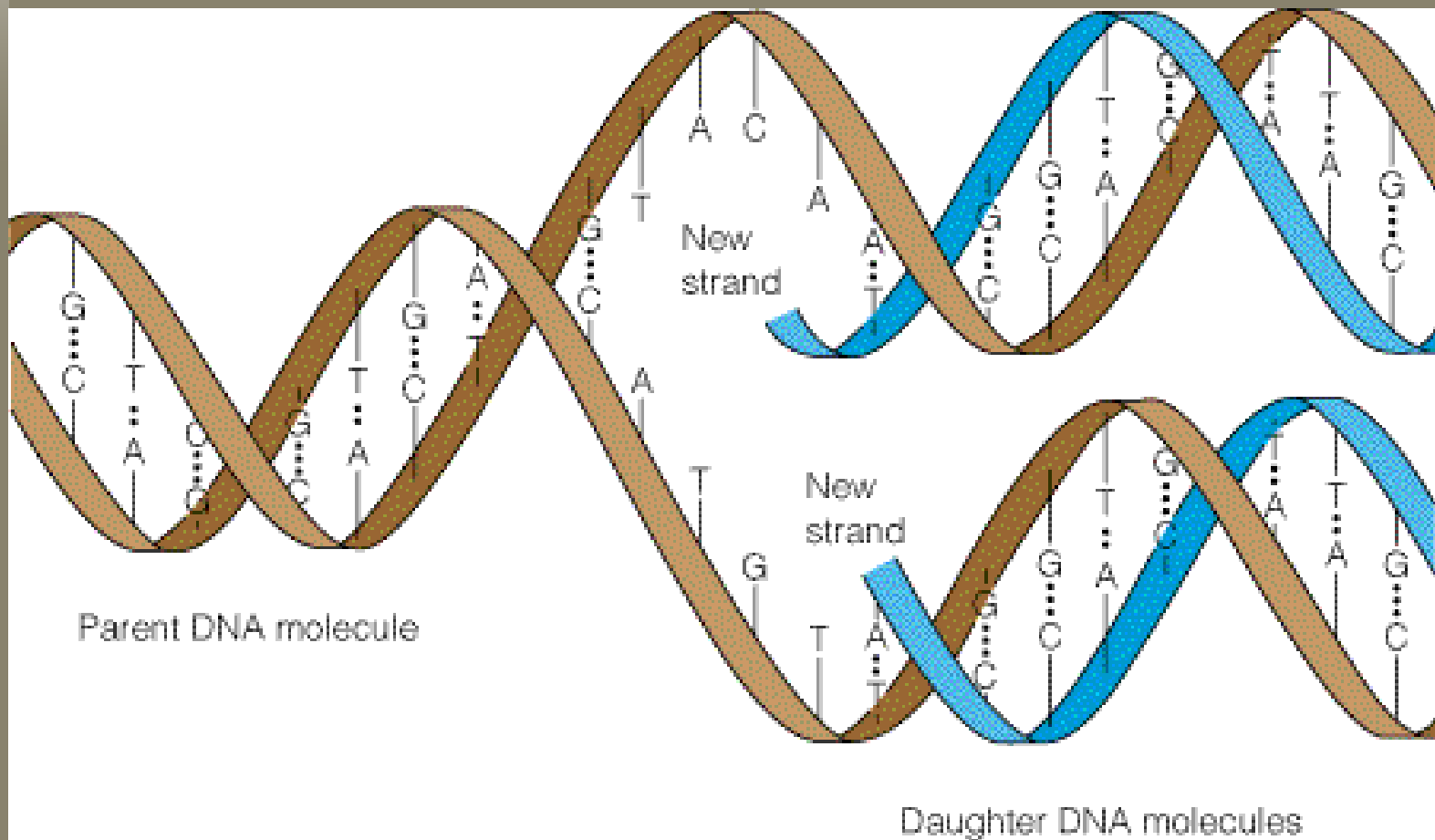
Thymine
Thy
T

一對一對應方式的鎖碼



雙螺旋的奧秘-物競天擇的優勝者

分子的自我助長與穩定之結構



問題二: 訊息如何傳遞?

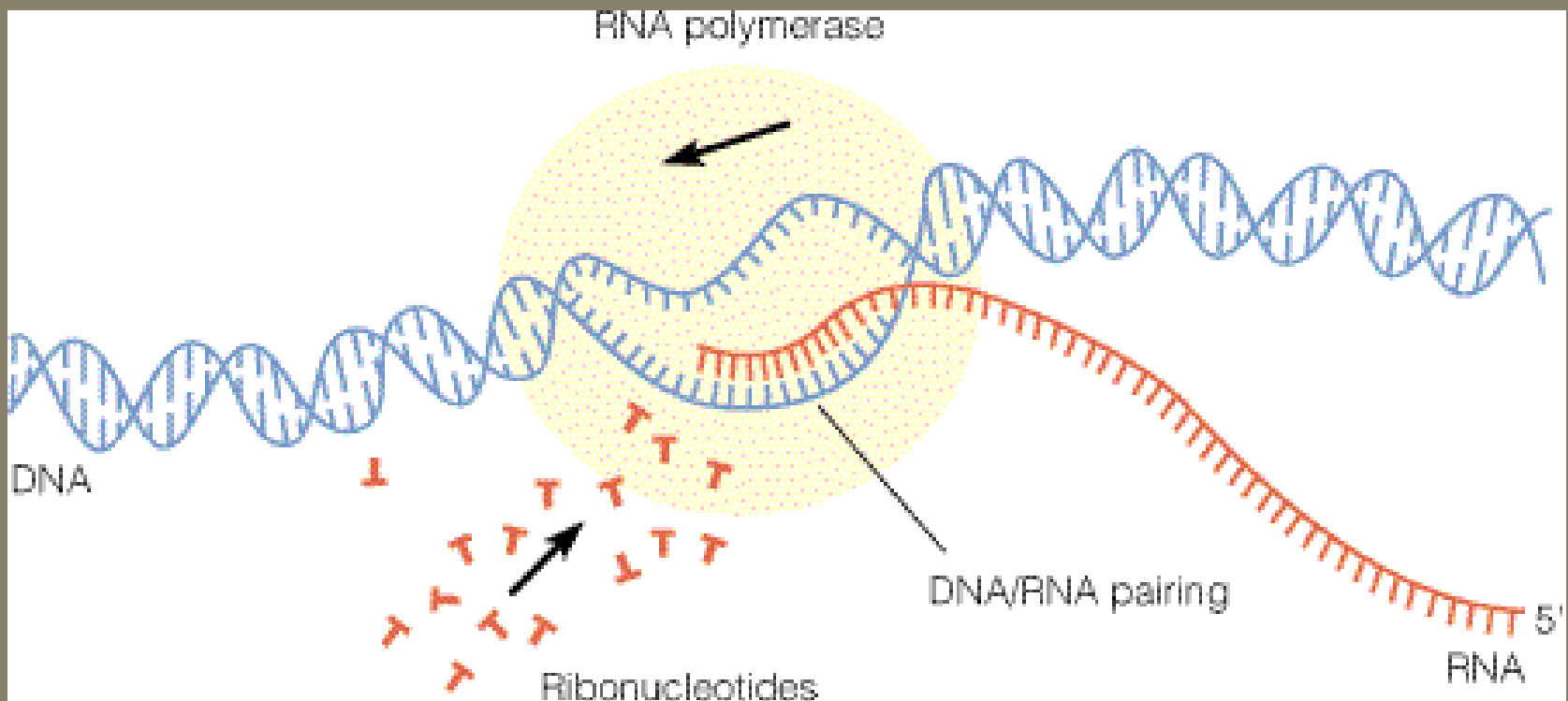
由DNA到RNA的轉錄行為

The base pairing rules for making RNA from DNA

DNA is transcribed as in RNA

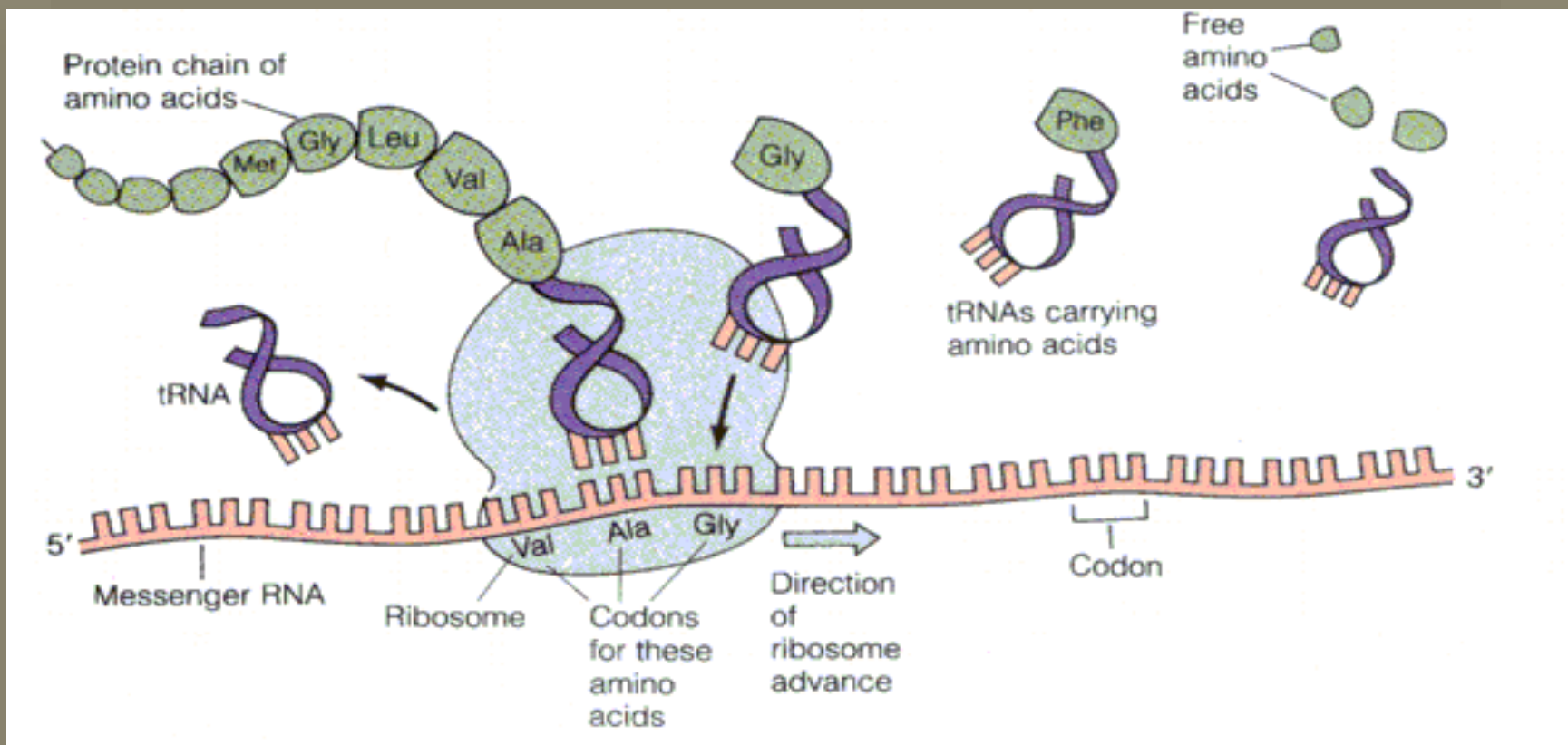
G to C C to G A to U

T to A



由核酸到胺基酸的訊息傳遞

由RNA讀取訊息將之轉譯(translation)
成為胺基酸線性聚合物

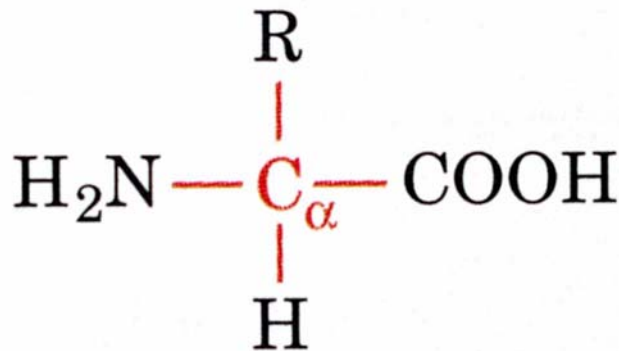


Genetic Code

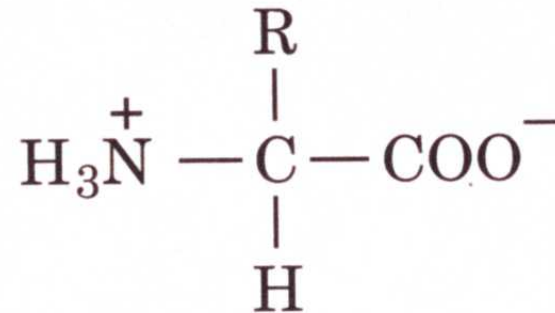
		Second position						
		U	C	A	G			
First position	U	UUU } Phe	UCU } Ser	UAU } Tyr	UGU } Cys	U	Third position	
		UUC } Phe	UCC } Ser	UAC } Tyr	UGC } Cys			C
		UUA } Leu	UCA } Ser	UAA Stop	UGA Stop			A
		UUG } Leu	UCG } Ser	UAG Stop	UGG Trp			G
	C	CUU } Leu	CCU } Pro	CAU } His	CGU } Arg	U		
		CUC } Leu	CCC } Pro	CAC } His	CGC } Arg	C		
		CUA } Leu	CCA } Pro	CAA } Gln	CGA } Arg	A		
		CUG } Leu	CCG } Pro	CAG } Gln	CGG } Arg	G		
	A	AUU } Ile	ACU } Thr	AAU } Asn	AGU } Ser	U		
		AUC } Ile	ACC } Thr	AAC } Asn	AGC } Ser	C		
		AUA } Ile	ACA } Thr	AAA } Lys	AGA } Arg	A		
	AUG Met/start	ACG } Thr	AAG } Lys	AGG } Arg	G			
	G	GUU } Val	GCU } Ala	GAU } Asp	GGU } Gly	U		
		GUC } Val	GCC } Ala	GAC } Asp	GGC } Gly	C		
		GUA } Val	GCA } Ala	GAA } Glu	GGA } Gly	A		
		GUG } Val	GCG } Ala	GAG } Glu	GGG } Gly	G		

Amino Acids 胺基酸

胺基酸為生物蛋白質的基本組成單位。雖然蛋白質所含的胺基酸數目十分龐大，但是這些蛋白質胺基酸多半是由同樣的二十種不同的胺基酸所重複排列組合而成。這些胺基酸的共同結構如下（R為Remainder，代表該分子其他剩餘的部分）



胺基酸的通式結構

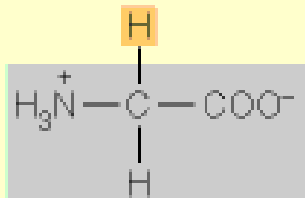


胺基酸的極性結構（zwitterionic form通常發生於生理狀態pH值時）

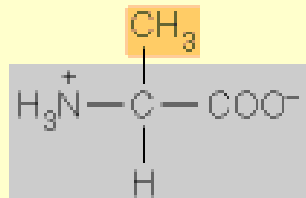
Classes of -Amino Acids

Aliphatic side chains (a diverse group - more nonpolar ones, prefer interior of protein molecule)

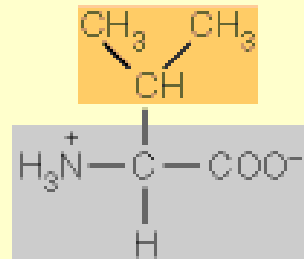
ALIPHATIC AMINO ACIDS



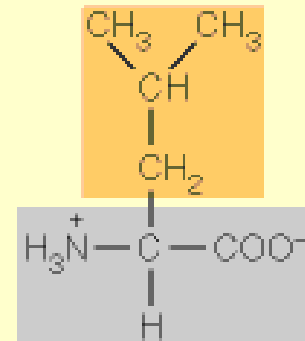
Glycine (Gly) G



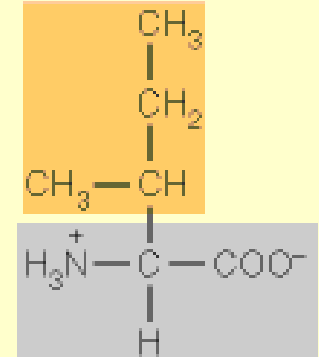
Alanine (Ala) A



Valine (Val) V



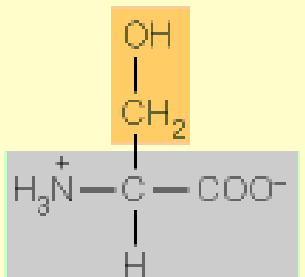
Leucine (Leu) L



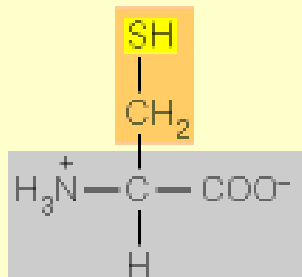
Isoleucine (Ile) I

Hydroxyl or Sulfur-Containing Side Chains (weakly polar side chains, except MET)

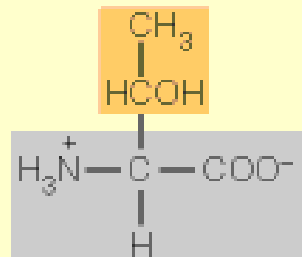
AMINO ACIDS WITH HYDROXYL- OR SULFUR-CONTAINING SIDE CHAINS



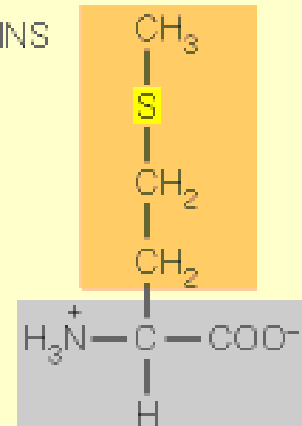
Serine (Ser) S



Cysteine (Cys) C

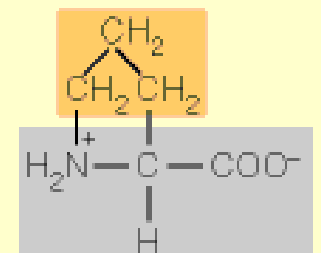


Threonine (Thr) T



Methionine (Met) M

CYCLIC AMINO ACID

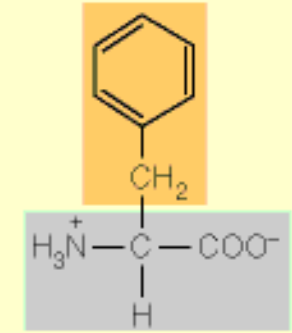


Proline (Pro) P

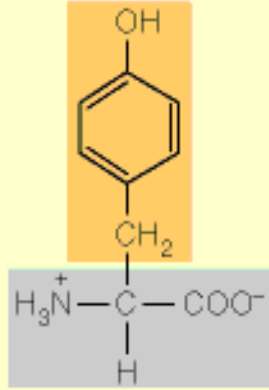
Aromatic Amino Acids (Strong absorption of light in near UV)

Basic Amino Acids (Strongly polar, usually on exterior of proteins)

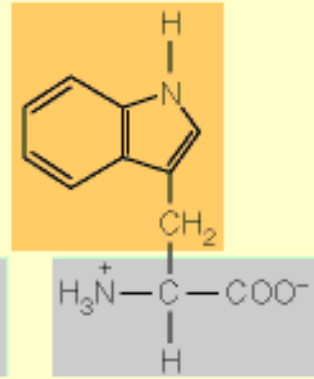
AROMATIC AMINO ACIDS



Phenylalanine (Phe) F

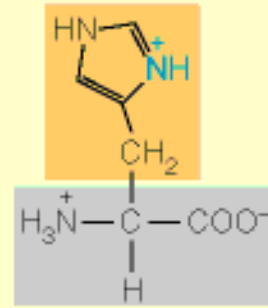


Tyrosine (Tyr) Y

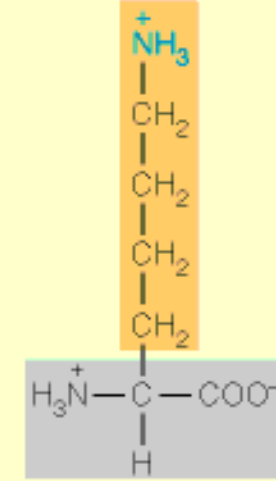


Tryptophan (Trp) W

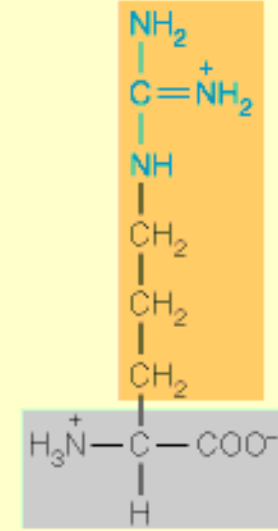
BASIC AMINO ACIDS



Histidine (His) H



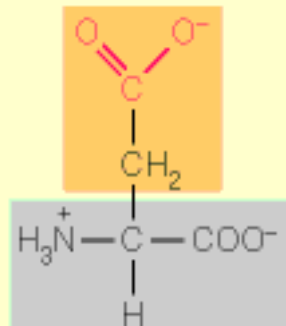
Lysine (Lys) K



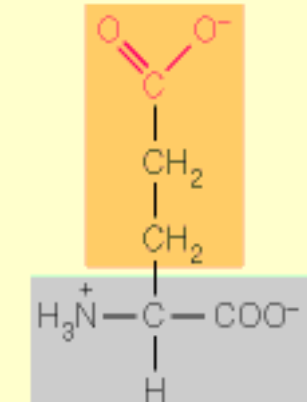
Arginine (Arg) R

Acidic Amino Acids and Their Amides (ASP and GLU strongly acid, ASN and GLN polar but not charged. All prefer exterior of protein)

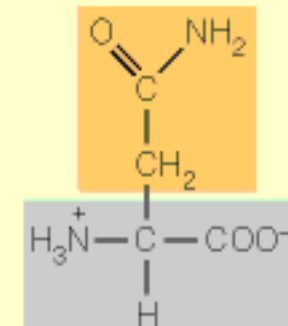
ACIDIC AMINO ACIDS AND THEIR AMIDES



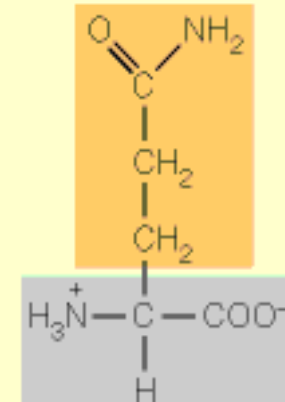
Aspartic acid (Asp) D



Glutamic acid (Glu) E



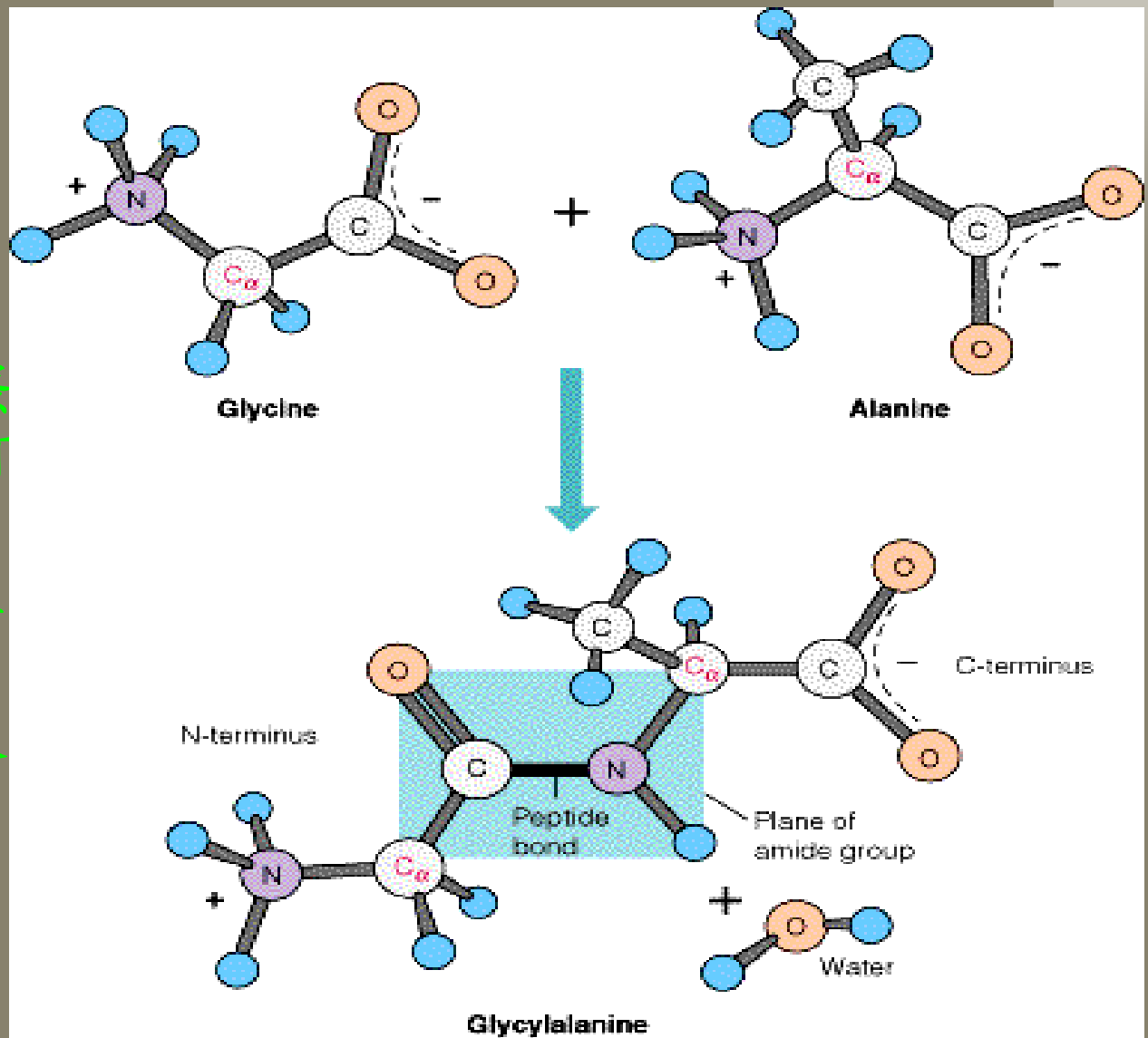
Asparagine (Asn) N



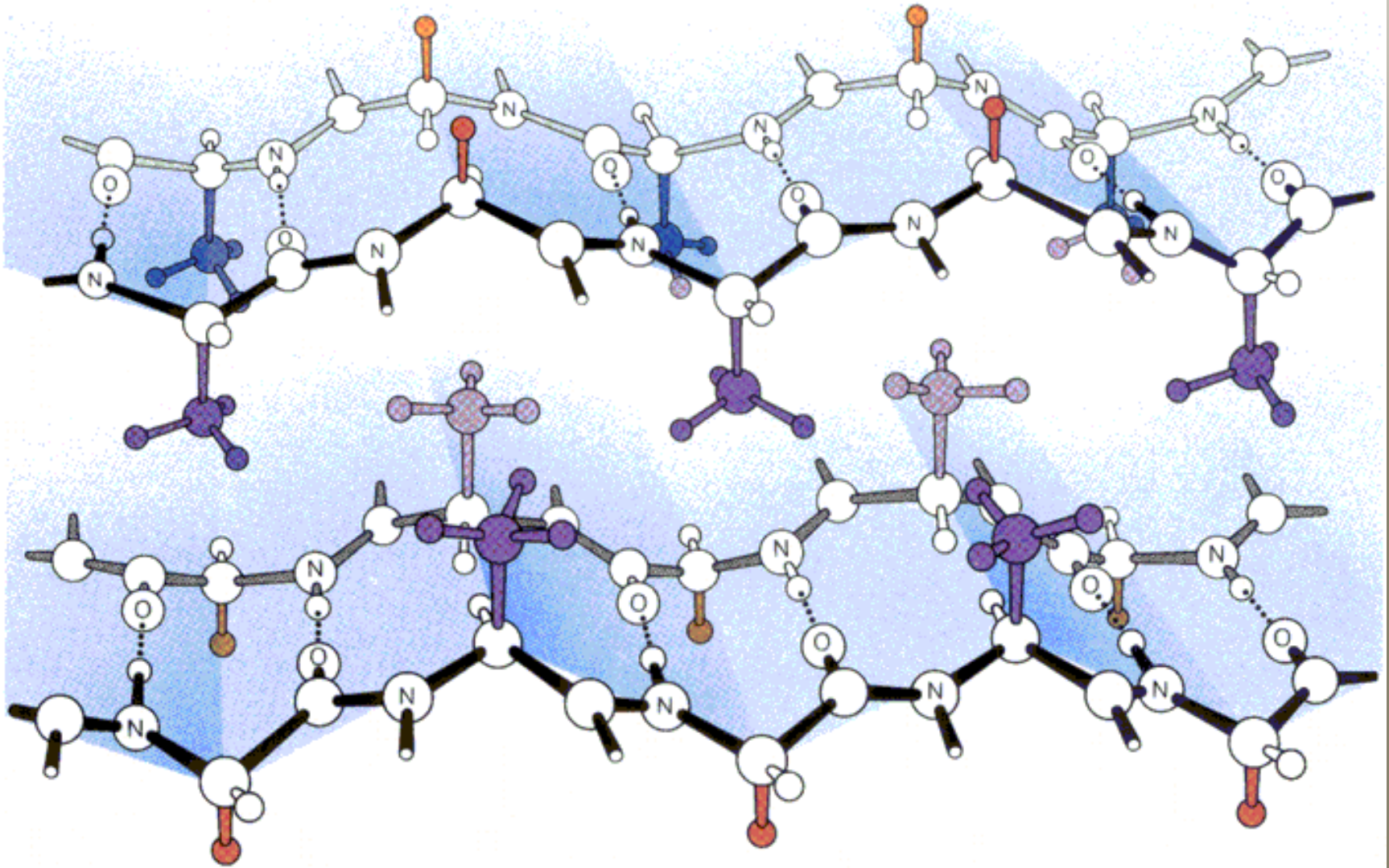
Glutamine (Gln) Q

胺基酸與蛋白質

蛋白質為以胺基酸為基本單元分子所聚合成具有構造與代謝功能的巨型大分子。例如肌球蛋白(myosin)與肌動蛋白(actin)為肌肉中可收縮的組成；胰島素(insulin)為調節血糖的激素；血紅素(hemoglobin)為血液輸送氧氣分子著主要傳輸機構；膠原纖維(collagen fiber)為支撐器官的架構。



蜘蛛人的武器

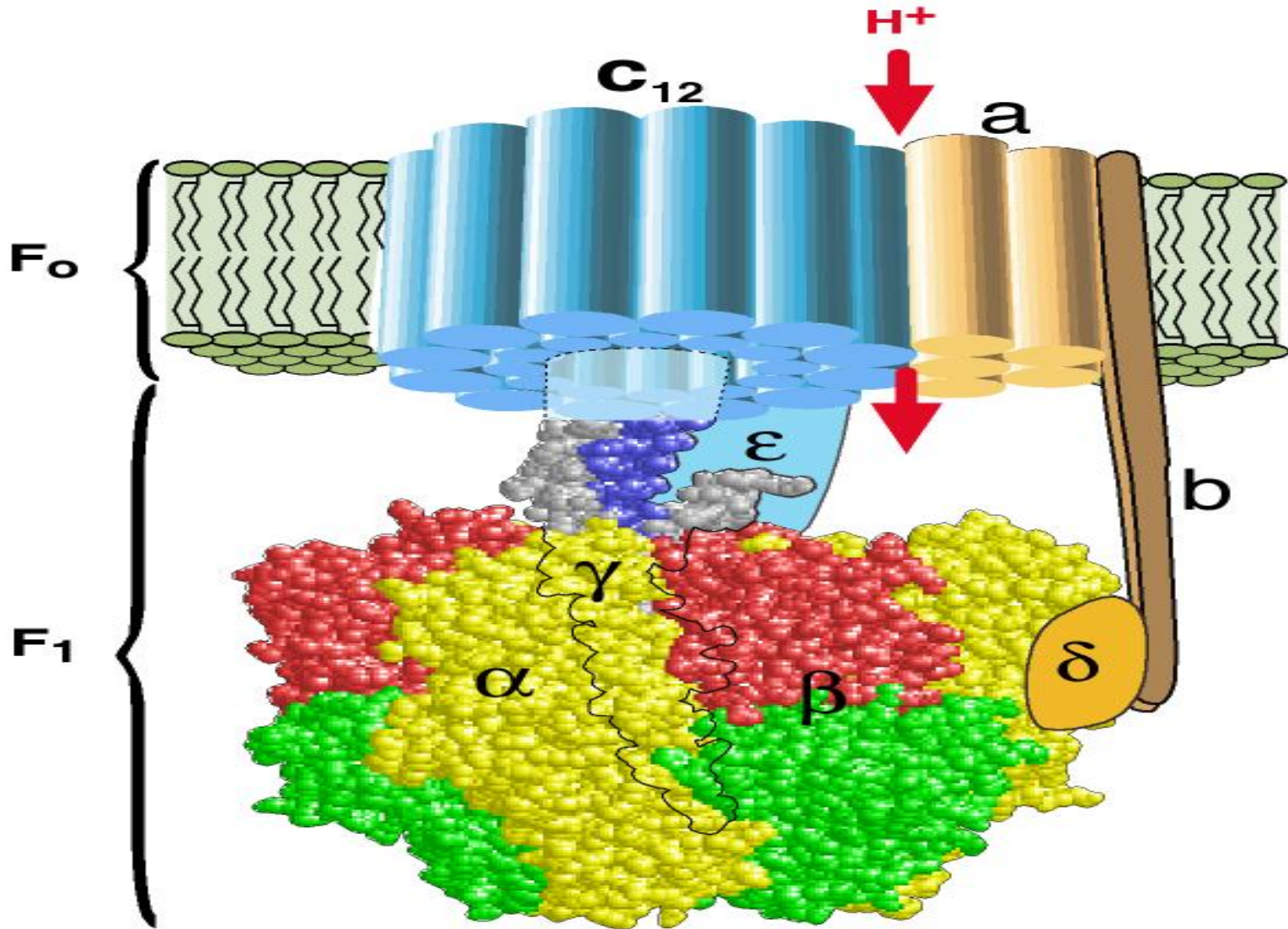


Side chains of

■ Gly (—H)

■ Ala (—CH₃)

只有幾個奈米的轉動馬達



H. Wang and G. Oster (1998). Nature 396:279-282.

問題三:細胞如何形成?