



Genetics

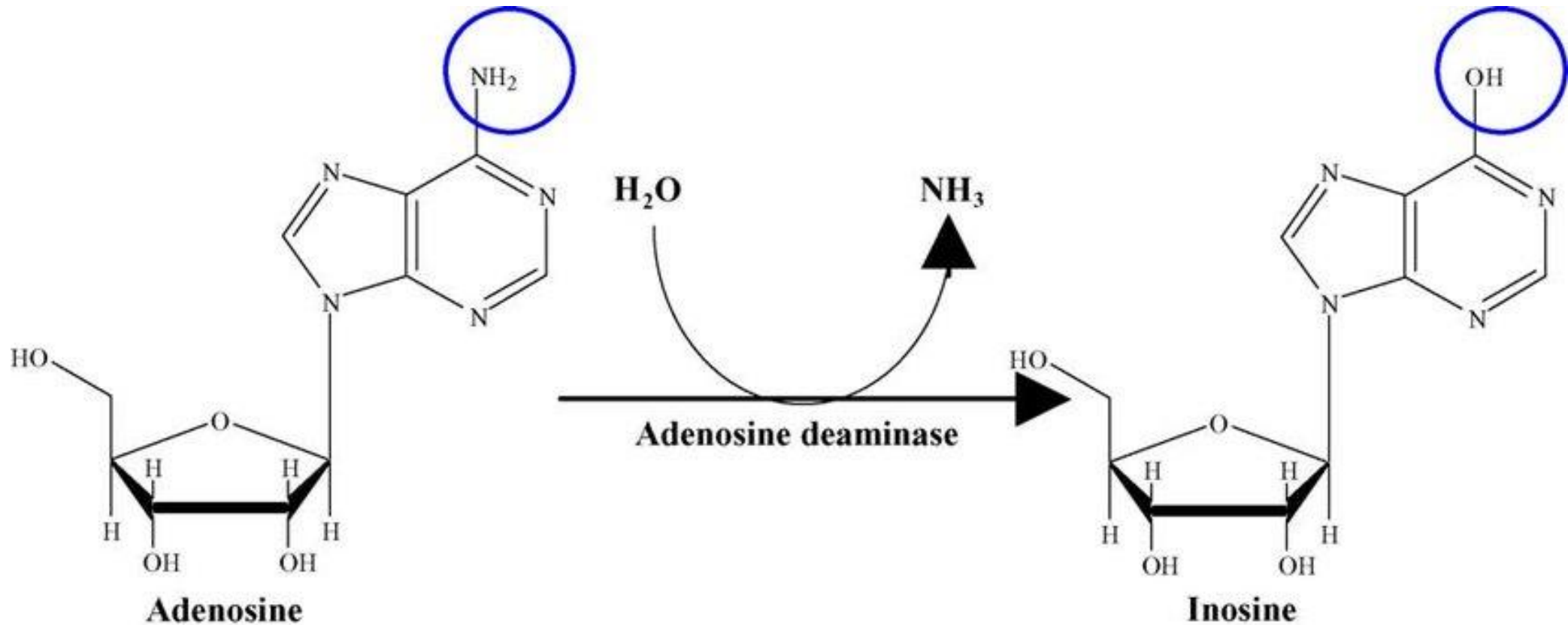
***Subject* : Genetics**

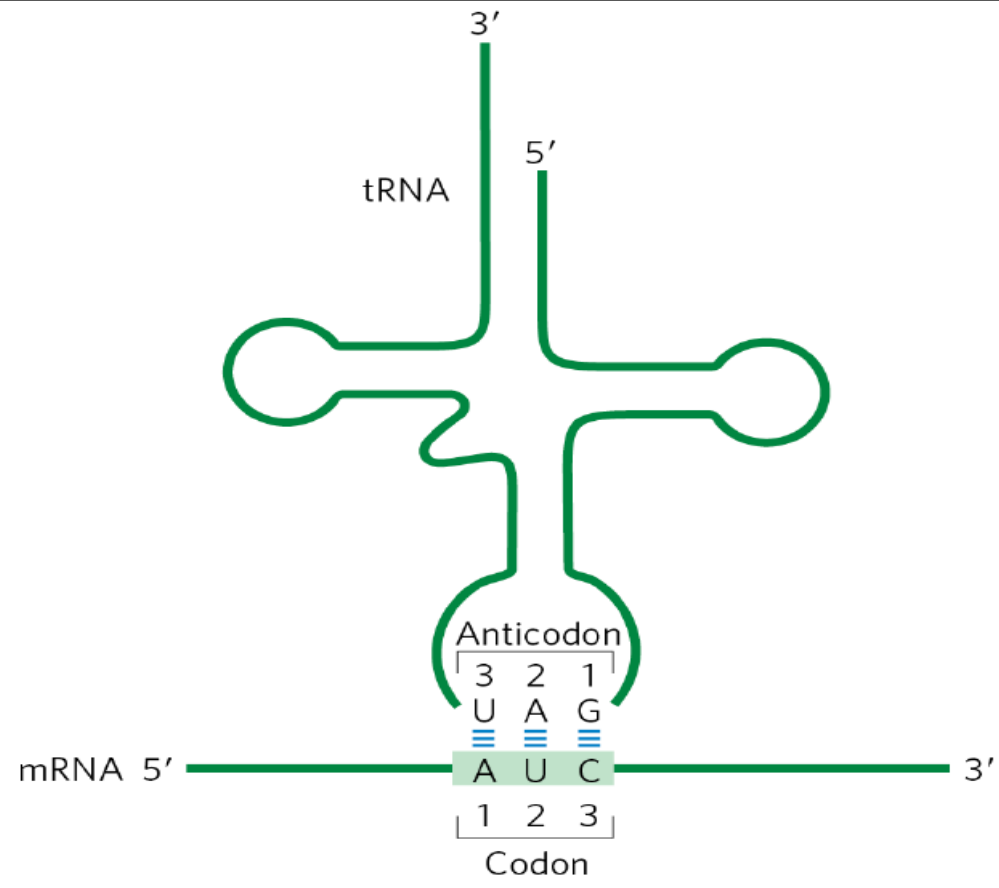
***Lec no* : 14**

***Done By* : Mahmoud Al Qusairi**

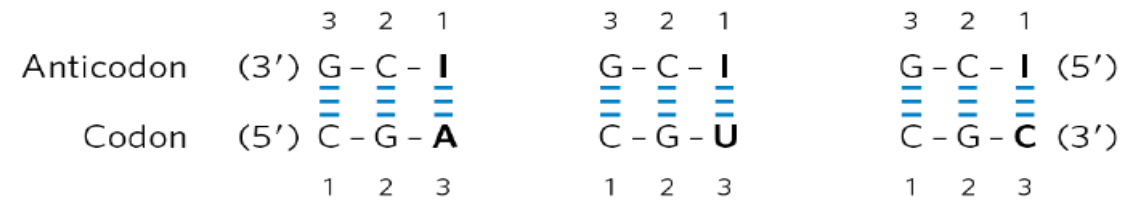
وَقُلْ رَبِّ زِدْنِي عِلْمًا

Wobble Base





(a)



(b)

Characteristics of Genetic Code

➤ **Non-overlapping and commaless:**

The genetic code is non-overlapping and commaless, that is, the code is read from a fixed starting point as a continuous sequence of bases, taken three at a time.

❖ For example, AGCUGGAUACA is read as AGC/UGG/AUA/CAU without any “punctuation” between the codons.

Overlapping refers to how the code is read. The first three bases are read as one codon, then the next three as the second etc, therefore each base is read only once and the bases do not overlap. *

* Nonoverlapping code

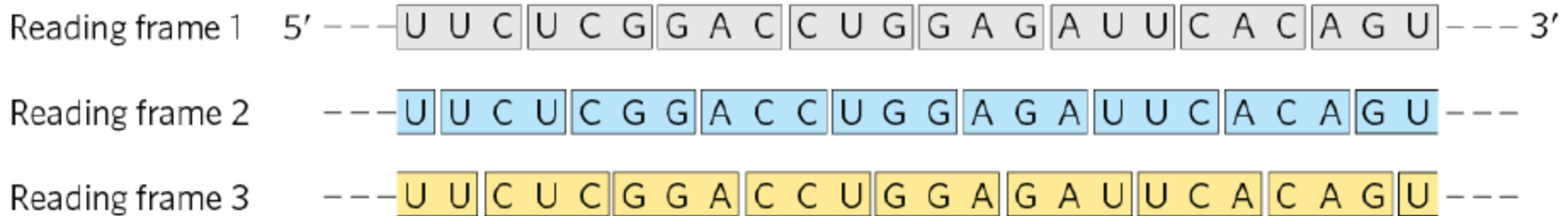
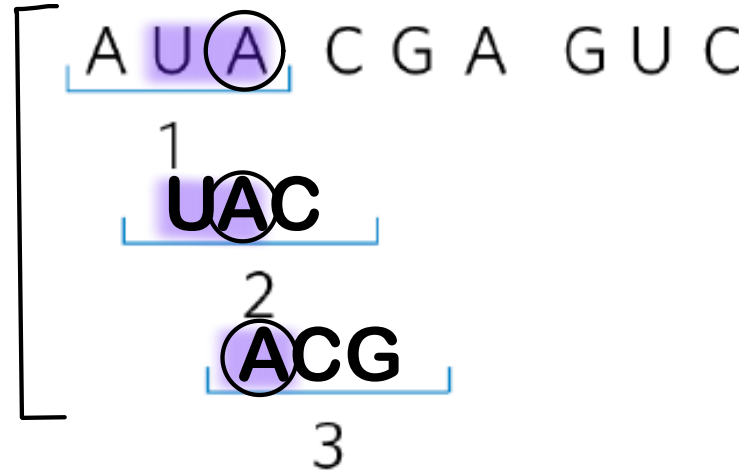
لا يوجد فواصل بين الكودونات في genetic code



Overlapping code

عملية دخول نوكليوتيد nucleotide
في احدى مفاصل codon

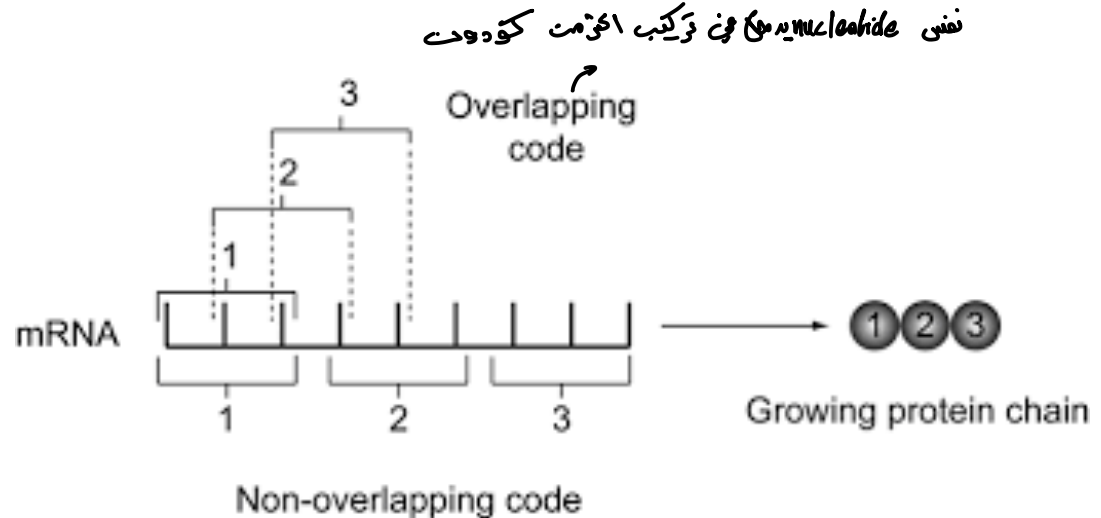
لا يمكن ان يحدث mutation بسبب overlapping



The codon is non-overlapping

ترکیب خارجیه

- A non overlapping code means that the same letter is not used for two different codons.
- In other words, no single base can take part in the formation of more than one codon.
- The adjacent codons do not overlap.
- Example: There are Bases : CATGAT
- Non-overlapping Code : 2 that is CAT and GAT;
- Overlapping Code : 4 that is CAT, GAT, ATG and TAT



Characteristics of Genetic Code

على ٣ نيوكليوتيد مع بعض يتيم مراتهم ٥ codon

➤ **Reading frames**: usually one reading frame will produce a functional protein, the codons are read from a specific starting point (initiating codon) on the mRNA as a continuous uninterrupted sequence of bases taken 3 at a time.

القراءة من ٣ → ٥

➤ **Unidirectional**: The letters in each codon are written from 5' -end to the 3' -end and codons on mRNA are written and read also from 5' -end to the 3' -end.

Characteristics of Genetic Code

- The genetic code functions via linker molecules. ^{tRNA} The tRNAs are the crucial adaptor, matching amino acids with DNA codons.

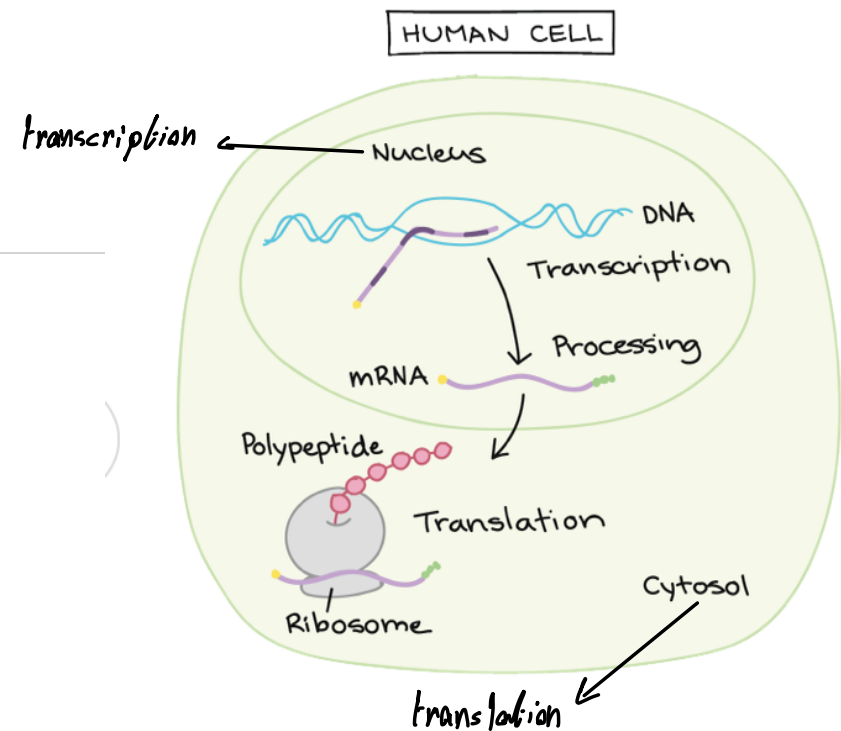


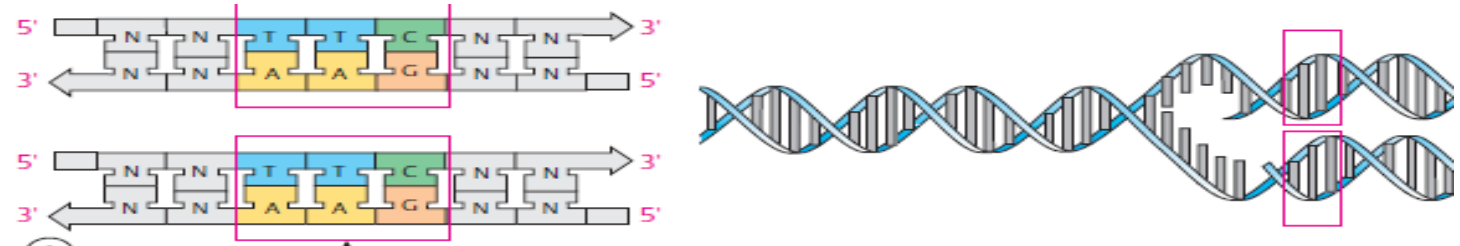
Thank you 😊

Protein Synthesis (Translation)

Nebras Melhem

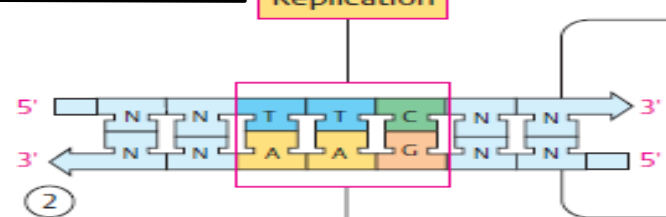
Dr. Walaa Bayoumie El Gazzar





①

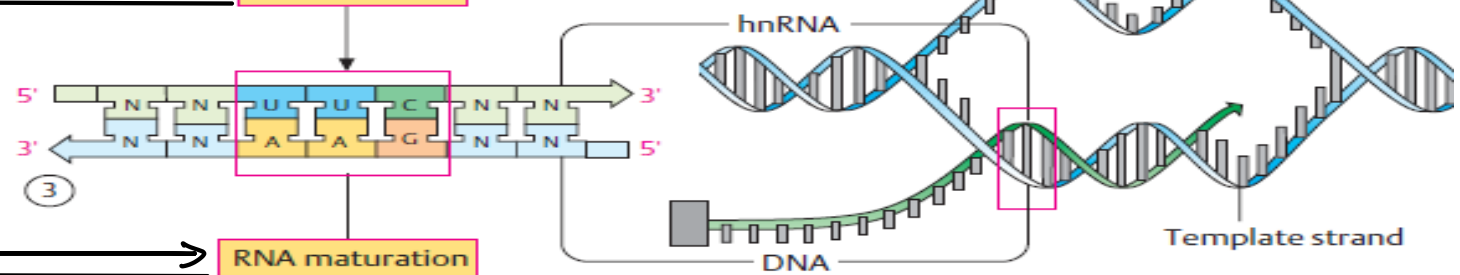
Replication



②

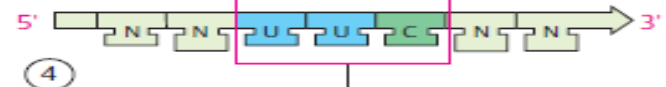
Transcription

in nucleus



③

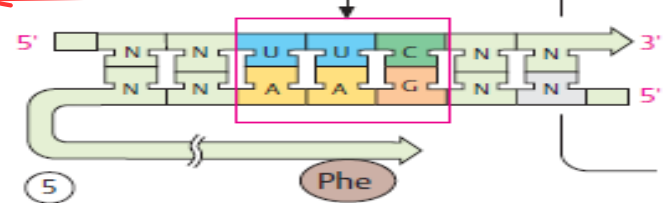
RNA maturation



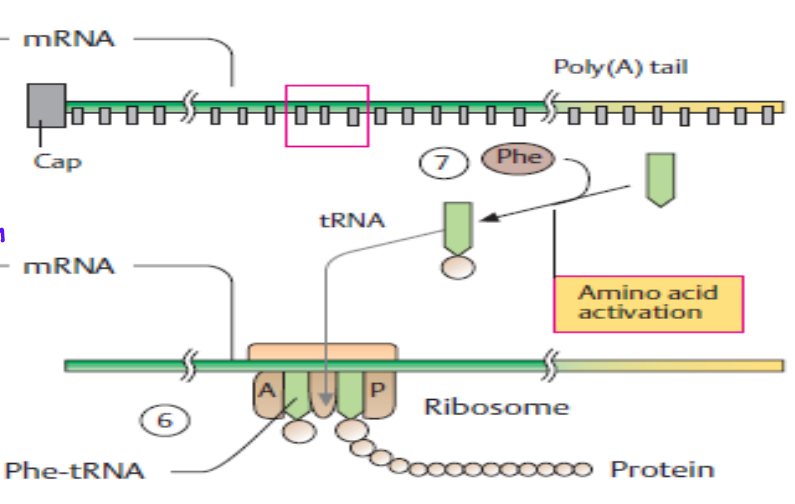
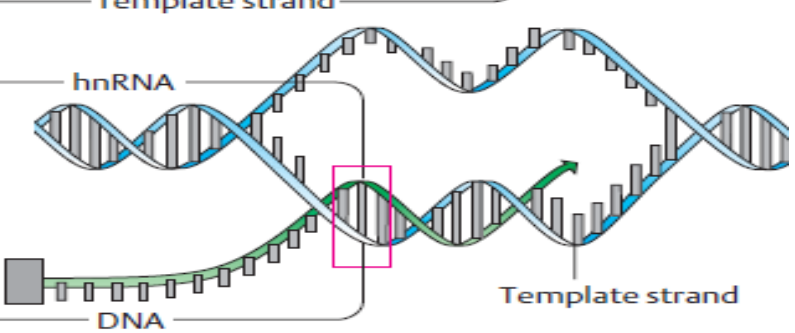
④

Translation

in cytoplasm at ribosome



⑤



synthesis of mRNA

mRNA modifications

produce of polypeptide chain

mRNA, rRNA, tRNA : نحتاج فيها الى activated (mature mRNA)

Aminoacyl-tRNA synthetases (AARSs) are the enzymes that catalyze the aminoacylation reaction by covalently linking an amino acid to its cognate tRNA in the first step of protein translation

* tRNA يحمل a.a الذي يعني codon الموجود على mRNA
لأنه ذلك حتى يتمكن tRNA من العمل يحتاج a.a (activated a.a)
Aminoacyl t-RNA synthetase activation عن طريق
a.a + activation من طريق

تربط a.a مع tRNA

Steps of protein synthesis

- Activation of amino acid (AA) and synthesis of aminoacyl-tRNA: ^{↳ the first step of translation}

a.a loads
↑
synthesis tRNA

↳ is enzyme that specific to only one type of a.a → 20 enzymes (لكل a.a انزيم معين) لأن كل واحد يكون موجود

Aminoacyl t-RNA synthetase belongs to the enzyme family which is required for attachment of AAs to their corresponding tRNA.

Each member of this family recognizes a specific AA and all the tRNAs that correspond to that AA.

The enzymes check their work, and if the incorrect amino acid has been linked to a particular tRNA, the enzyme will remove the amino acid from the tRNA and try again utilizing the correct amino acid.

Steps of protein synthesis

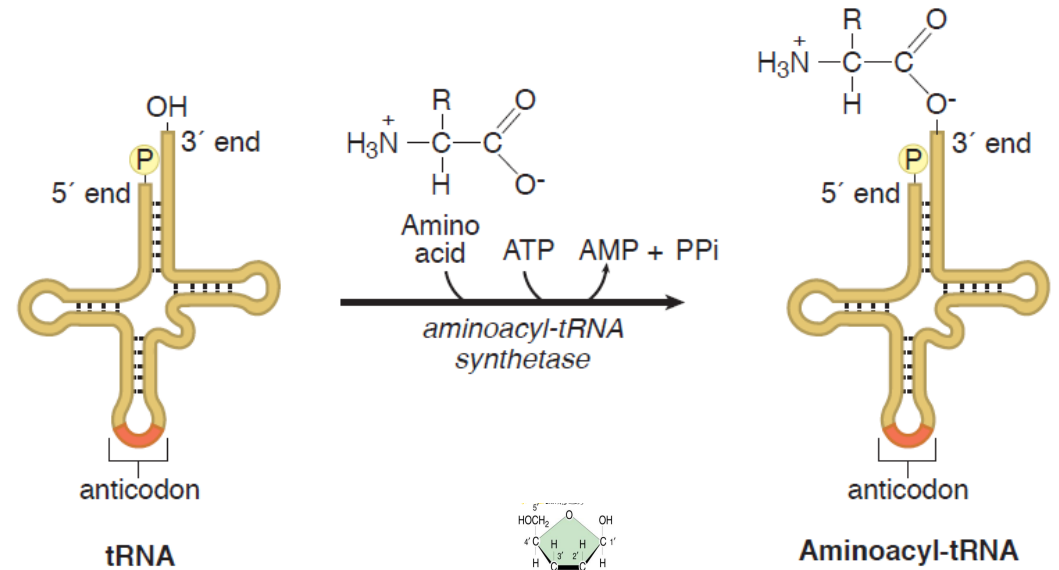
- The enzyme recognizes the **-R radical** of the amino acid and recognizes the **anticodon** of the tRNA.
- Transfer-RNAs for different amino acids differ not only in their anticodon but also at other points, giving them slightly different overall configurations. The **aminoacyl-tRNA synthetases** recognize the correct tRNAs primarily through their overall configuration, not just through their anticodon.
- In the cytosol, there are 20 species for this enzyme, one specific for each of the 20 amino acids required for protein synthesis.
- This enzyme connects the **carboxyl group** of the **amino acid** to the **3'-OH** of the **specific tRNA**.

Steps of protein synthesis

دissociation
 405 ← 605

- Each type of amino acid is activated by a different aminoacyl tRNA synthetase.
- Two high-energy bonds from an ATP are required.
- The aminoacyl tRNA synthetase transfers the activated amino acid to the 3' end of the correct tRNA.
- The amino acid is linked to its cognate tRNA with an energy-rich bond.

This bond will later supply energy to make a peptide bond linking the amino acid into a protein.



بما ان A.A يرتبط عند 3' end (تكون hydroxy group على 3' end free) hydroxy group
 ترتبط مع hydroxy group at 3' end of tRNA
 (carboxy group at A.A)

RNA — Ribose

Glutamate

كل هذا حدث في cytoplasm

First component of translation

الوحدة المميزة والاختلاف من A.A للآخر. A-group هي البرزج

Amino Acid	Structure
Alanine	<chem>CC(N)C(=O)O</chem>
Valine	<chem>CC(C)C(N)C(=O)O</chem>
Leucine	<chem>CC(C)C(C)C(N)C(=O)O</chem>
Proline	<chem>C1CCNCC1</chem>
Serine	<chem>CC(N)C(=O)O</chem>
Threonine	<chem>CC(O)C(N)C(=O)O</chem>
Cysteine	<chem>CC(N)C(S)C(=O)O</chem>
Asparagine	<chem>CC(N)C(=O)N</chem>
Glutamine	<chem>CC(N)C(=O)N</chem>
Aspartic acid	<chem>CC(N)C(=O)O</chem>
Glutamic acid	<chem>CC(N)C(=O)O</chem>
Proteinogenic Amino Acids	

يرتبط مع A.A ولكن على صورة AMP (activated a.a)

ATP → AMP + 2P
hydrolysis of ATP
يطلق الطاقة اللازمة لربط A.A مع tRNA

بأقرب بعد activation of a.a ويرتبط به

specific binding site
السكريوت تسمى من جهة فقط
A.A
يتعرف الانزيم على A.A عن طريق A-group

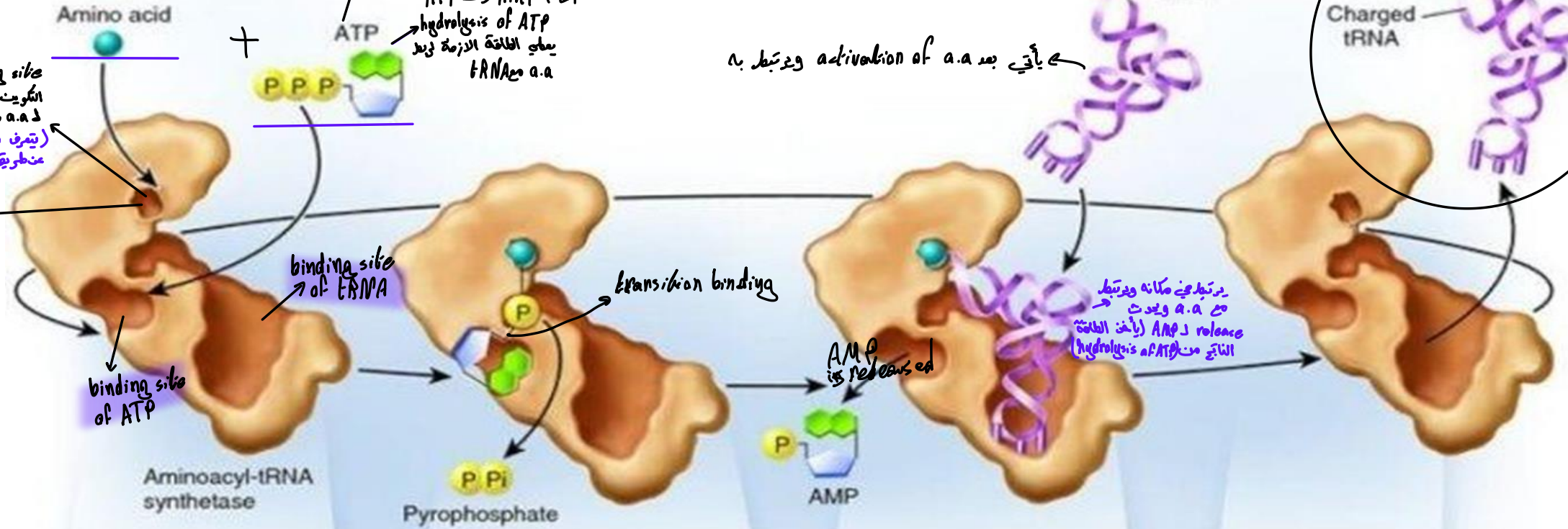
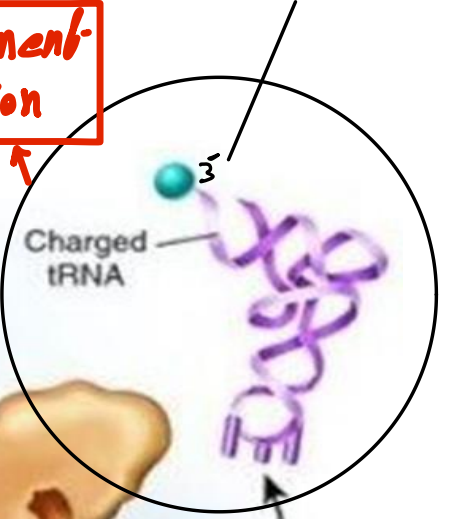
binding site of a.a

binding site of tRNA

transition binding

AMP is released

يرتبط في مكانه ويرتبط مع A.A ويحدث AMP release (أيضاً الطاقة الناتجة من ATP hydrolysis)



1 A specific amino acid and ATP bind to the aminoacyl-tRNA synthetase.

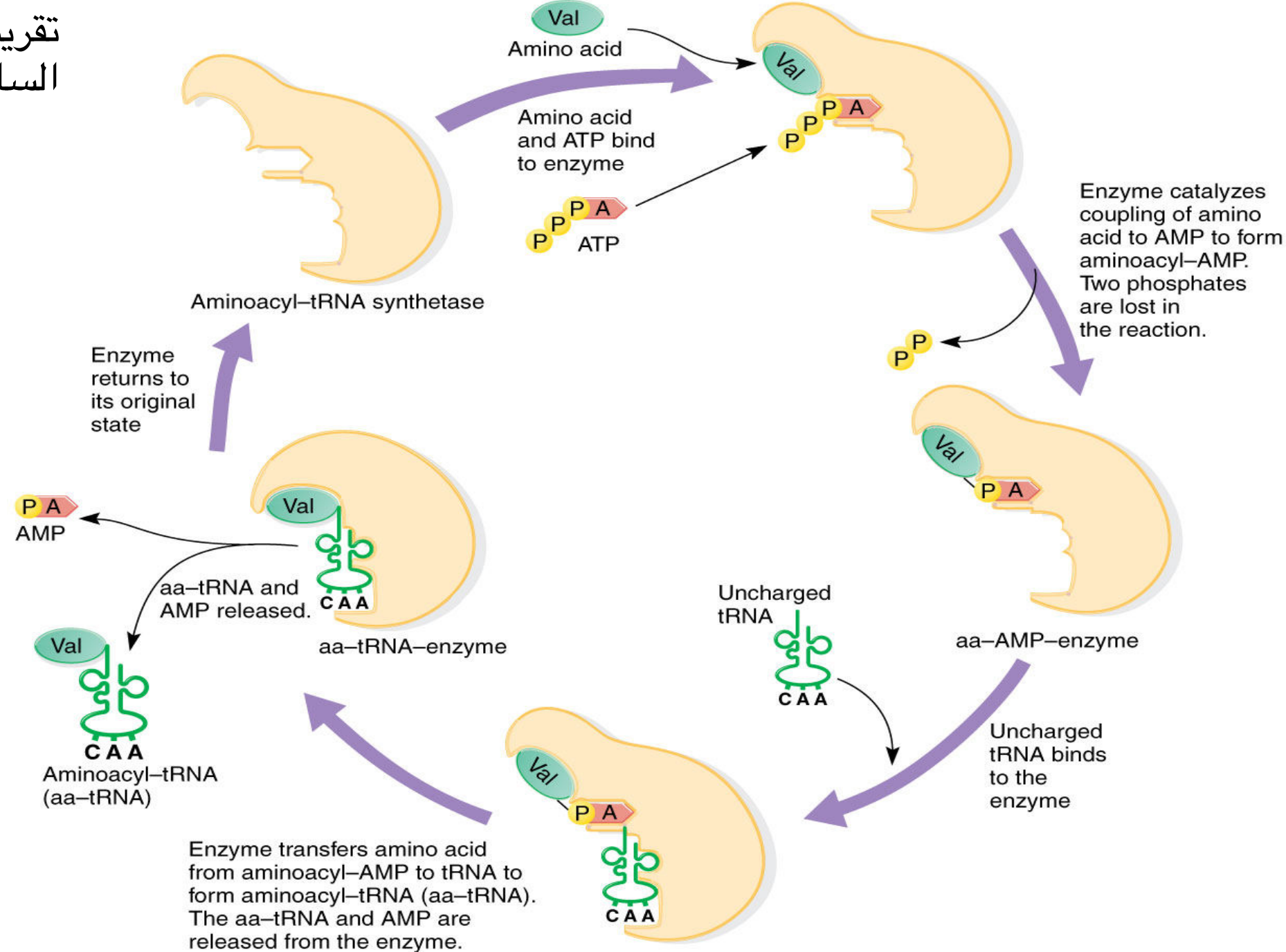
2 The amino acid is activated by the covalent binding of AMP, and pyrophosphate is released.

3 The correct tRNA binds to the synthetase. The amino acid is covalently attached to the tRNA. AMP is released.

4 The charged tRNA is released.

Aminoacyl-tRNA synthetases (AARSs) are the enzymes that catalyze the aminoacylation reaction by covalently linking an amino acid to its cognate tRNA in the first step of protein translation

تقريباً نفس السلايد السابق



Translation phases

تجهيز لكي components اللازمة

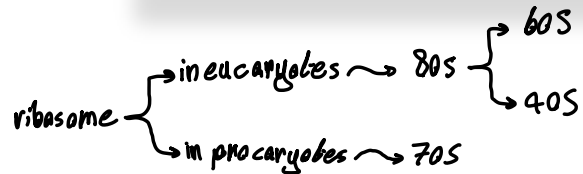
- I. Initiation ^{تجميع a.a من بعض}
- II. Elongation ^{تجميع}
- III. Termination

- Special protein factors for initiation (IF), elongation (EF), and termination (release factors), as well as GTP, are required for each stage.
-

I. Initiation → ribosome

اول شيء فيها هو تجسير

S → sedimentation velocity
لو أنزلت large subunit ووضعت في tube وعلقت في centrifuge وعلقت
centrifugation سرعة ترميها بنسبتها → unit ← (S) or (Svedberg unit)
60S sedimentation velocity ← large subunit
40S sedimentation velocity ← small subunit
80S ← large subunit and small subunit together
100S ليست
لأن sedimentation velocity لا تعتمد فقط على molecular weight
ولكنها تعتمد أيضاً على shape

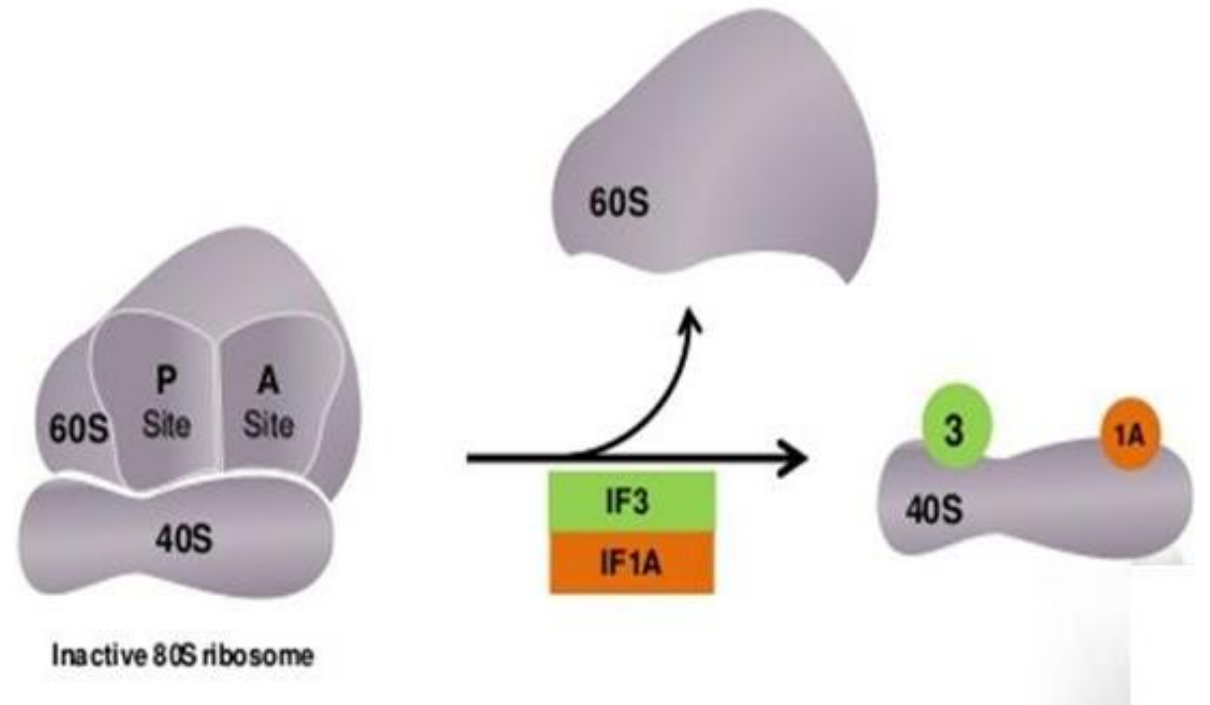


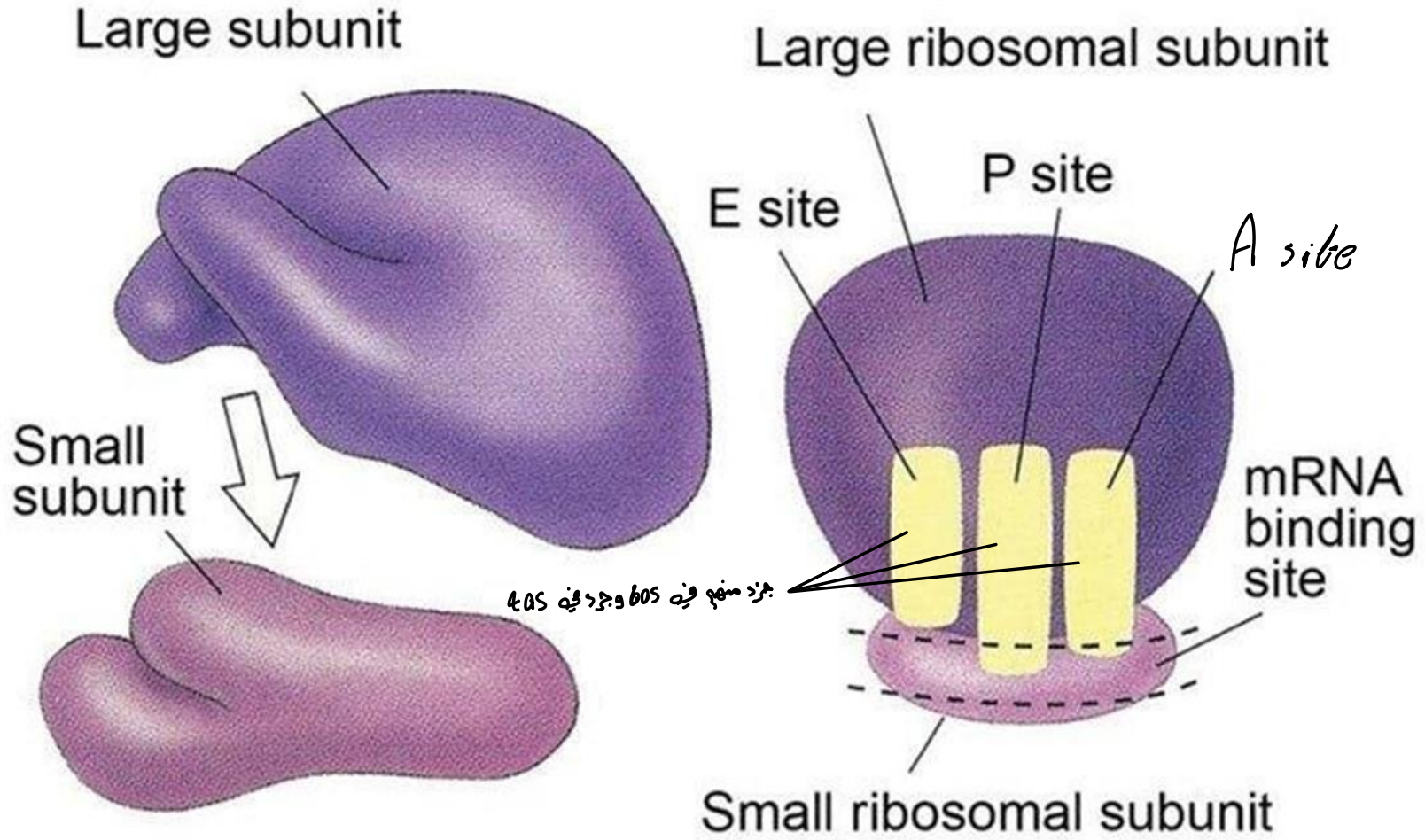
- Ribosomal dissociation
- Formation of 43S preinitiation complex
- Formation of 48S initiation complex
- Formation of 80S initiation complex

Ribosomal dissociation

يرتبط مع 40S subunit وينزعها عن 60S (IF-1A/IF3)

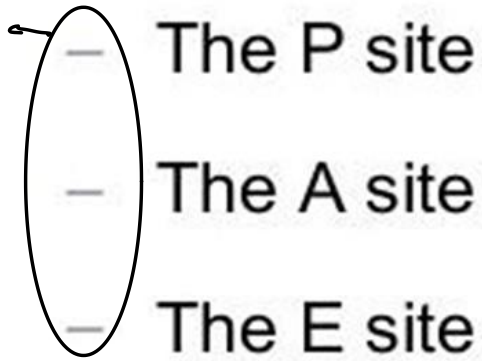
Two initiation factors (**IF-1A** and **IF3**) bind to the 40S subunit of the 80S ribosome and produce its dissociation to 40S and 60S ribosomal subunits.



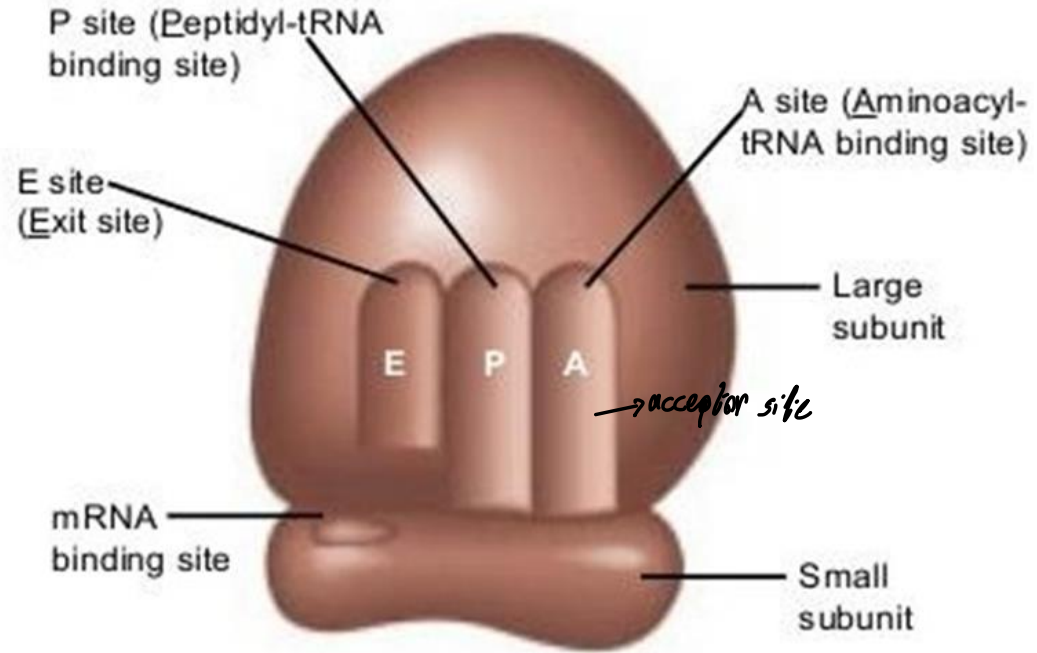


- The ribosome has three binding sites for tRNA

40S, 60S sites 3 موجودة في كل من



* لكي يحدث translation mRNA يجب ان يربط بمخبر ribosome وحتى يتم ترجمة الكودونات الموجودة على mRNA يجب وجود component يقوم بذلك وهو tRNA



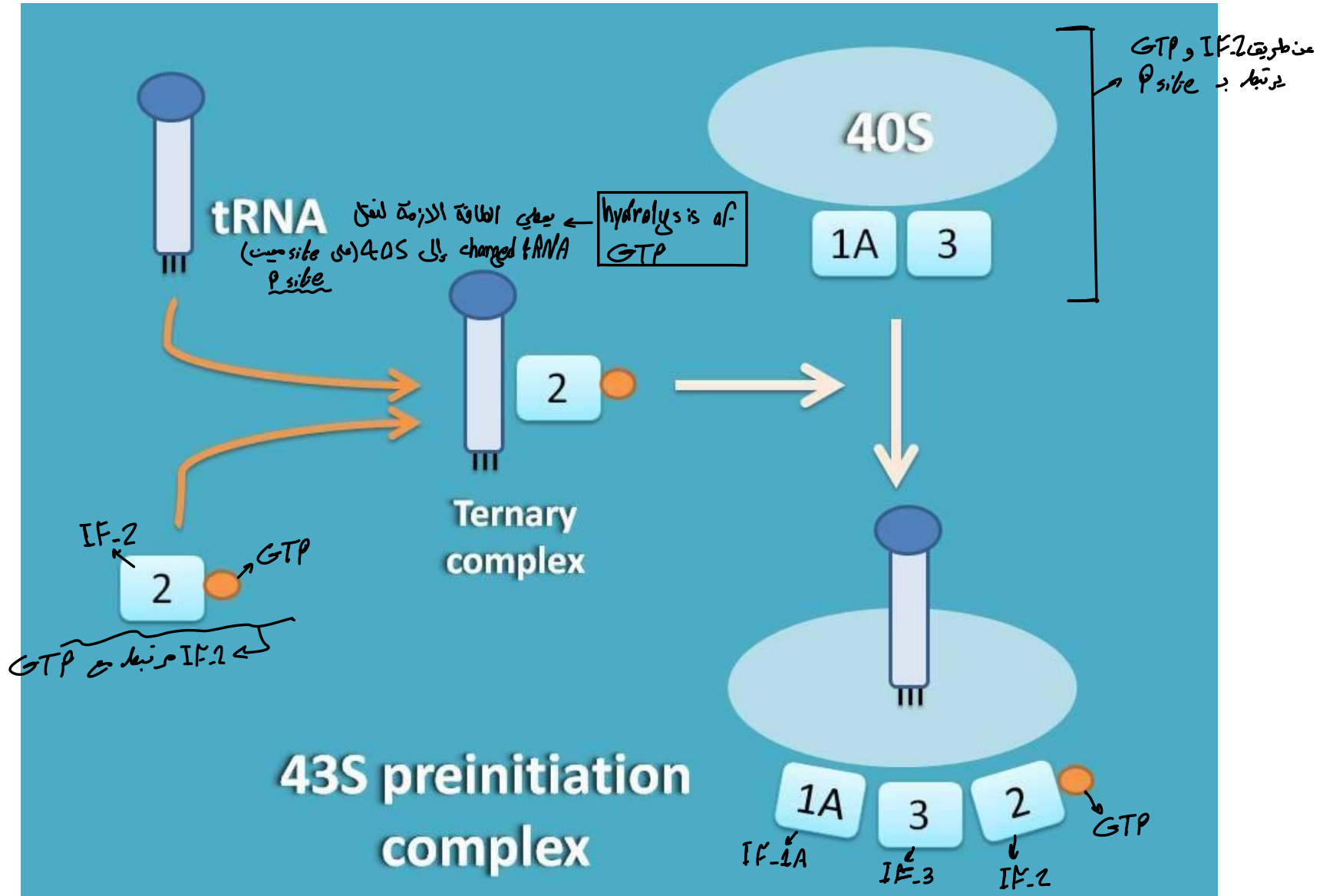
(b) Schematic model showing binding sites. A ribosome has an mRNA binding site and three tRNA binding sites, known as the A, P, and E sites. This schematic ribosome will appear in later diagrams.

Figure 17.16b

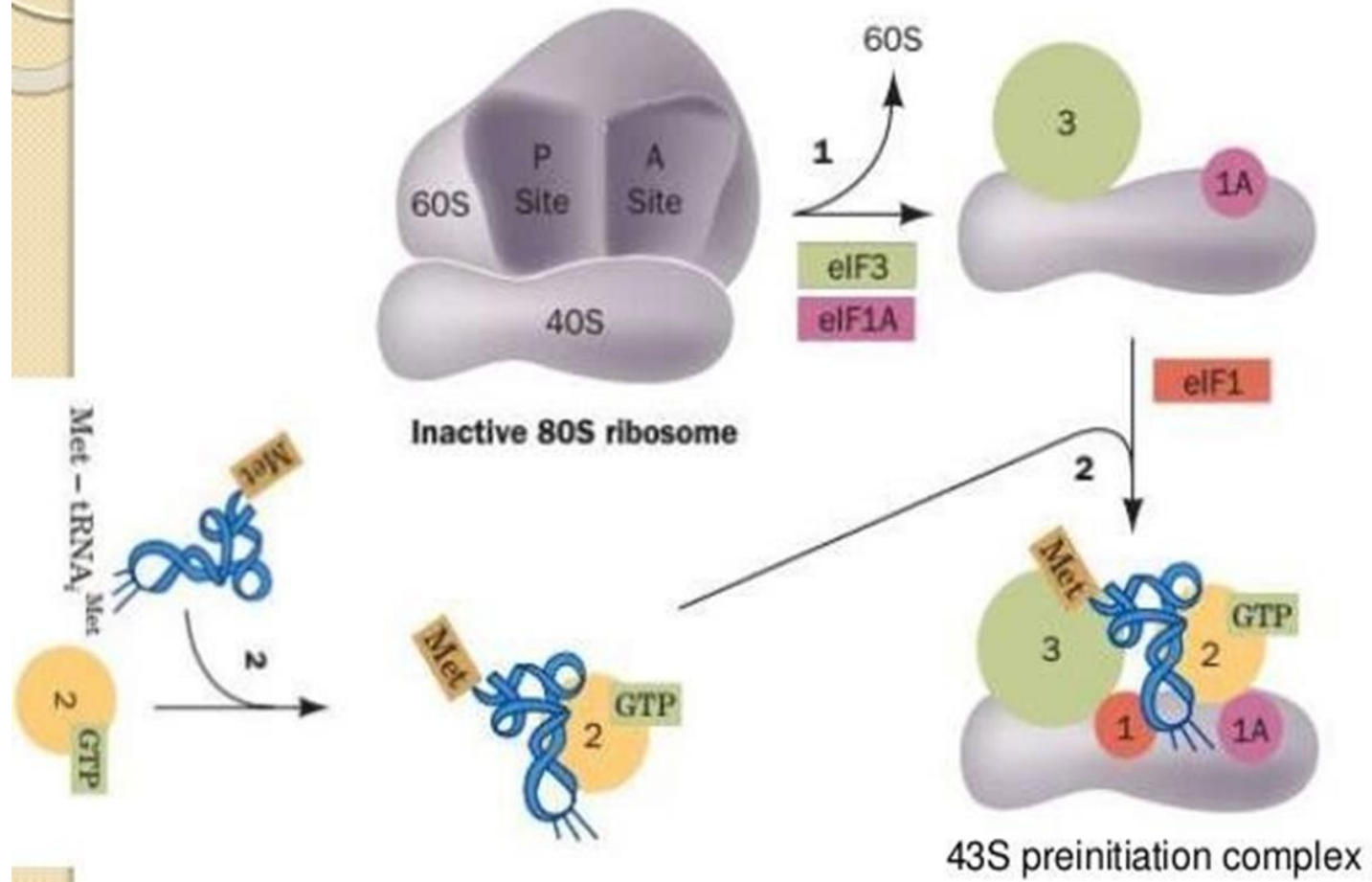
Formation of 43S preinitiation complex

* بعد عملیة dissociation سے يرتبط charged tRNA سے 40S

- This step requires :
 - IF-2 complexed with **GTP**
← يرتبط مع GTP
 - Methionine tRNA (met-tRNA)
- The **eIF-2** binds **GTP** then binds to met-tRNA_i (initiating methionyl-tRNA) to form a complex that binds to the *P-site of the 40S* ribosomal subunit, forming the 43S preinitiation complex.



Initiation in Eukaryotes



* tRNA methionin complex فيه tRNA methionine فيه ribosome (P site فيه tRNA methionine)
* لده يمشي على mRNA حتى يلاقه start codon (الكودون اناج ب methionine)

Formation of 48S initiation complex

* الالذ بدنا نفع activation of mRNA مع طريق eIF-4 الذي يرتبط على 5' end of mRNA (يعتد ايضا ارتباطه ل ATP بفرق اناج الطاقة) حتى يستطيع mRNA يرتبط مع 43S

- The mRNA is **activated** by several initiation factors (**eIF-4**), a process associated with hydrolysis of ATP.
- The 43S preinitiation complex becomes associated with the 5` capped end of the activated mRNA forming the 48S initiation complex .

Formation of 48S initiation complex

- The 43S preinitiation complex scans the activated mRNA for the initiating codon, which is usually the 1st AUG on the 5' side.

مع بفرض إيجاد start codon عند إيجاد start codon (أول ما يكون عند P site)

- The preinitiation complex stops moving on the mRNA when the initiating codon is in the P- site opposite the anticodon of the met-tRNA_i.

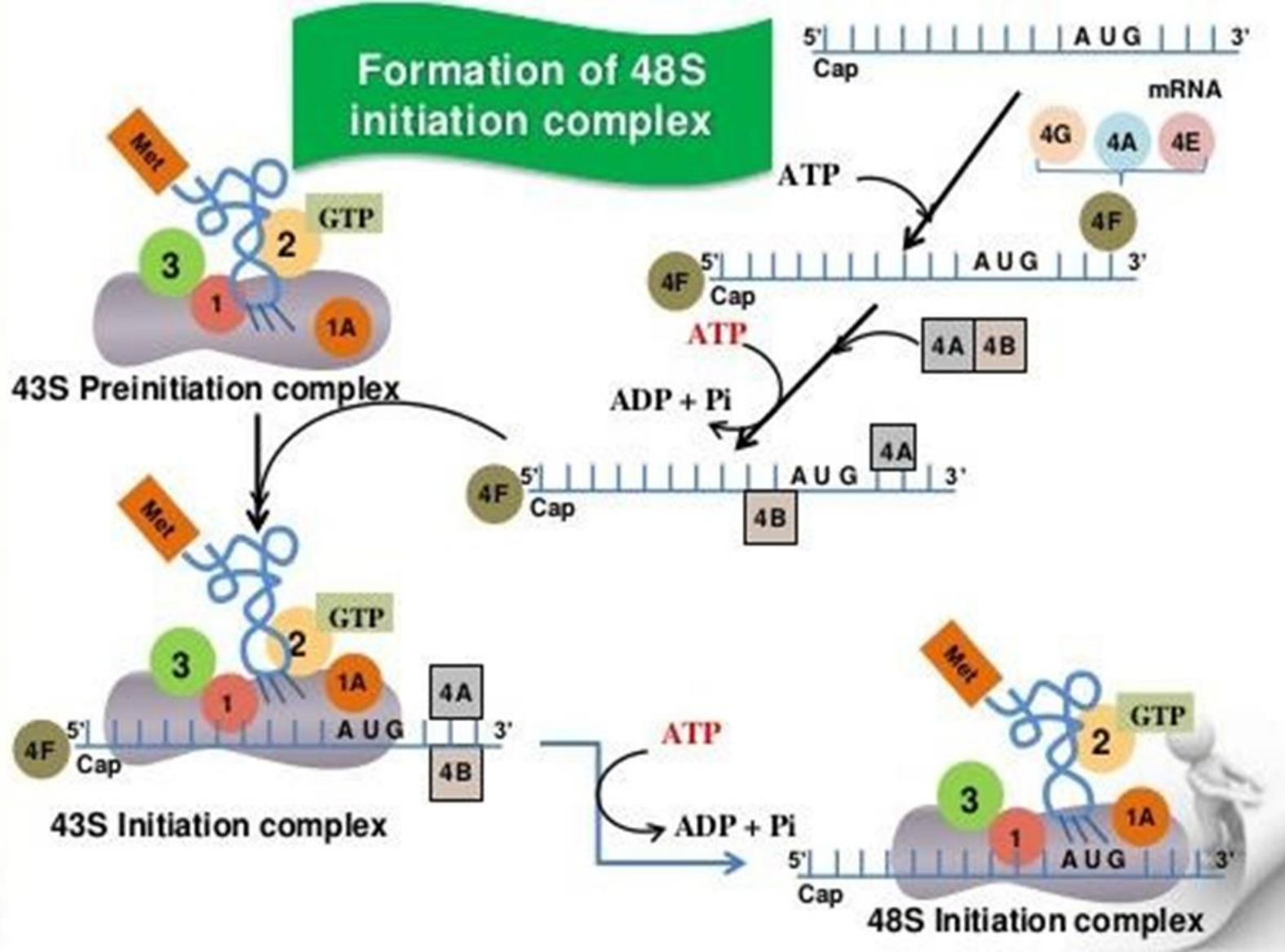
غارجية

43S preinitiation complex eIF2, eIF3, Met-tRNA, eIF1, eIF1A

Cap-binding complex + mRNA eIF4A, B, E, G

43S complex binds to 5' end of mRNA

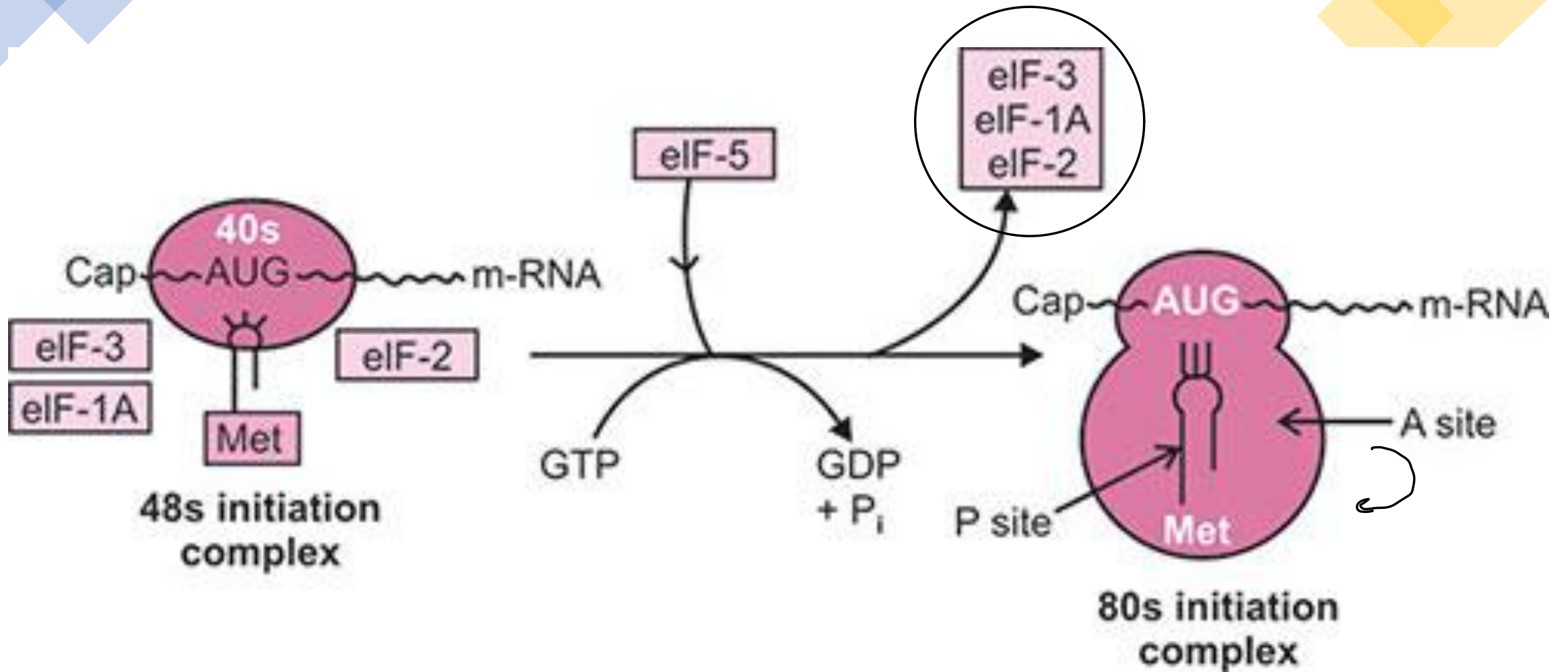
48S complex forms at initiation codon eIF2, EIF3 eIF1, 1A eIF4A, B, F

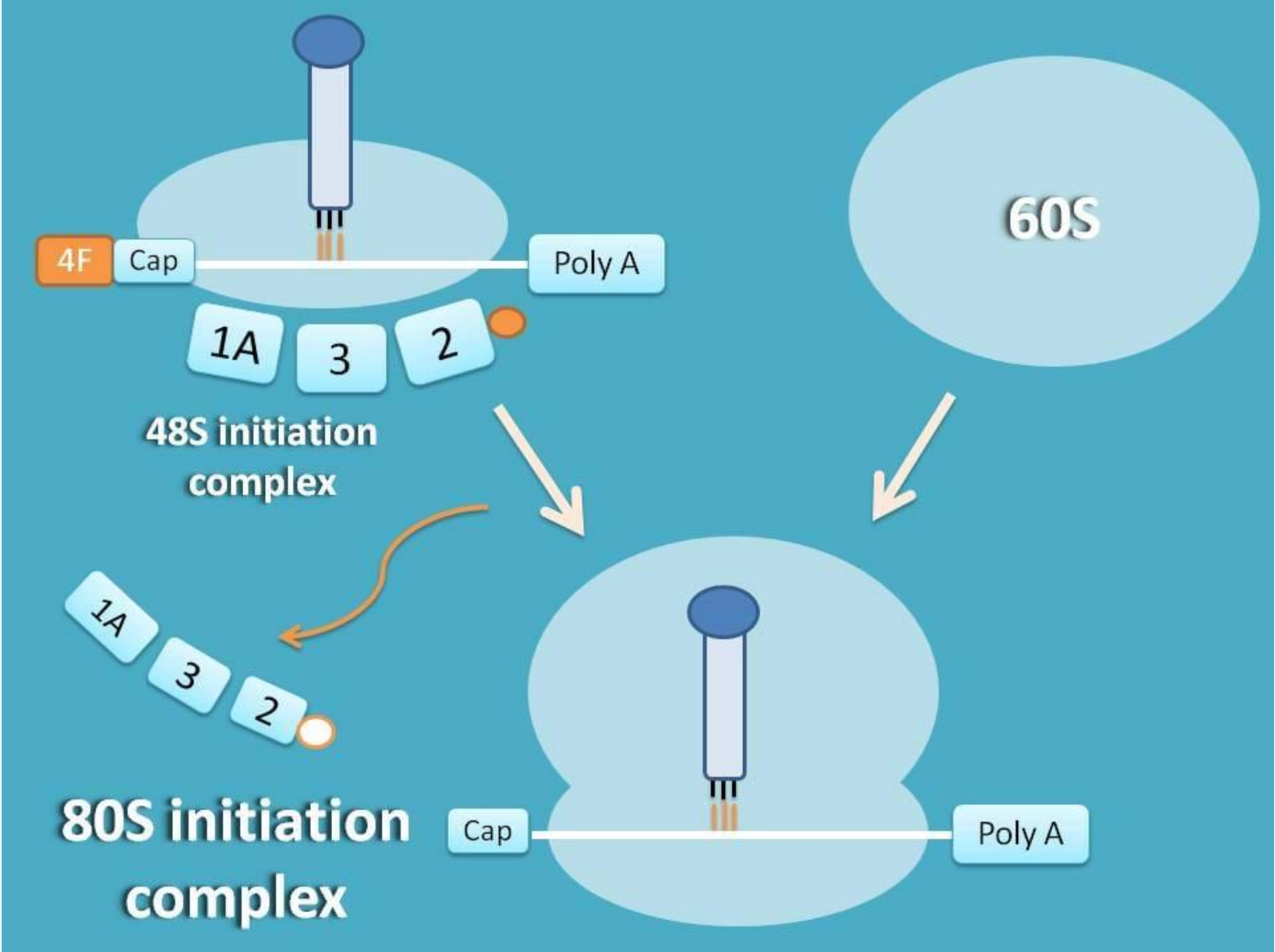


Formation of 80S initiation complex

شوتبند مع 60S وينقلها إلى 40S و ينفصل عن 80S
dissociation of all initiation factors عند ارتباط 60S مع 40S يحدث

- With the help of the **eIF-5**, the 60S ribosomal subunit binds to the 48S initiation complex, forming the 80S ribosome.
- This is associated with the **release of all eIFs** as well as the **hydrolysis of GTP to GDP and Pi**.
- At this point, met-tRNA is on the P-site (peptidyl site) of the ribosome ready for elongation & the A-site is free ready to accept the next aminoacyl-tRNA.





Eukaryotic translation initiation

