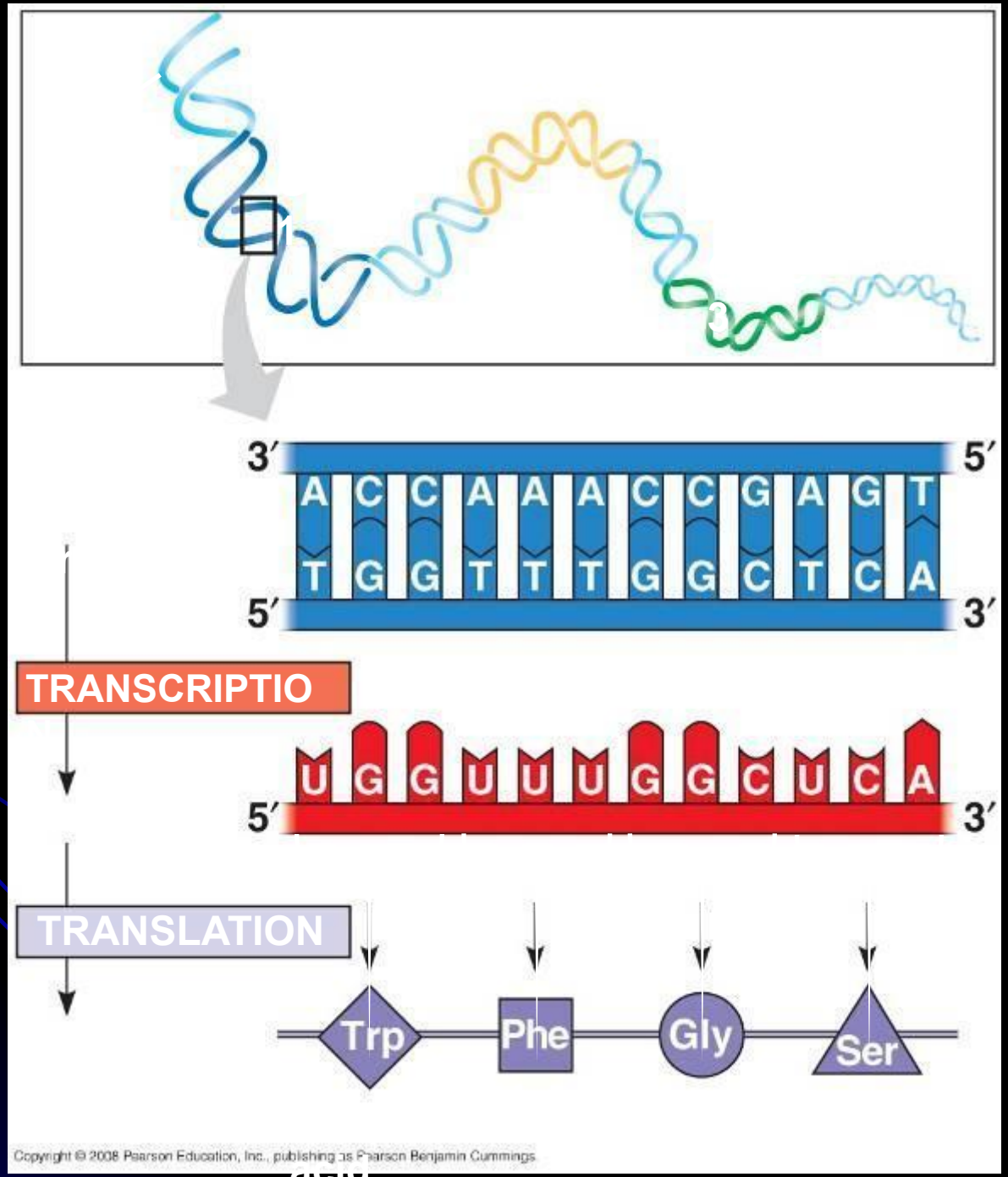
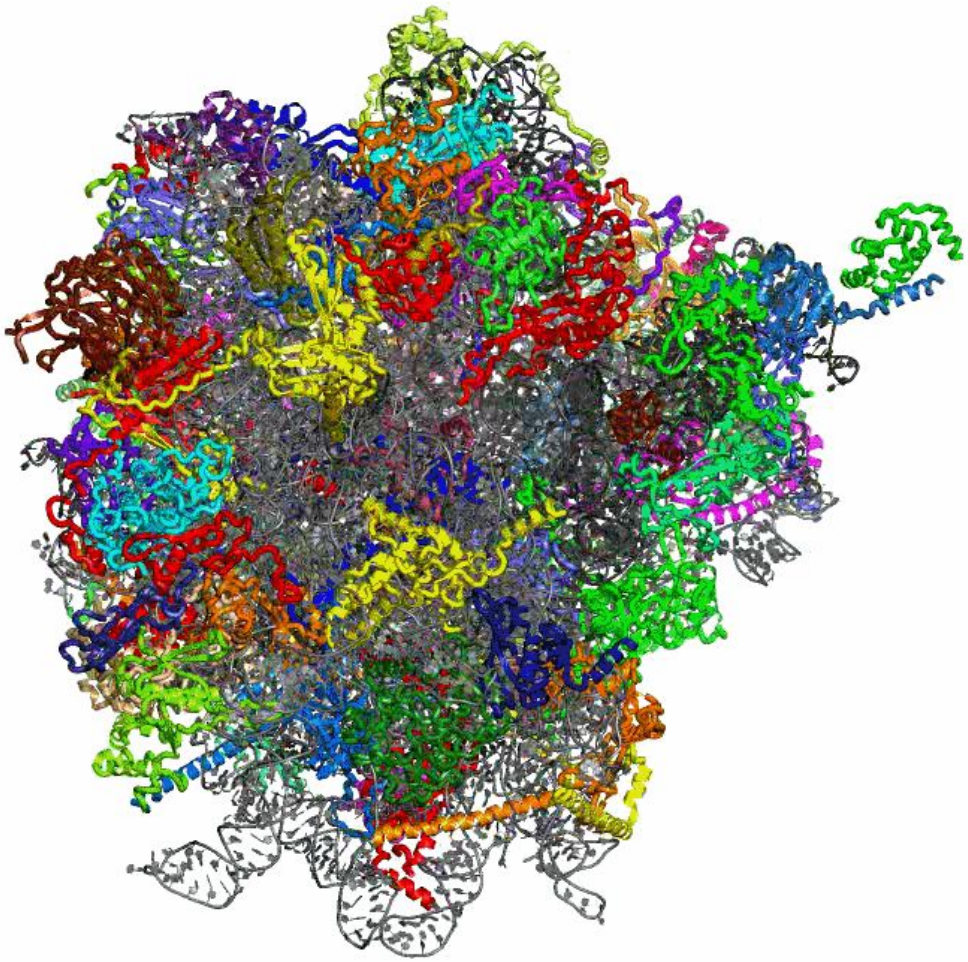

3′
5′
A C C A A A C C G A G T
T G G T T T G G C T C A
5′
3′
TRANSCRIPTIO
U G G U U U G G C U C A
5′
3′
TRANSLATION
Trp
Phe
Gly
Ser
Copyright © 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

acid

ТРАНСЛЯЦИЯ – перевод генетической информации с «языка» последовательности нуклеотидов (мРНК) на «язык» последовательности аминокислот (белок)

В трансляции участвуют:

- АРСаза
- транспортная РНК тРНК
- матричная РНК мРНК
- рибосома (рибосомная РНК рРНК)
- факторы



# Генетический код

1. Триплетный (кодон)

   (псевдодуплетный)
2. Неперекрывающийся, без пропусков
3. Вырожденный
4. Универсальный

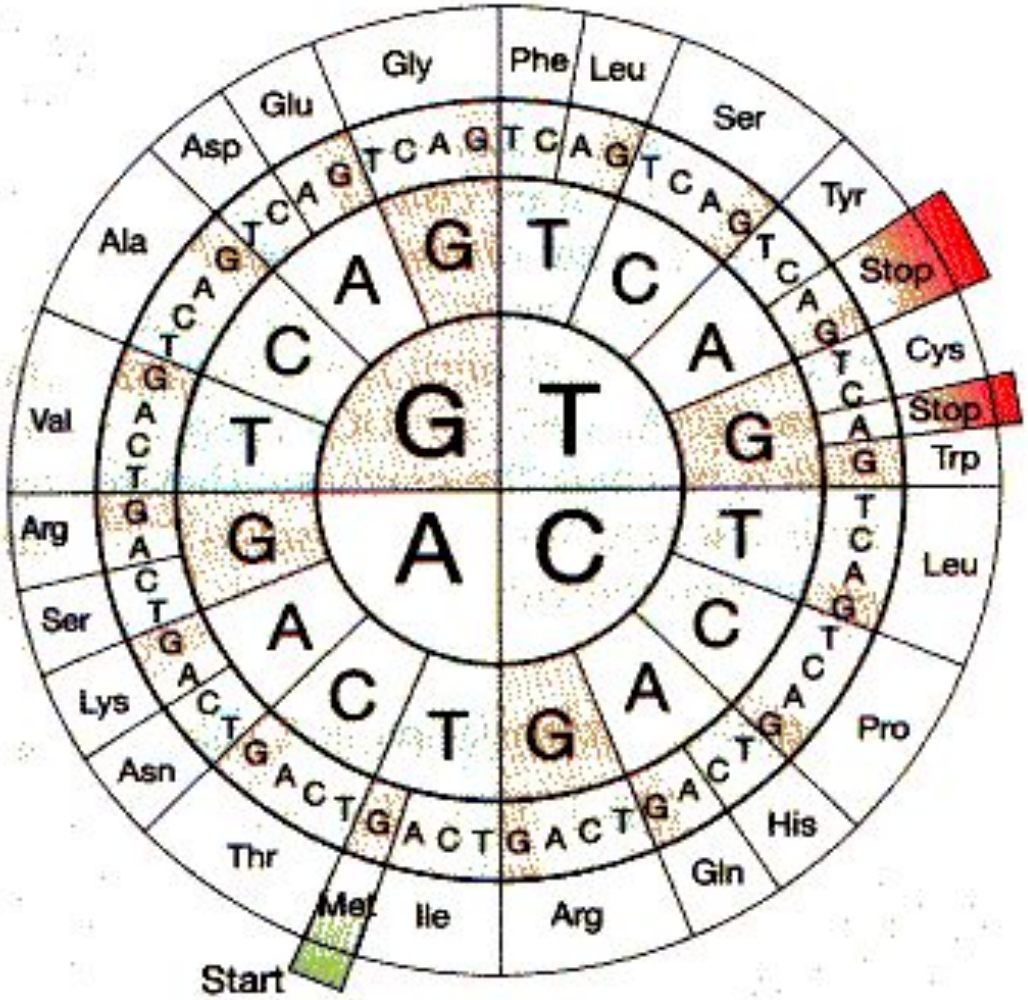
Открытая рамка считывания кодонов мРНК
Бесклеточная система
Расшифровка кода

М. Ниренберг,
ЮХА, 21 августа 1961 г

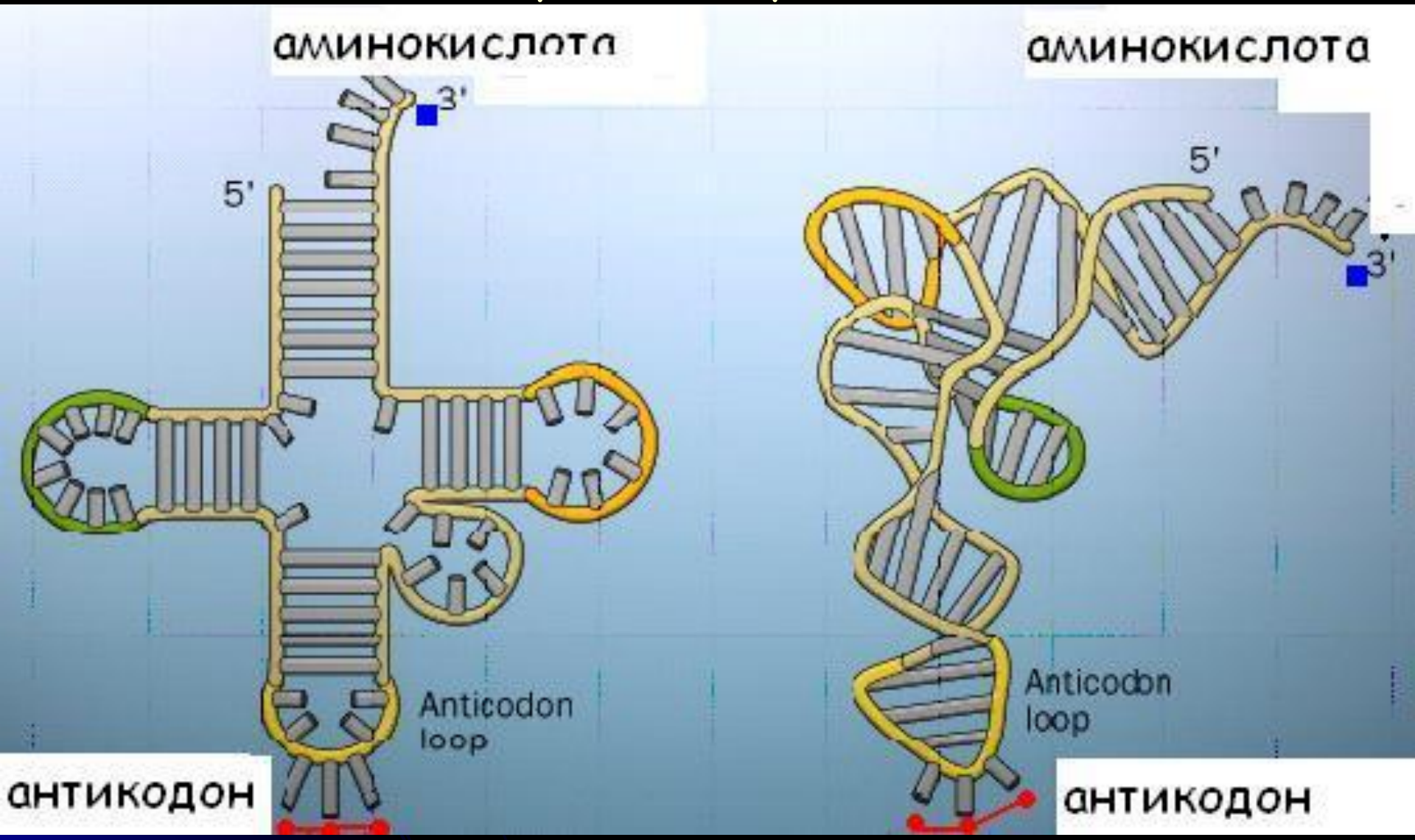
# Триплетный код: кодон - Ак

вторая буква

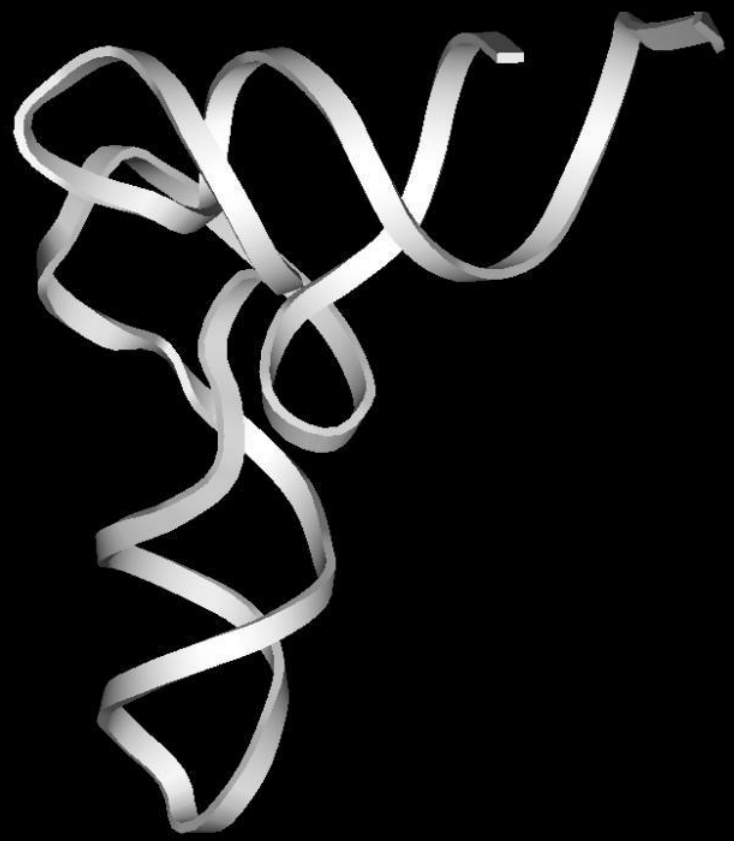
| первая буква | U | | | G | третья буква |
|---|---|---|---|---|---|
| U | UUU Phe<br>UUC<br>UUA Leu<br>UUG | UCU<br>UCC Ser<br>UCA<br>UCG | UAU Tyr<br>UAC<br>UAA Stop<br>UAG Stop | UGU Cys<br>UGC<br>UGA Stop<br>UGG Trp | U<br>C<br>A<br>G |
| C | CUU<br>CUC Leu<br>CUA<br>CUG | CCU<br>CCC Pro<br>CCA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

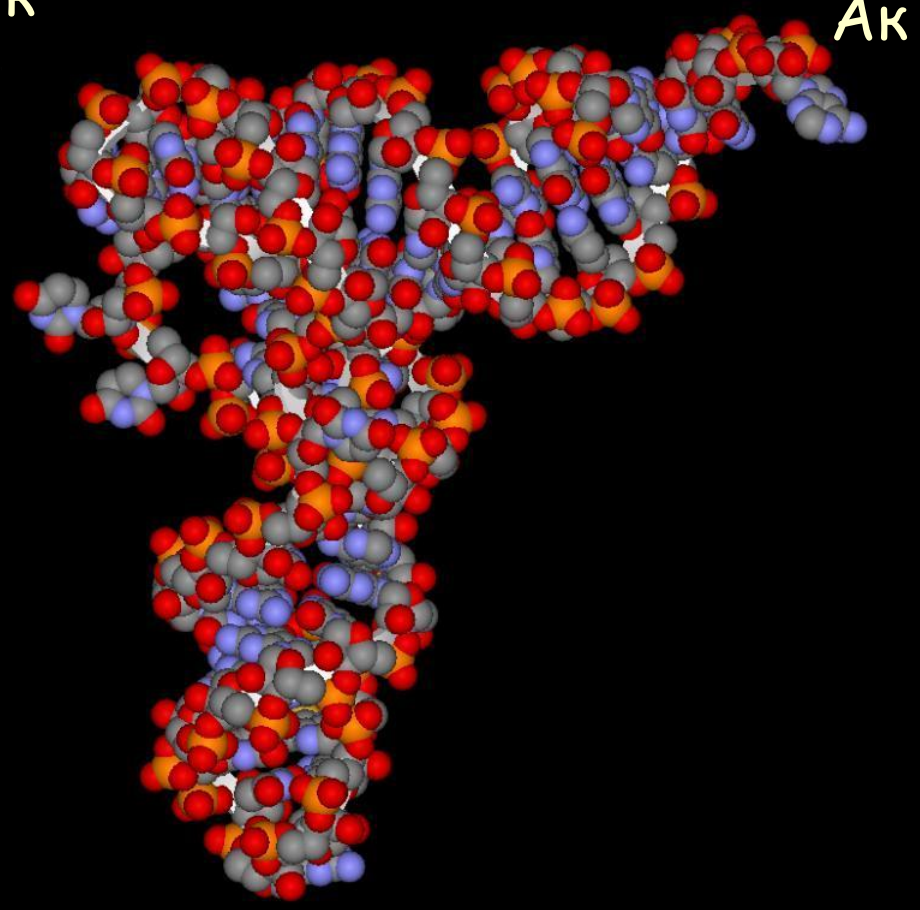

Gly
Phe
Leu
Ser
Tyr
Stop
Cys
Stop
Trp
Leu
Pro
His
Gln
Arg
Ile
Met
Start
Thr
Asn
Lys
Ser
Arg
Val
Ala
Asp
Glu
T C A G
G T C A
A G T C
C A G T

# Структура тРНК:
# вторичная и третичная



# Третичная структура тРНК




антикодон

антикодон

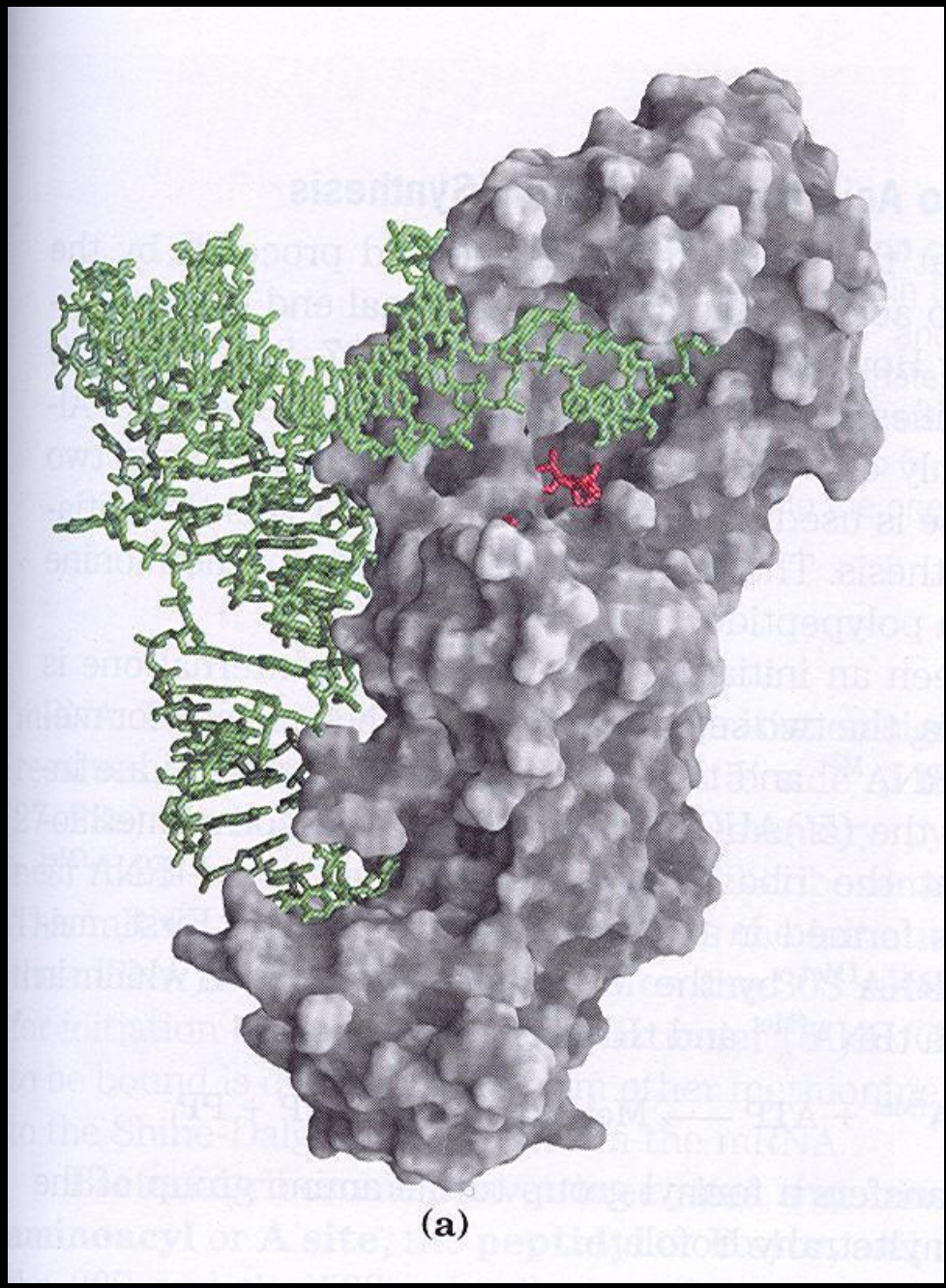
# ДЕКОДИРОВАНИЕ

аминоацил-тРНК-синтетаза (АРСаза)

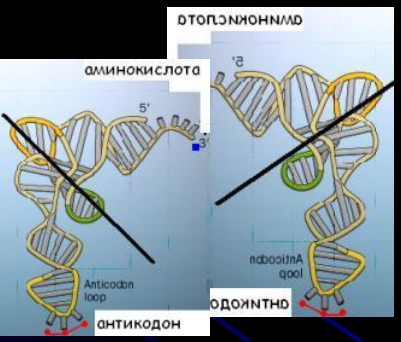
Ак + АТР = Ак-АМР + РР

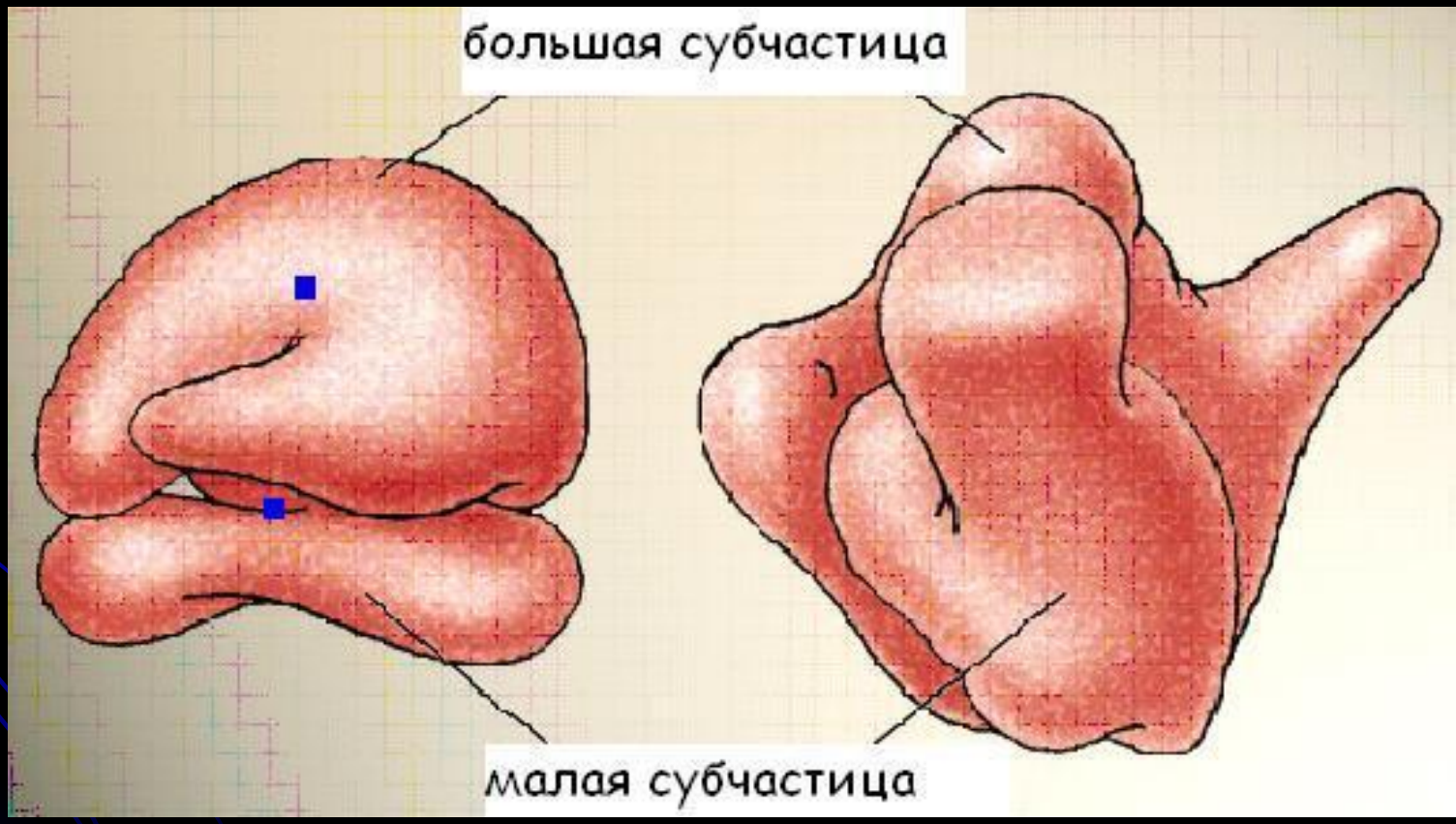
Ак-АМР + тРНК = Ак-тРНК + АМР

(НЕ рибосома!)



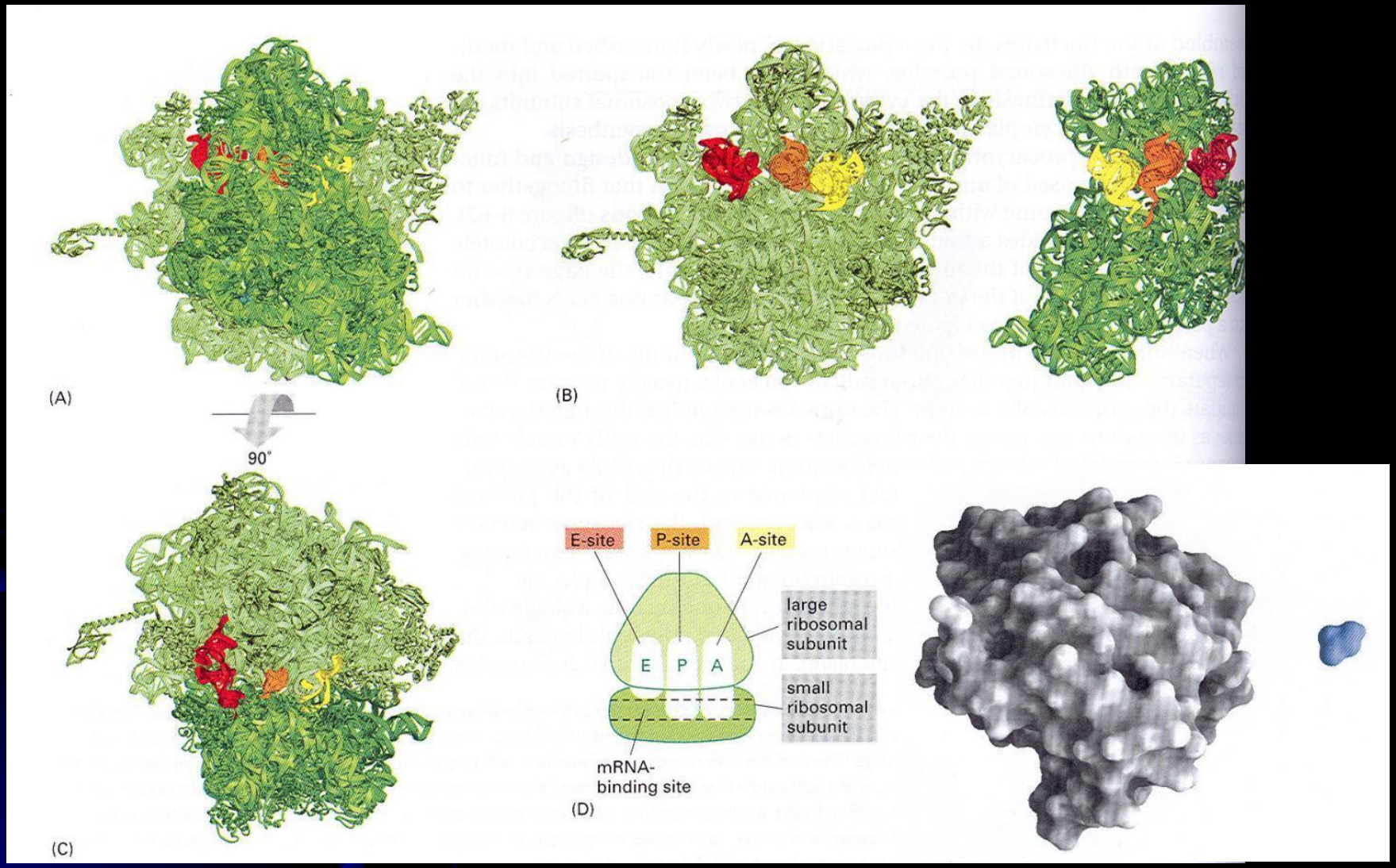
# РИБОСОМА - наноробот для биосинтеза белка
# 2 субчастицы – 2 функции




Обеспечивает кодон – антикодоновые взаимодействия мРНК и тРНК

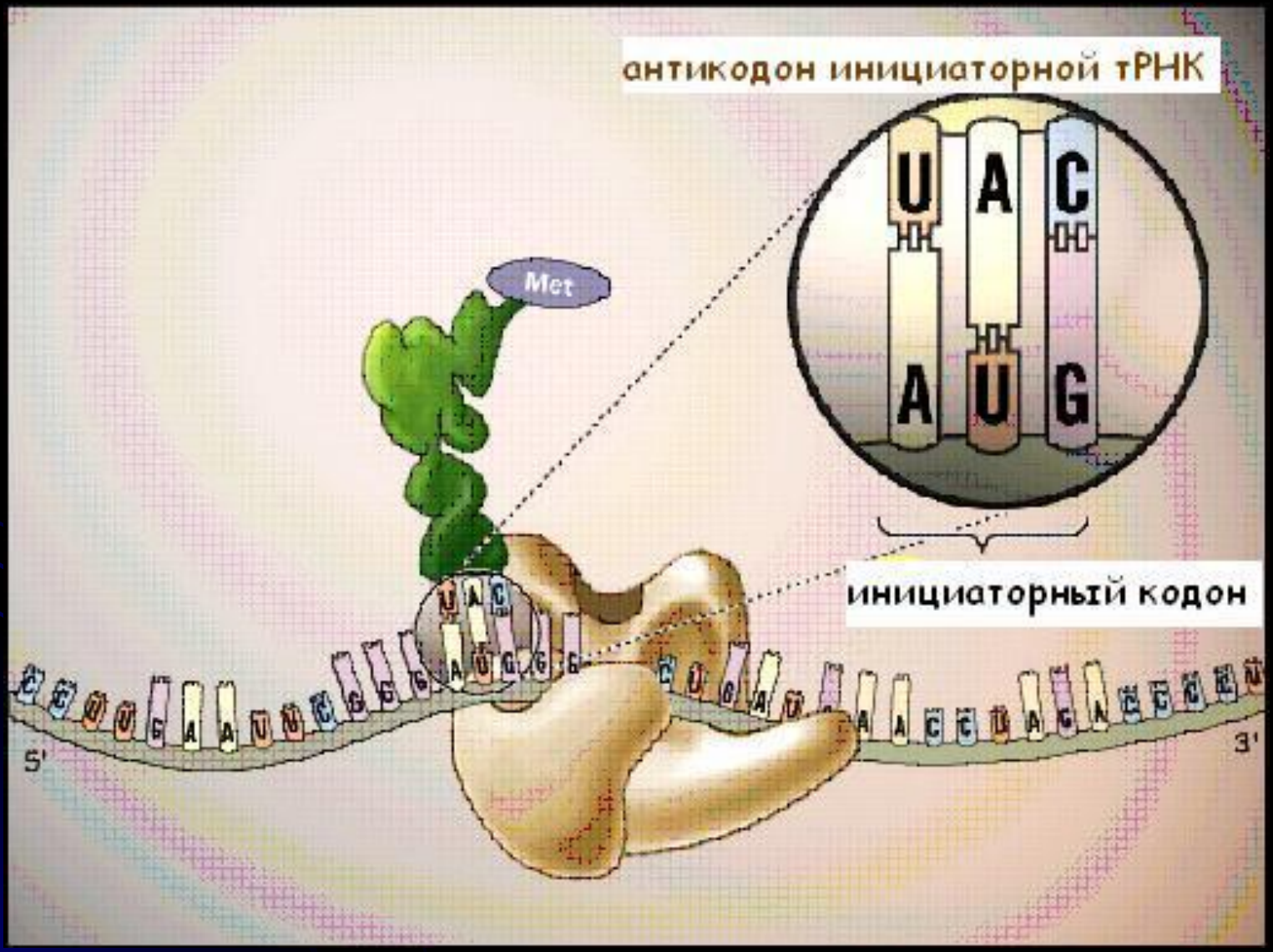
# Размеры фермента и субстрата



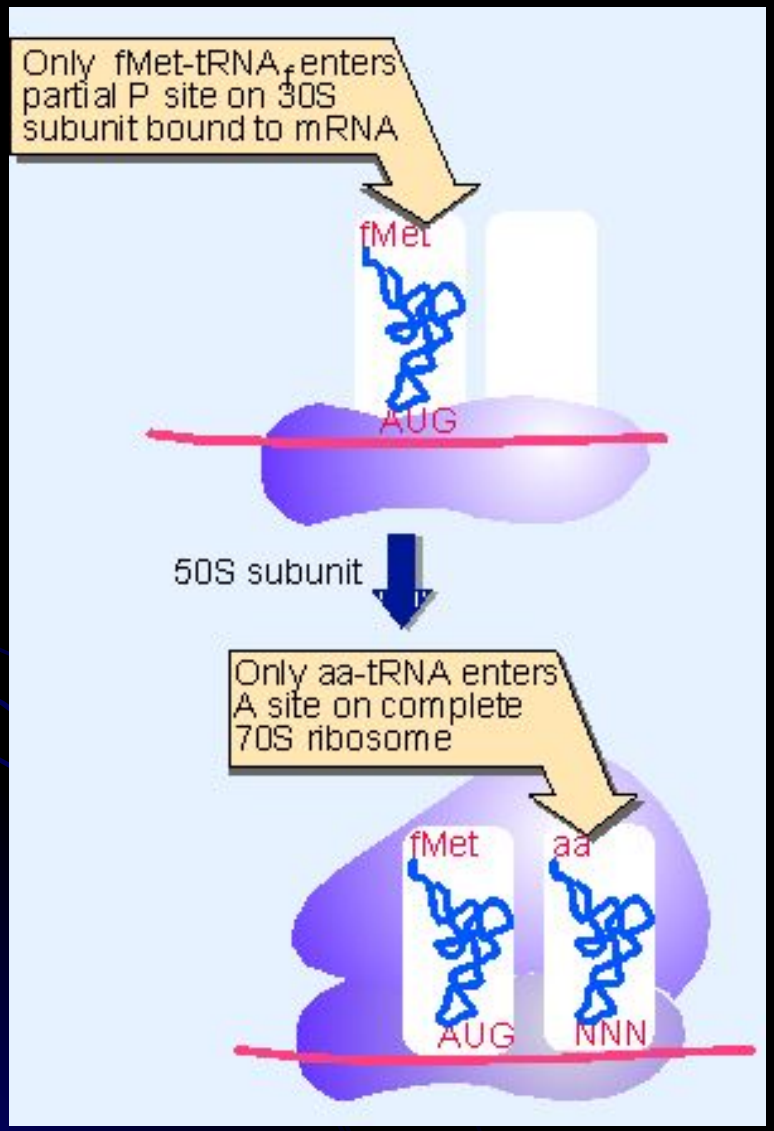

рибосома – тРНК: $3x10^6$ – $3x10^4$, химотрипсин – 2Ак: $2x10^4$ – $2x10^2$

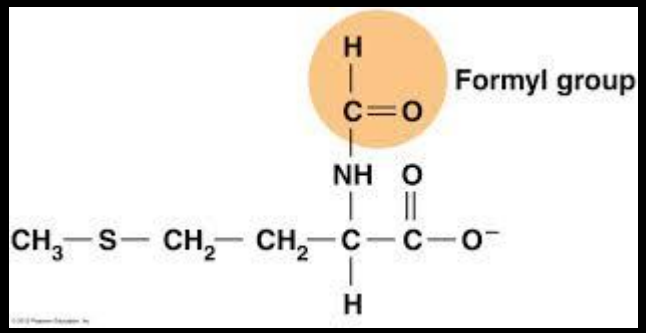
HHMI

# Инициация трансляции

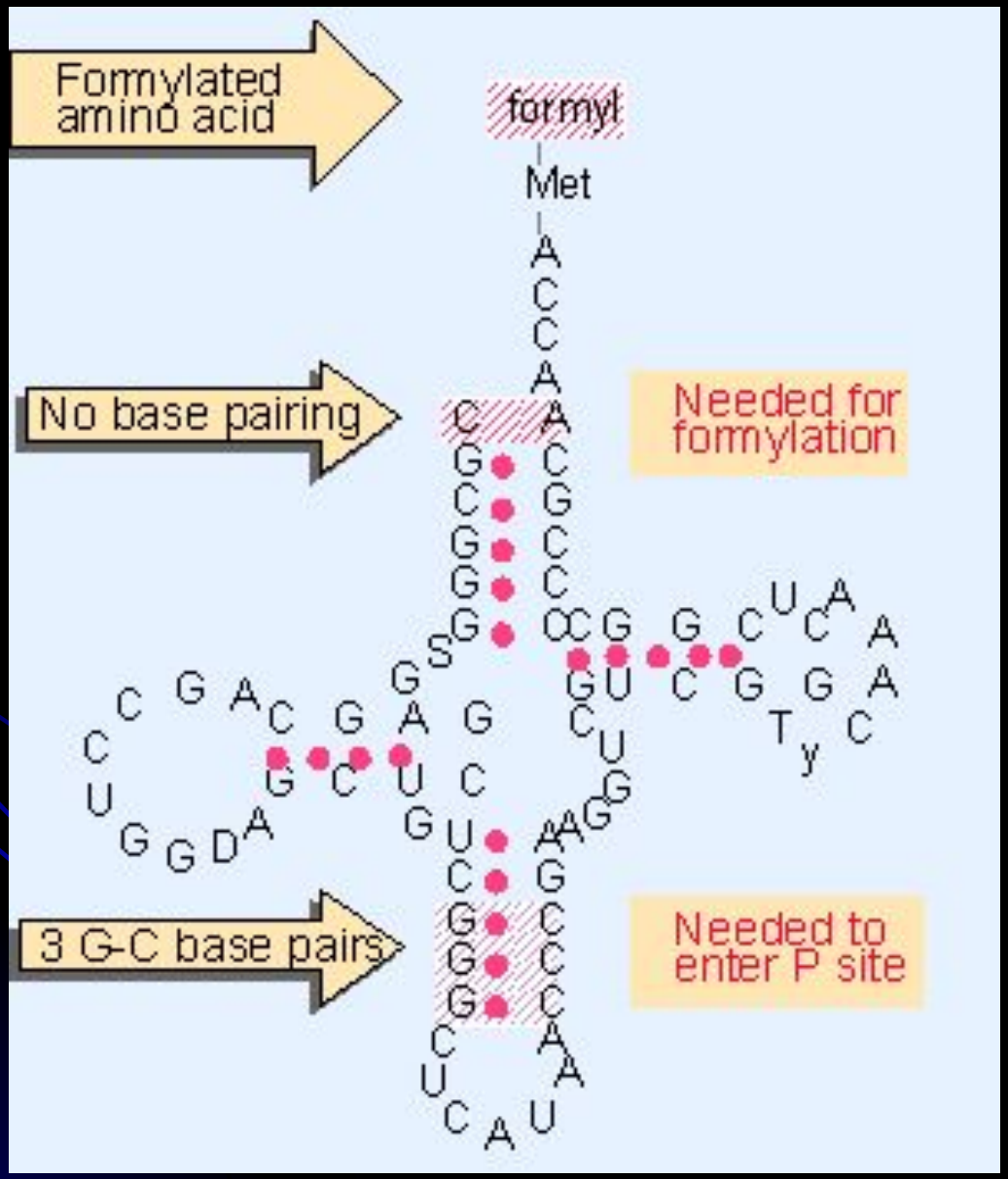


# Только инициаторная тРНК входит в частично Сформированный Р-сайт



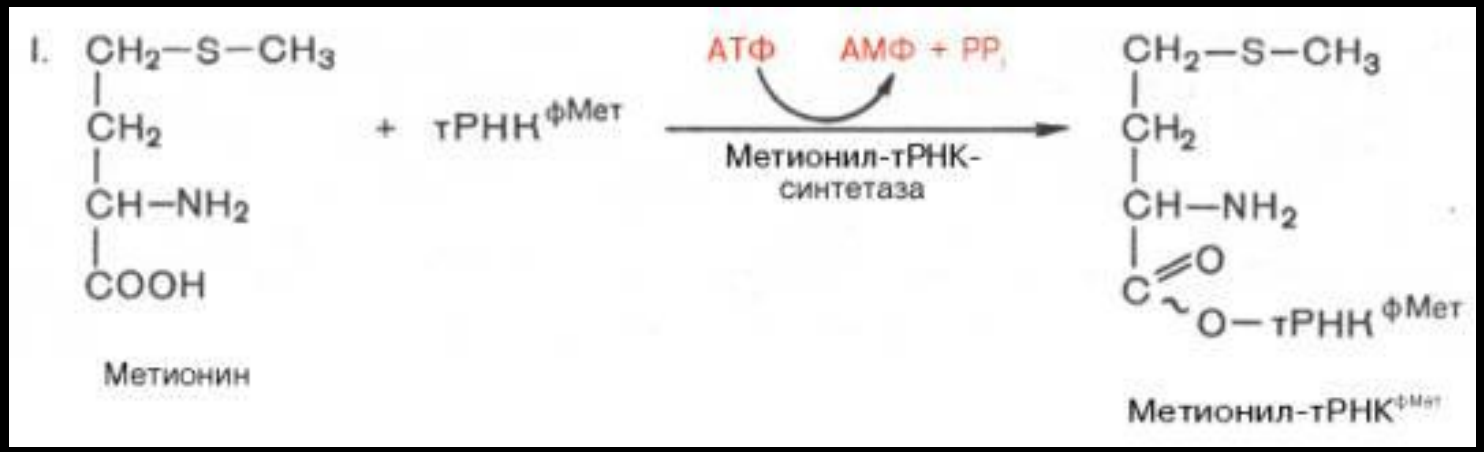



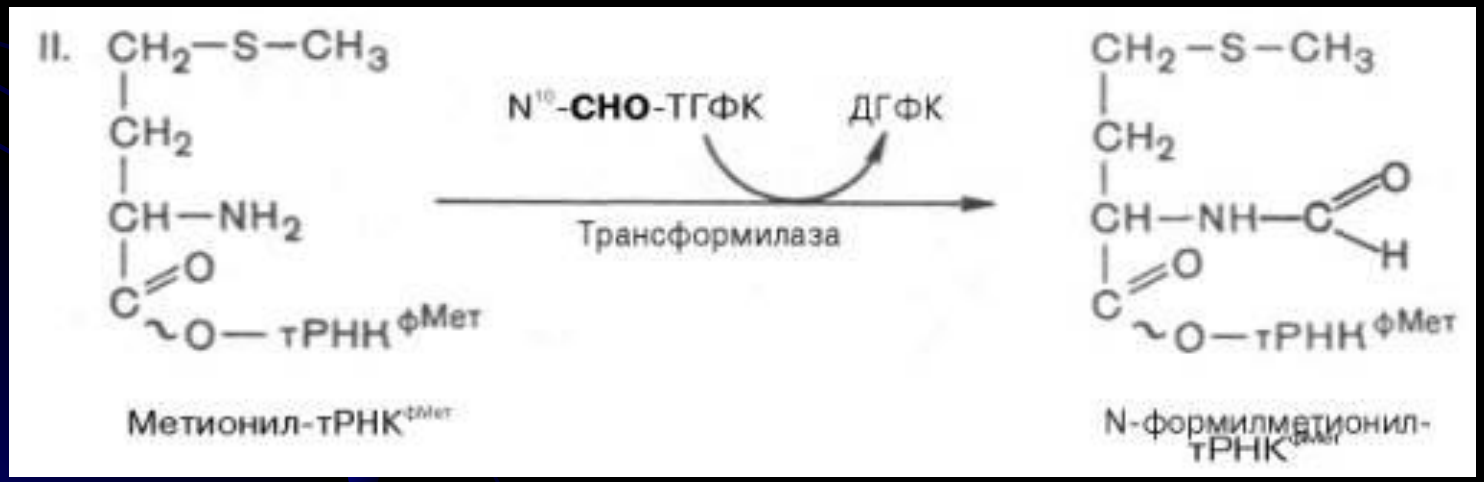
# Инициаторная тРНК



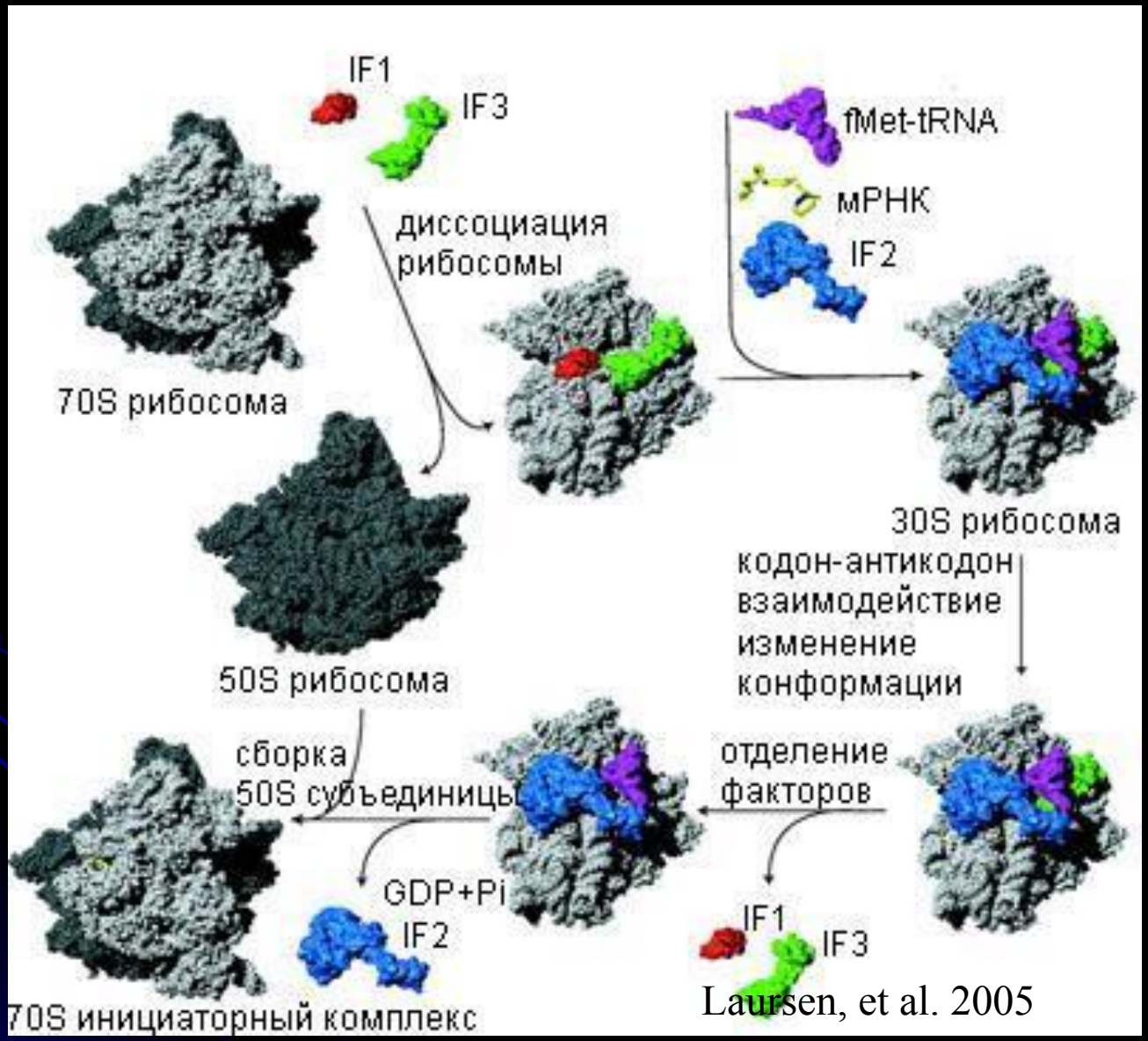

*прокариоты*

# Инициаторная тРНК



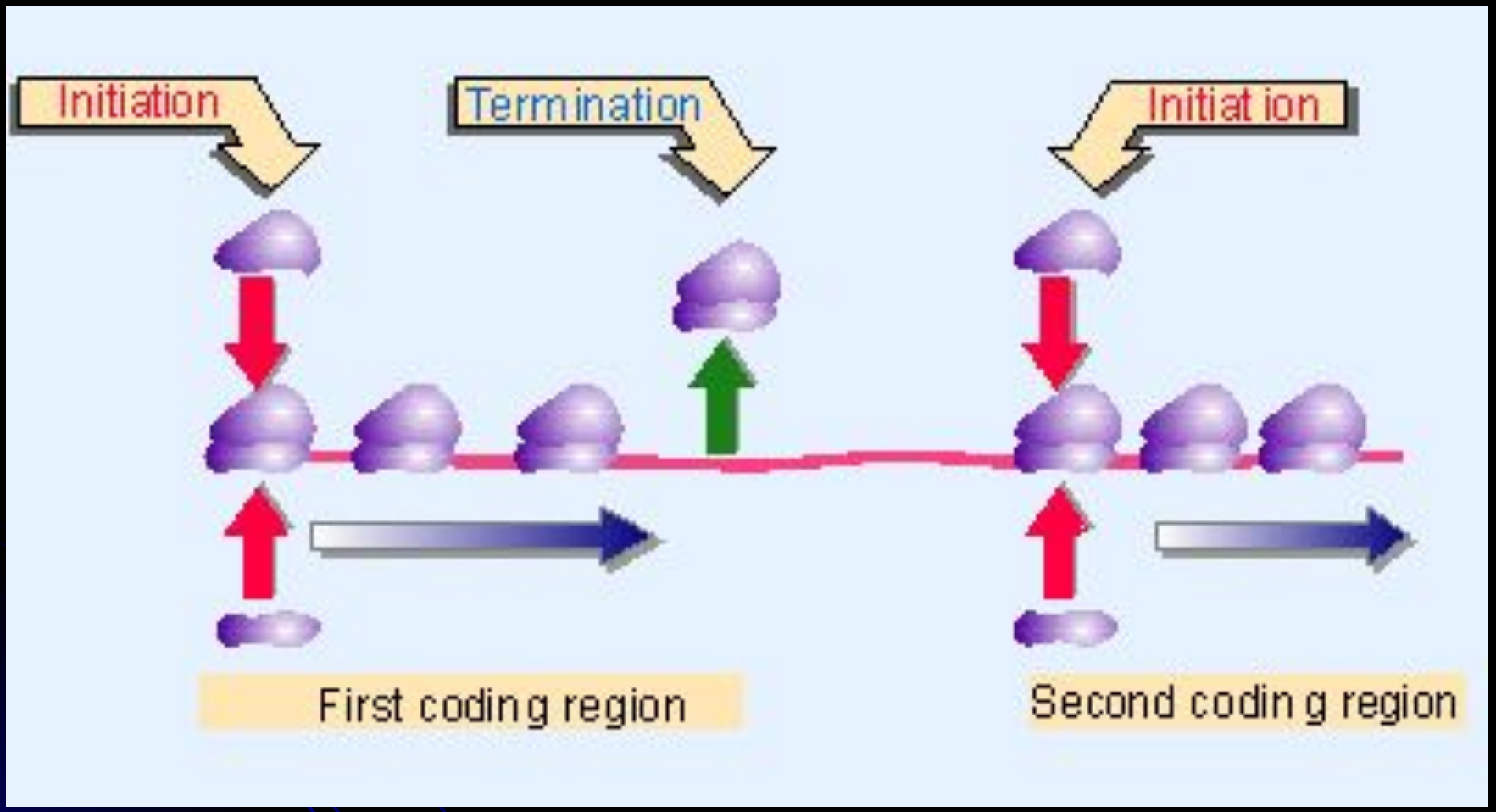



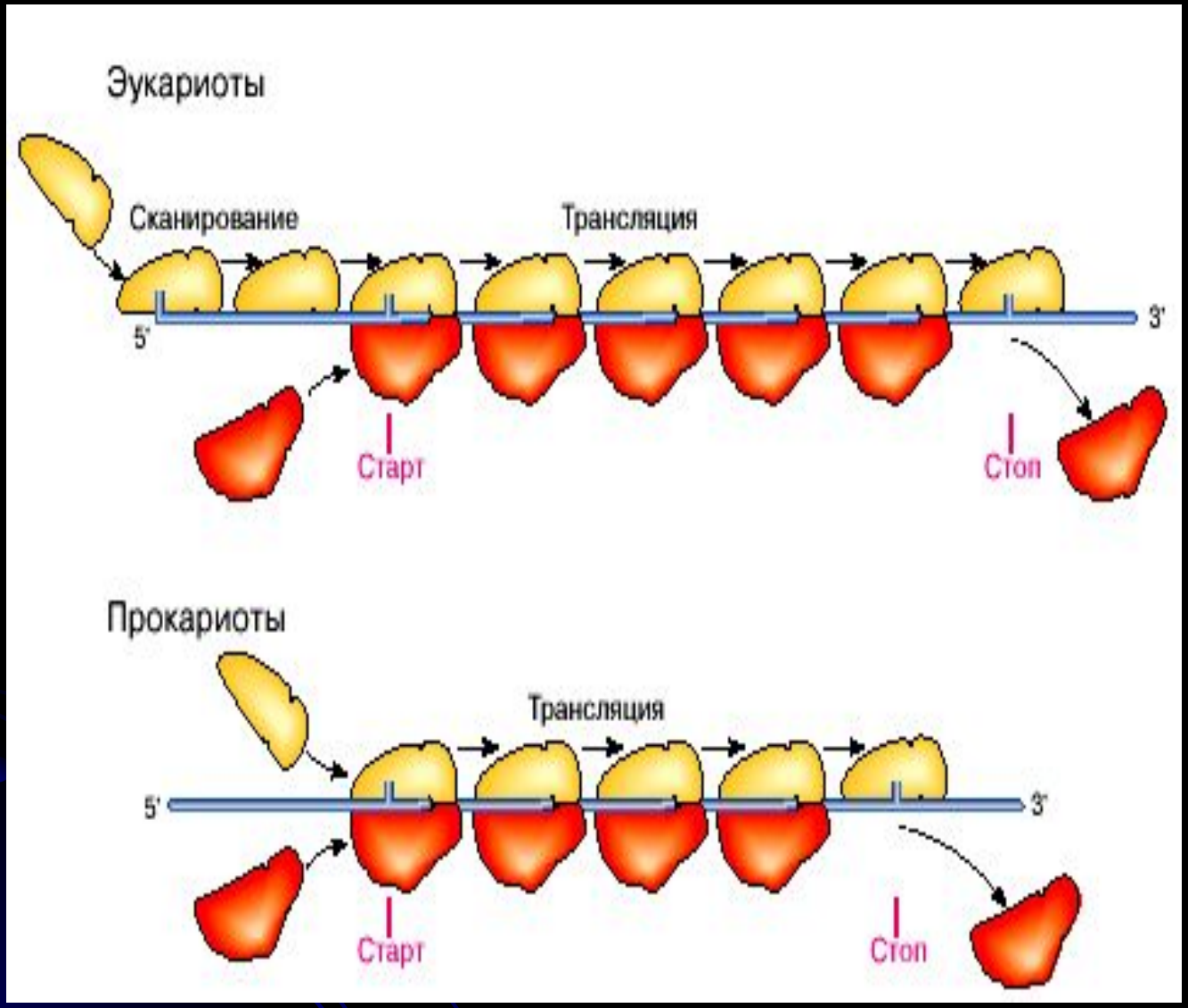
# Инициация трансляции у прокариот

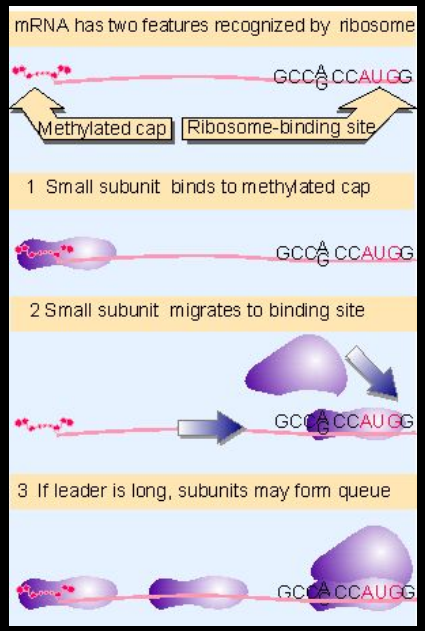



Laursen, et al. 2005

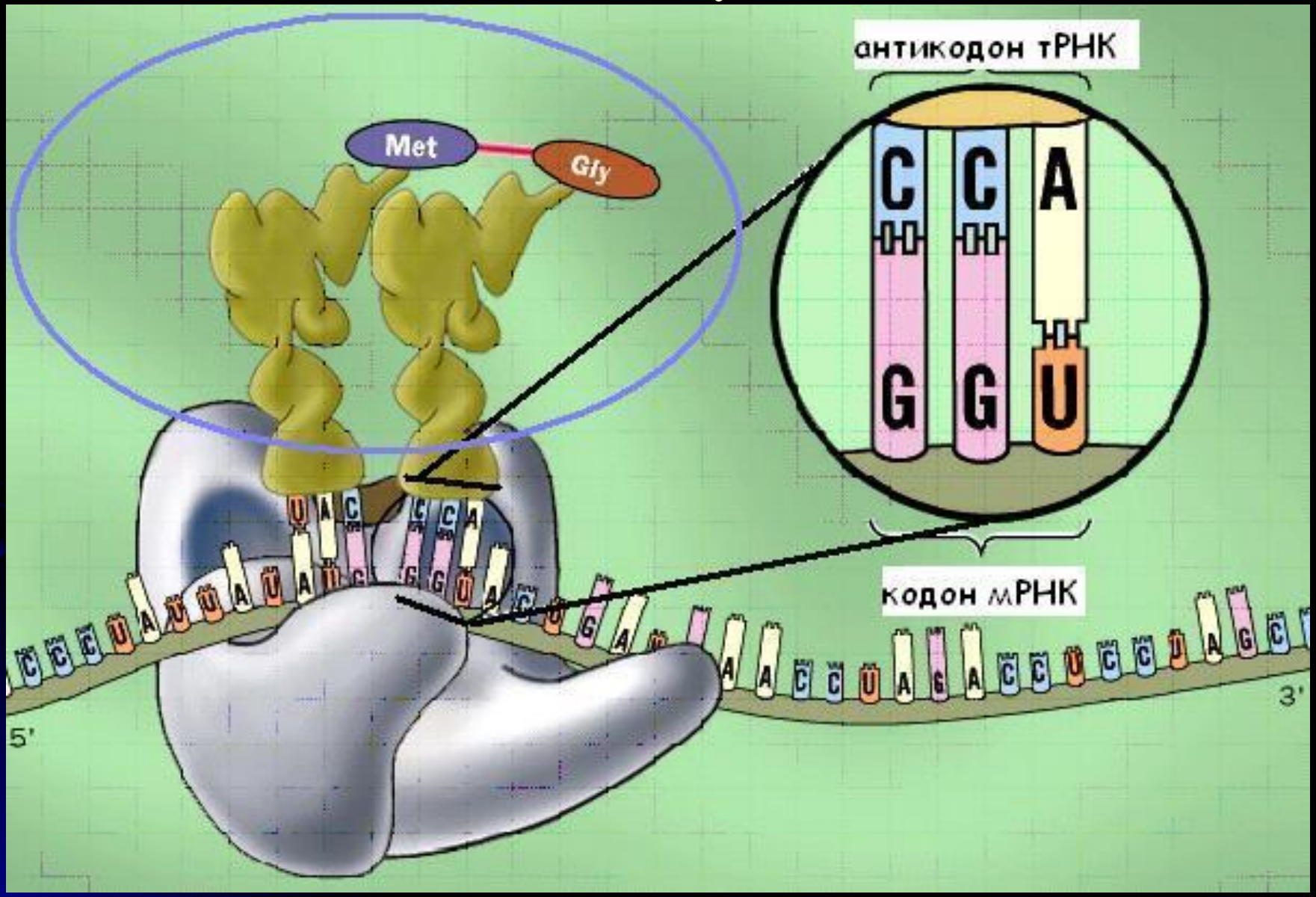
# Возможен синтез более одного белка с одной мРНК



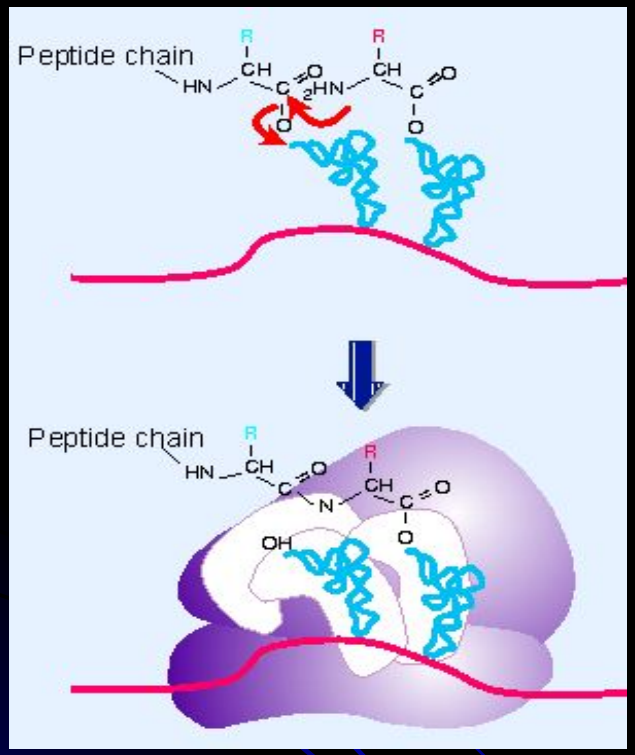

Эукариоты
Сканирование
Трансляция
5'
3'
Старт
Стоп
Прокариоты
Трансляция
5'
3'
Старт
Стоп

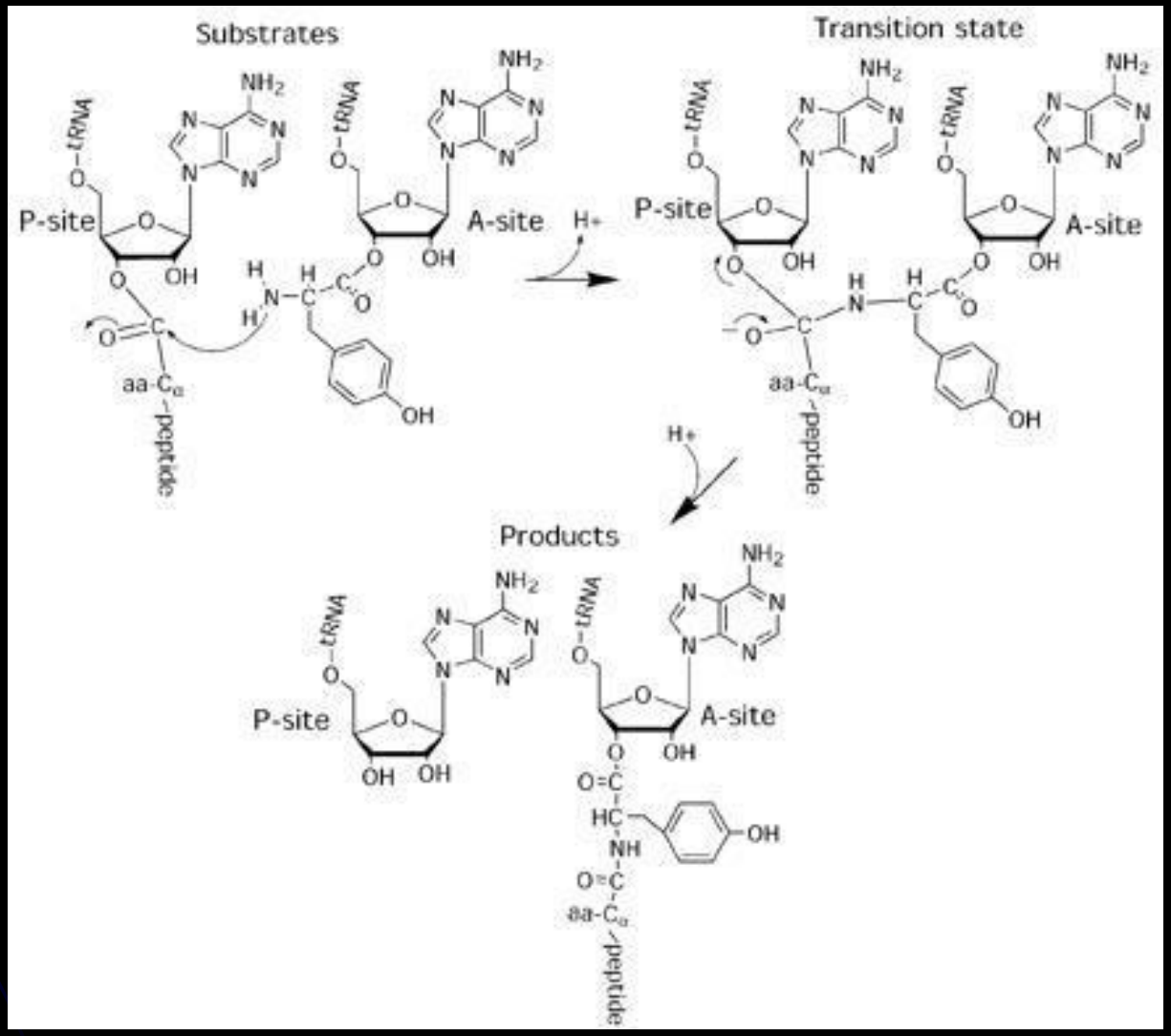

mRNA has two features recognized by ribosome
GCCACCAUGG
Methylated cap
Ribosome-binding site
1 Small subunit binds to methylated cap
GCCACCAUGG
2 Small subunit migrates to binding site
GCCACCAUGG
3 If leader is long, subunits may form queue
GCCACCAUGG

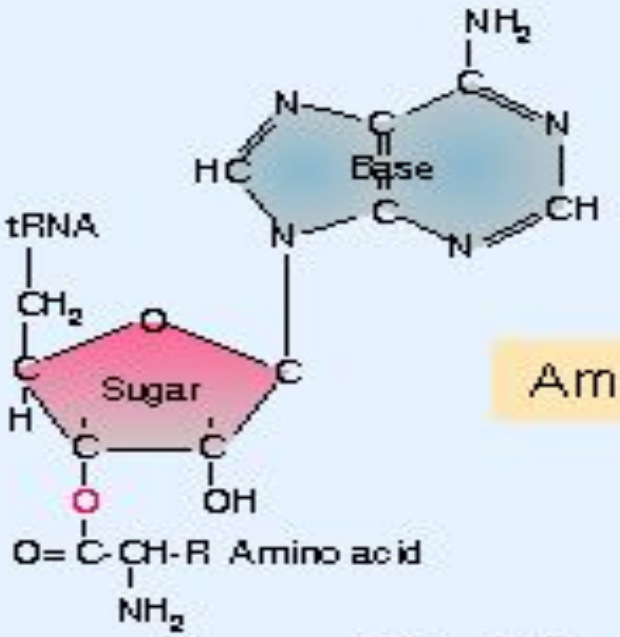
# Элонгация трансляции



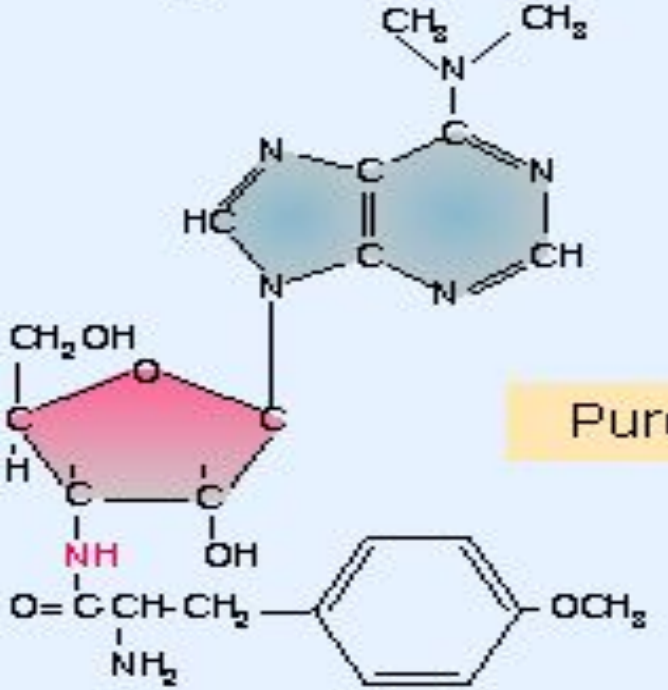
# Пептидил-трансферазная реакция



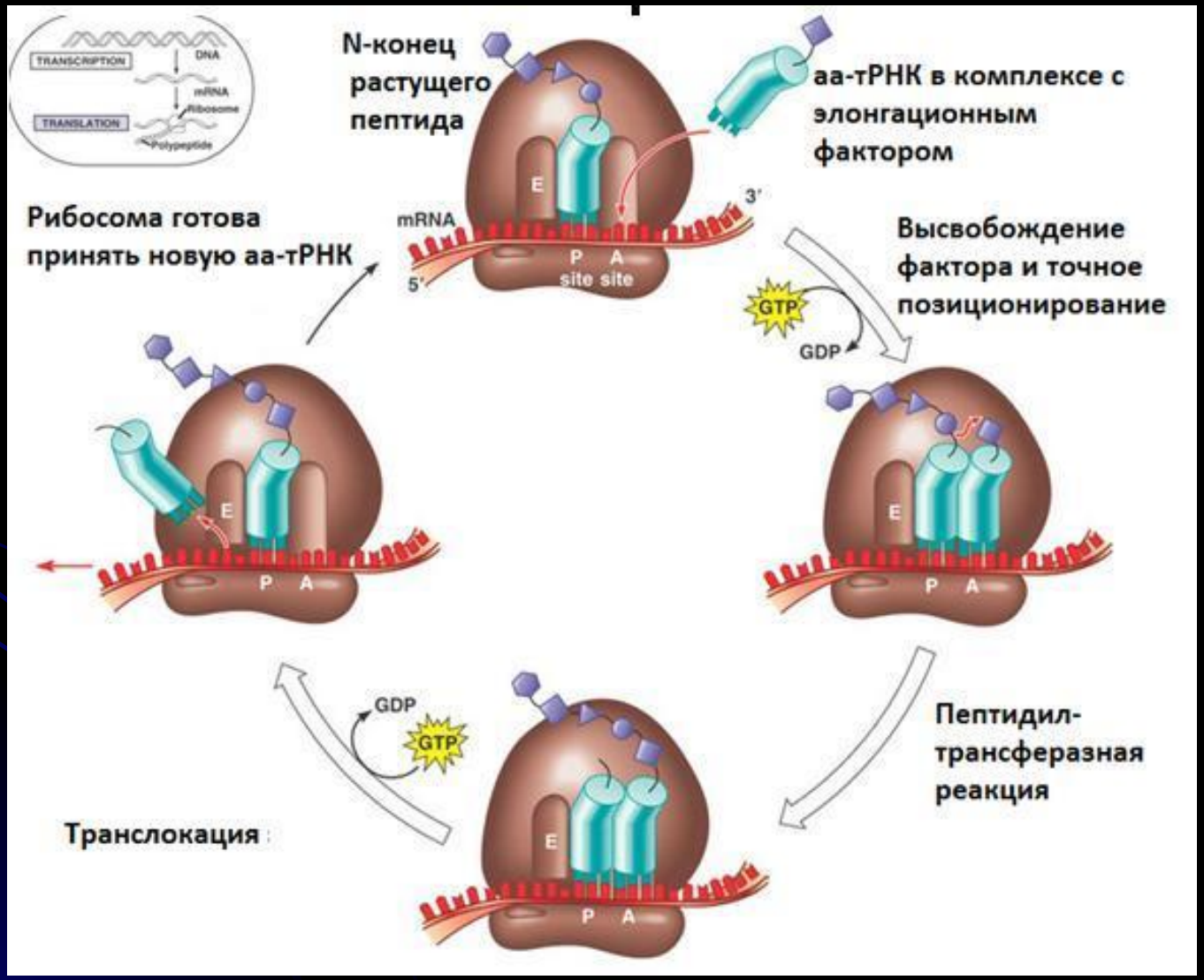


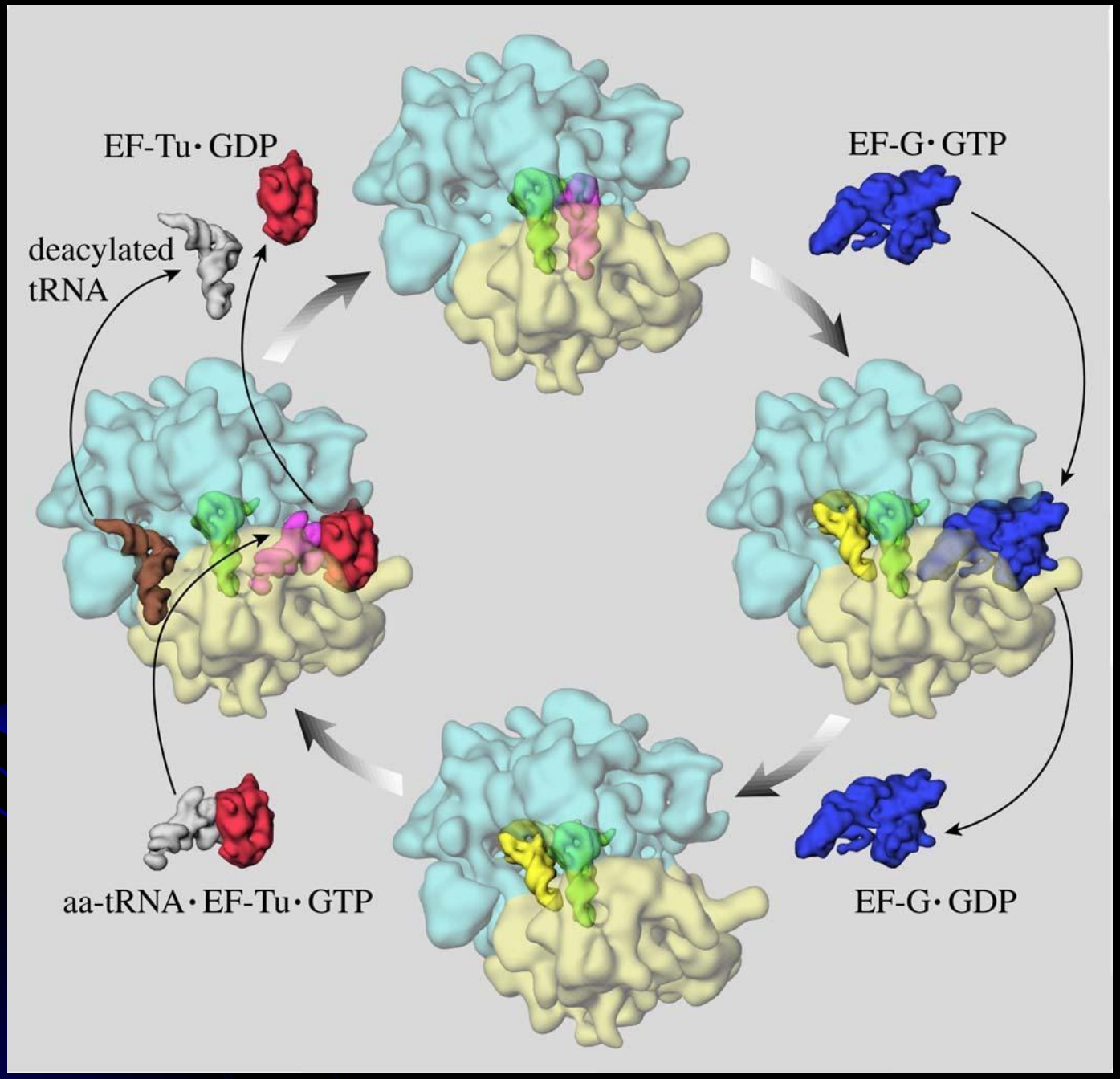

Aminoacyl-tRNA

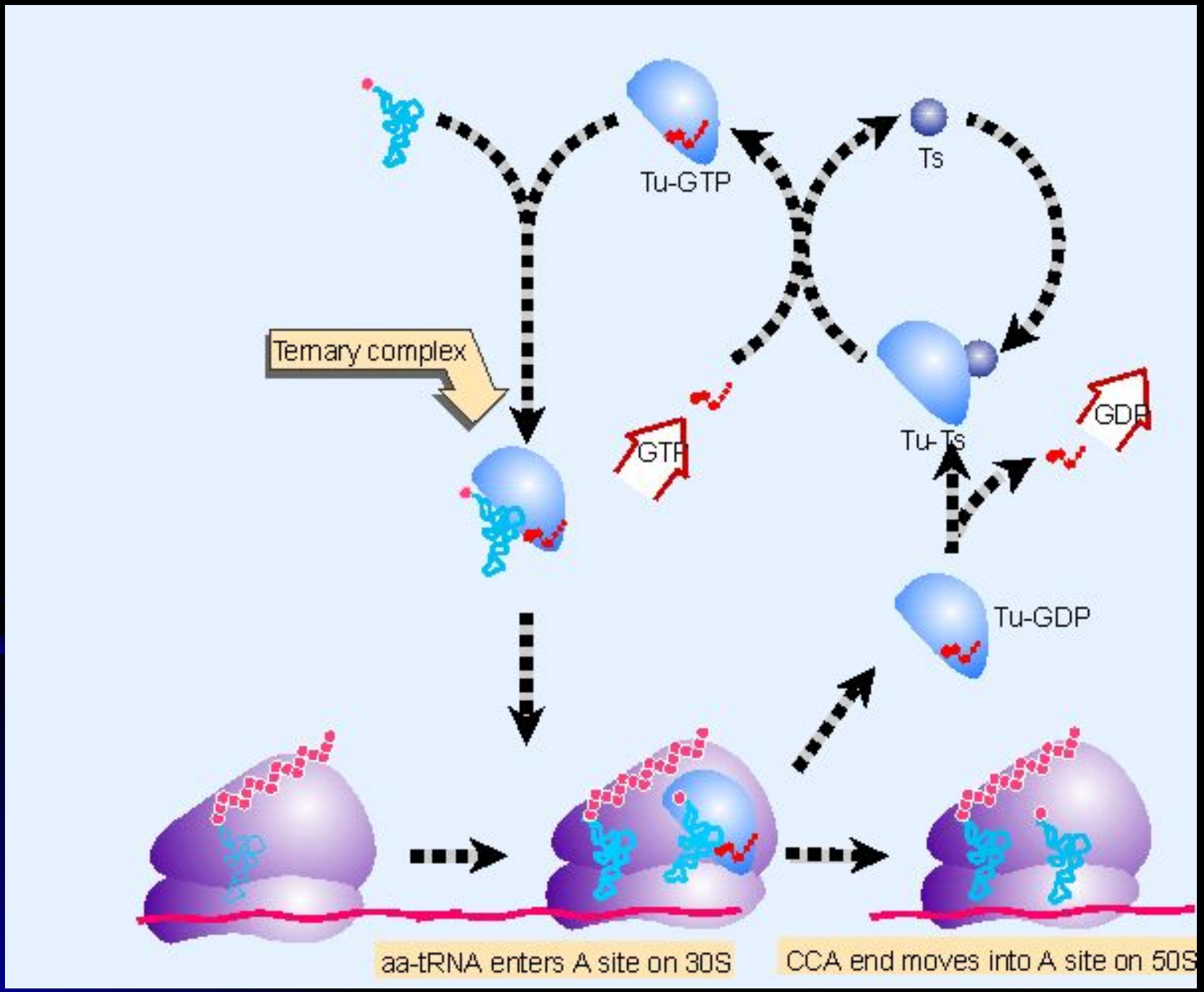



Puromycin

# Цикл работы рибосомы

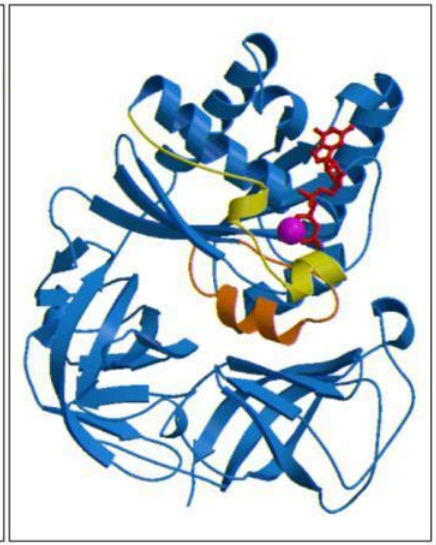



EF-Tu · GDP
EF-G · GTP
deacylated
tRNA
aa-tRNA · EF-Tu · GTP
EF-G · GDP

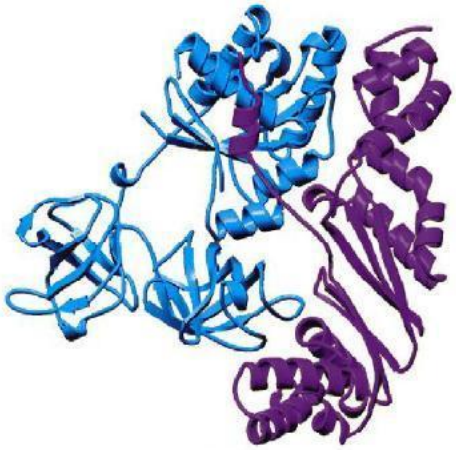

Tu-GTP
Ts
Ternary complex
GTP
Tu-Ts
GDP
Tu-GDP
aa-tRNA enters A site on 30S
CCA end moves into A site on 50S

# Комплексы EF-Tu

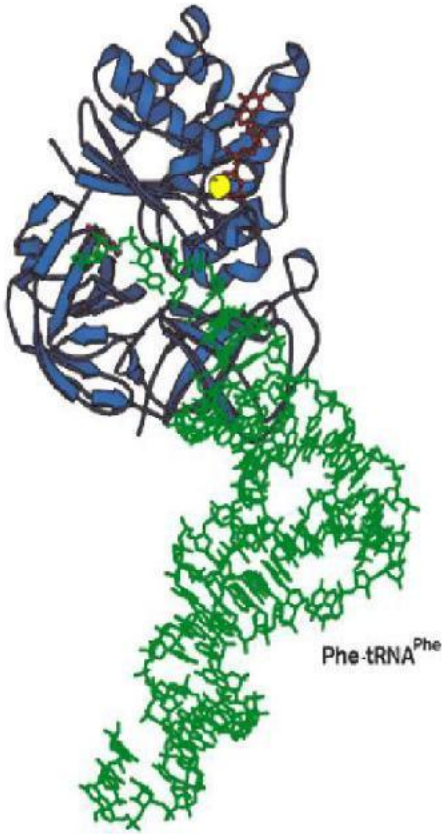
EF-Tu-**GDP**



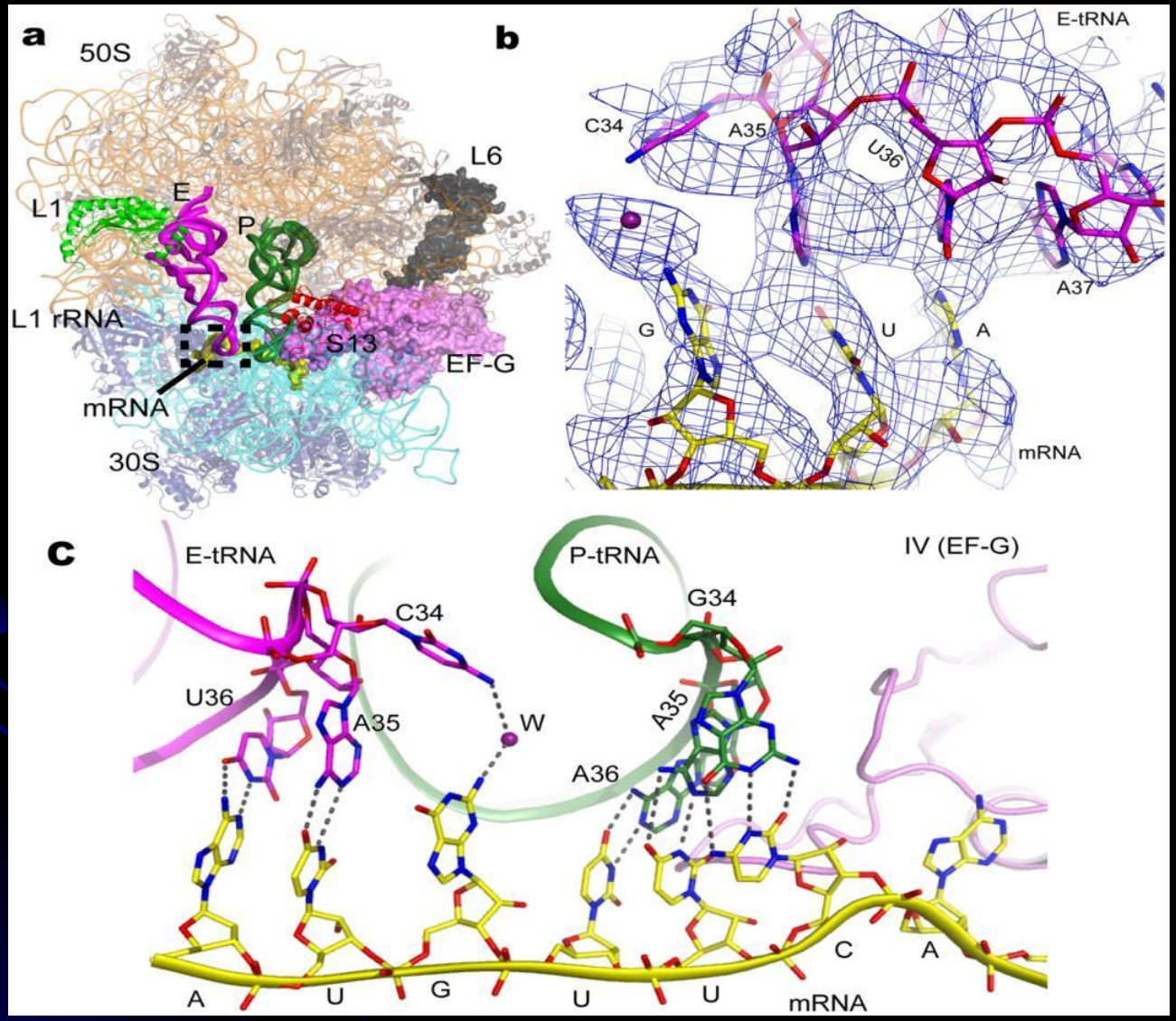
EF-Tu-**GTP**



EF-Tu–Ts

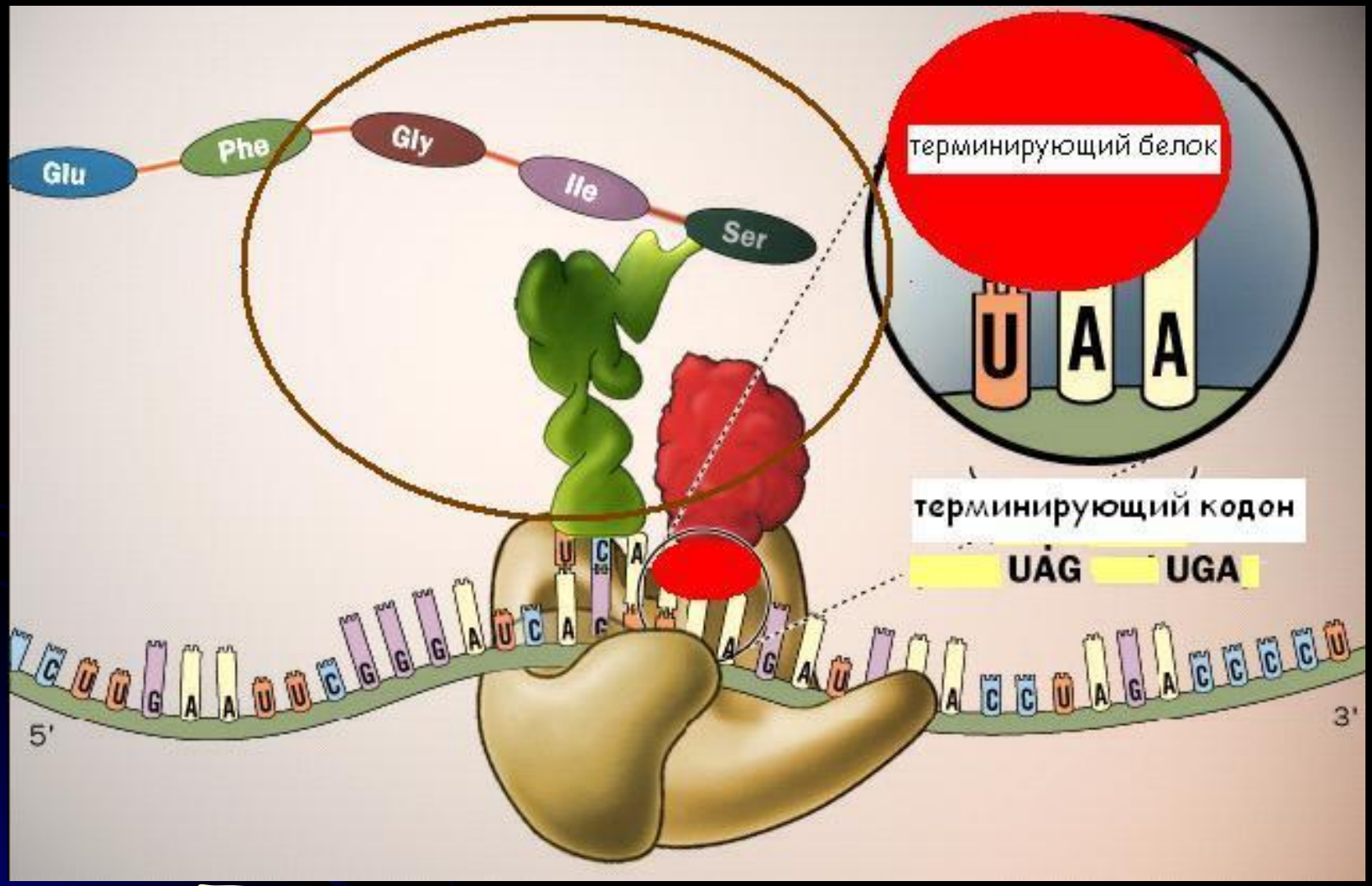


# Транслокация

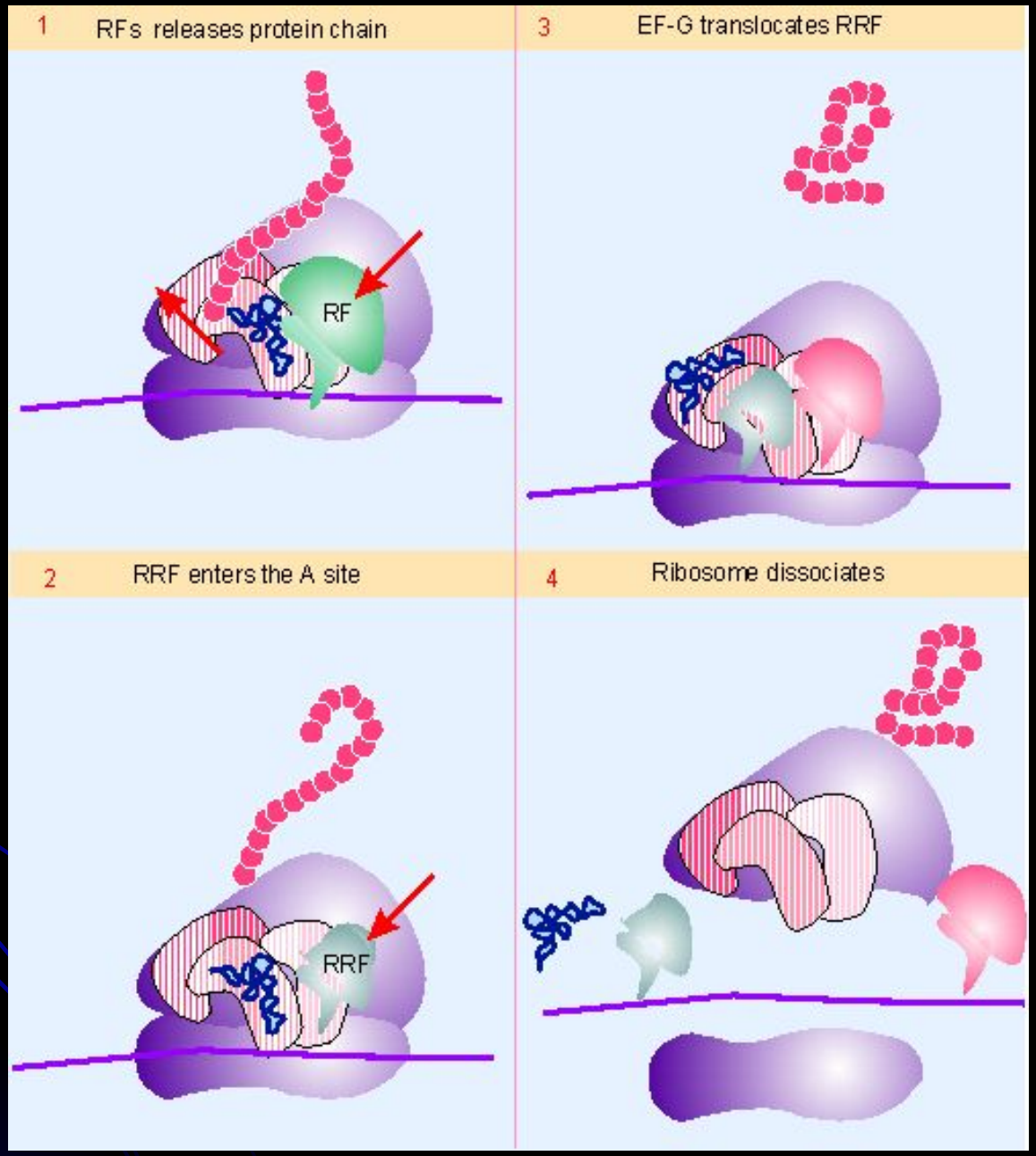


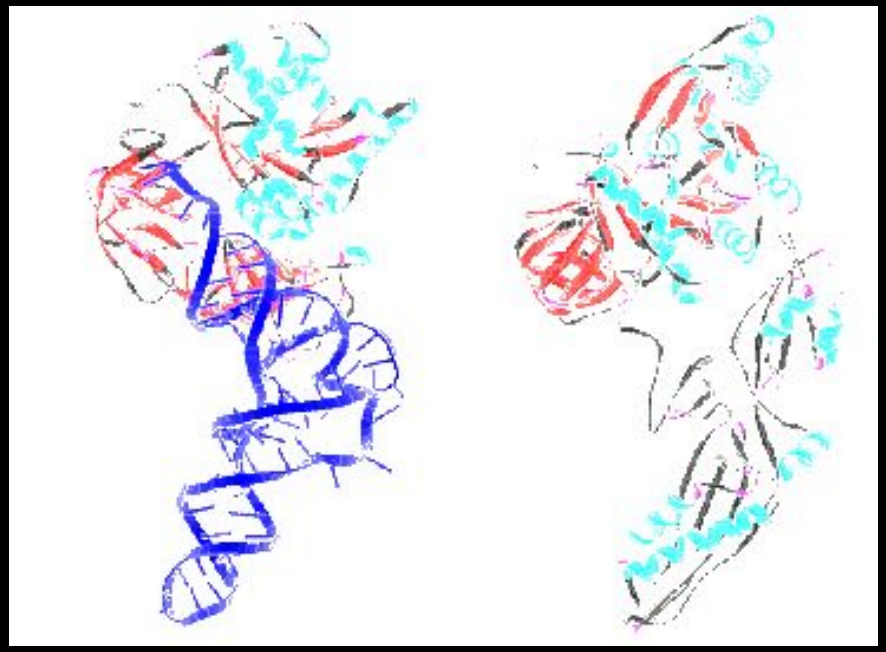

http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0058829

# Для терминирующего кодона мРНК НЕТ тРНК



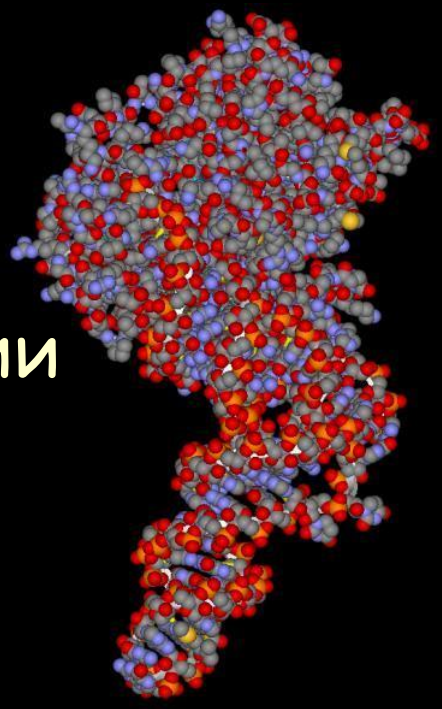

# Терминация трансляции

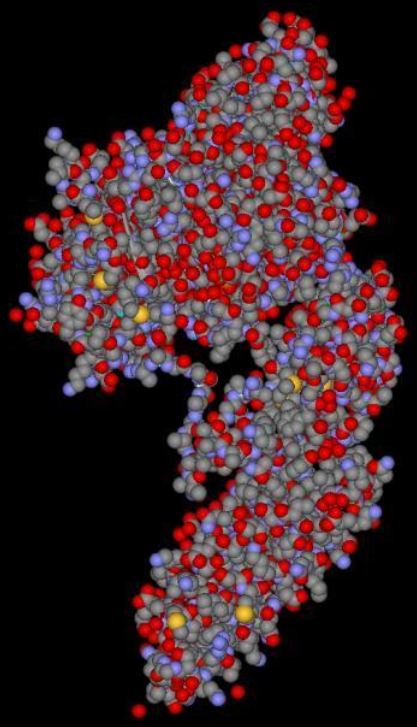

1
RFs releases protein chain
RF
3
EF-G translocates RRF
2
RRF enters the A site
RRF
4
Ribosome dissociates



# Мимикрия пространственной структуры

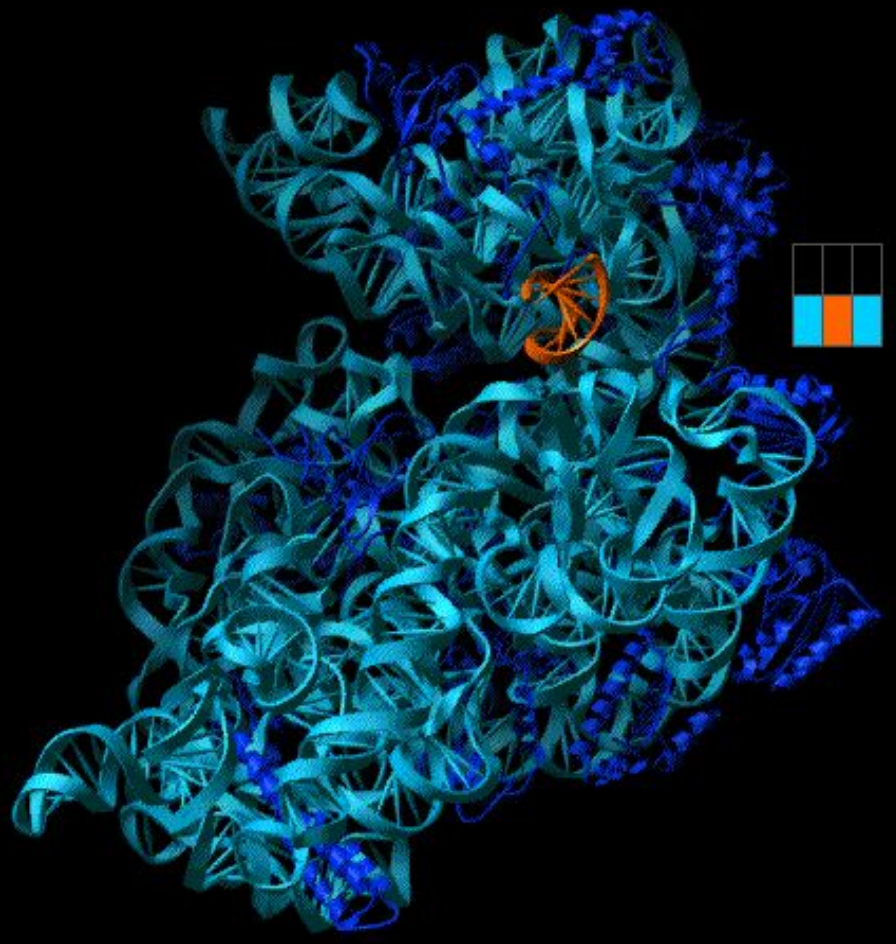
фактор элонгации + тРНК





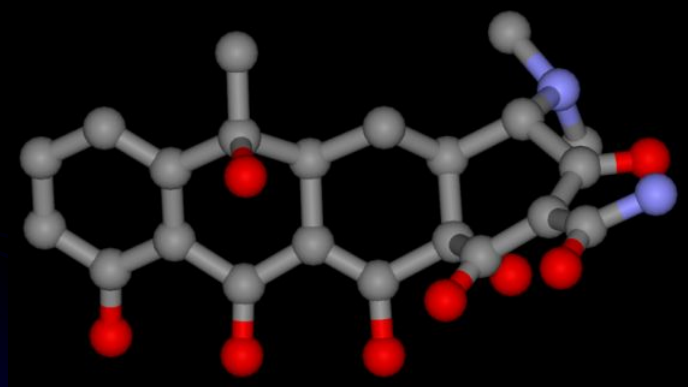
фактор транслокации

# Изменение конформации малой субчастицы рибосом

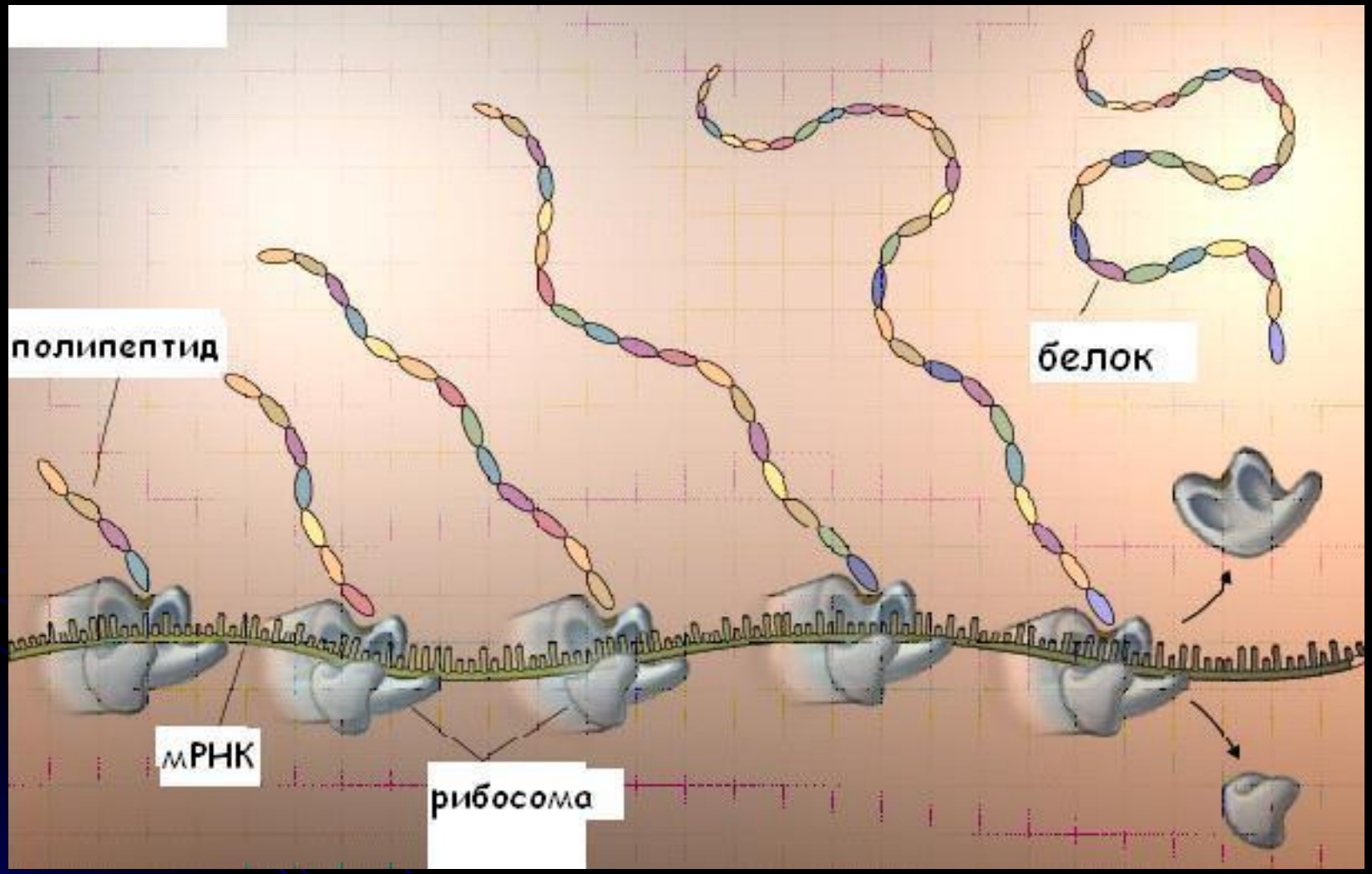


Кодон – антикодоновые взаимодействия

# Тетрациклин и рибосома – борьба Давида с Голиафом

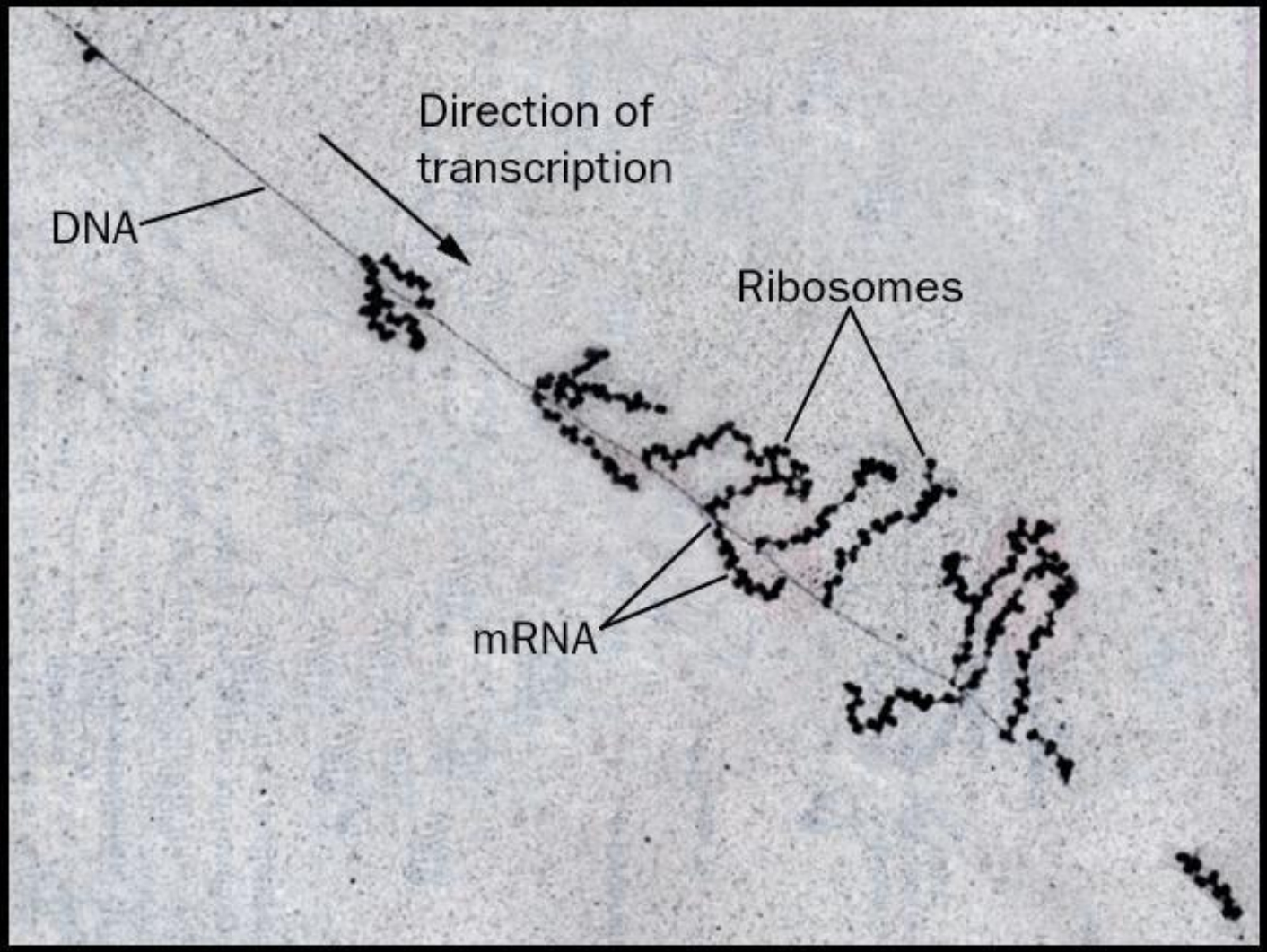


# Полисомы

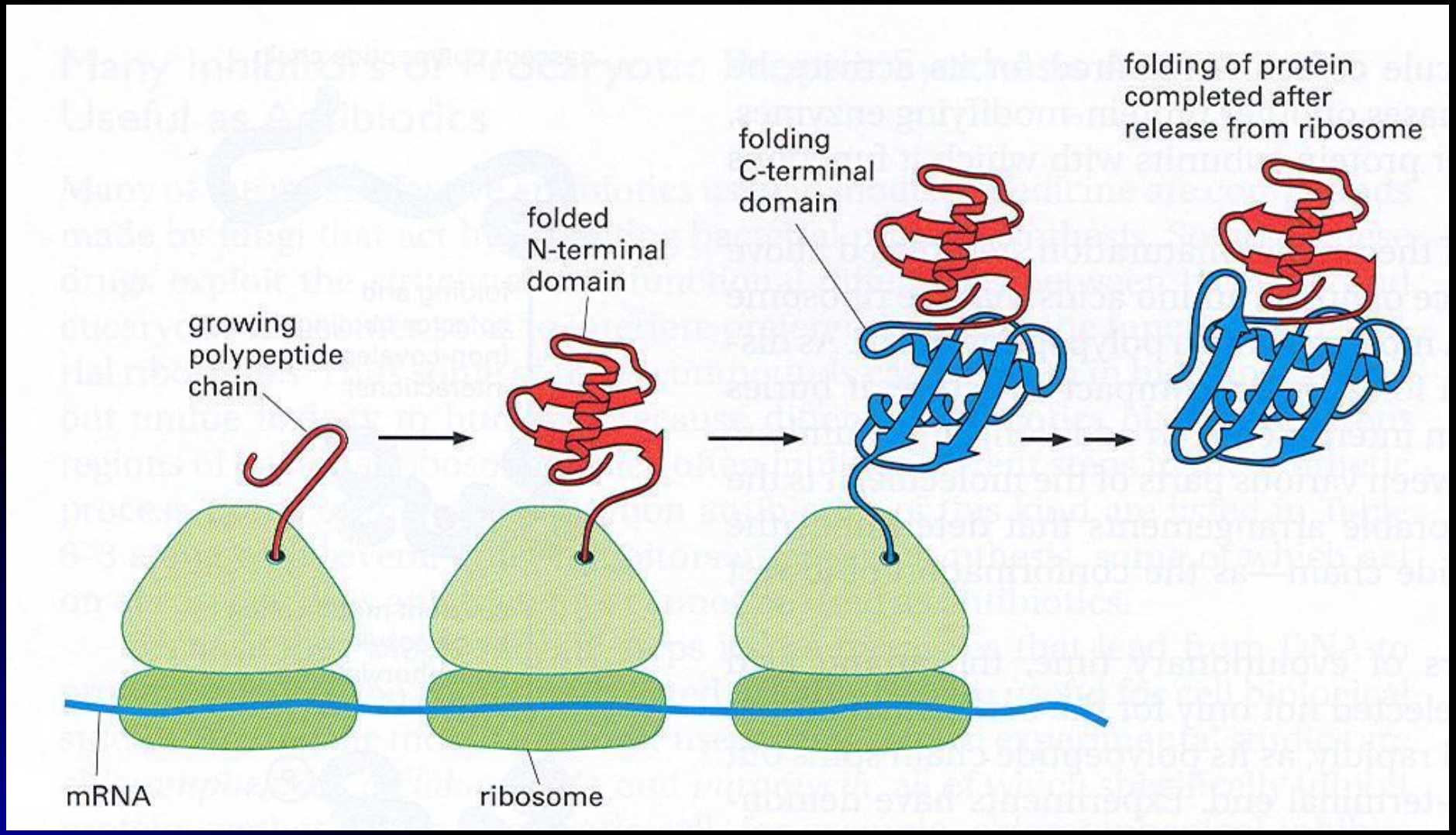



последо

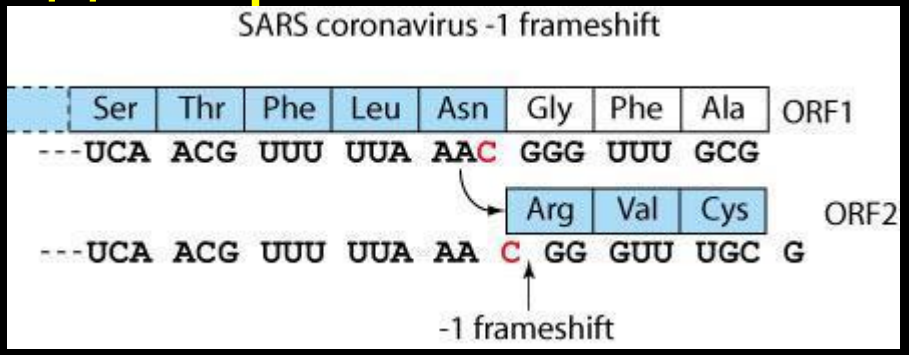
# Полисомы *in vivo*

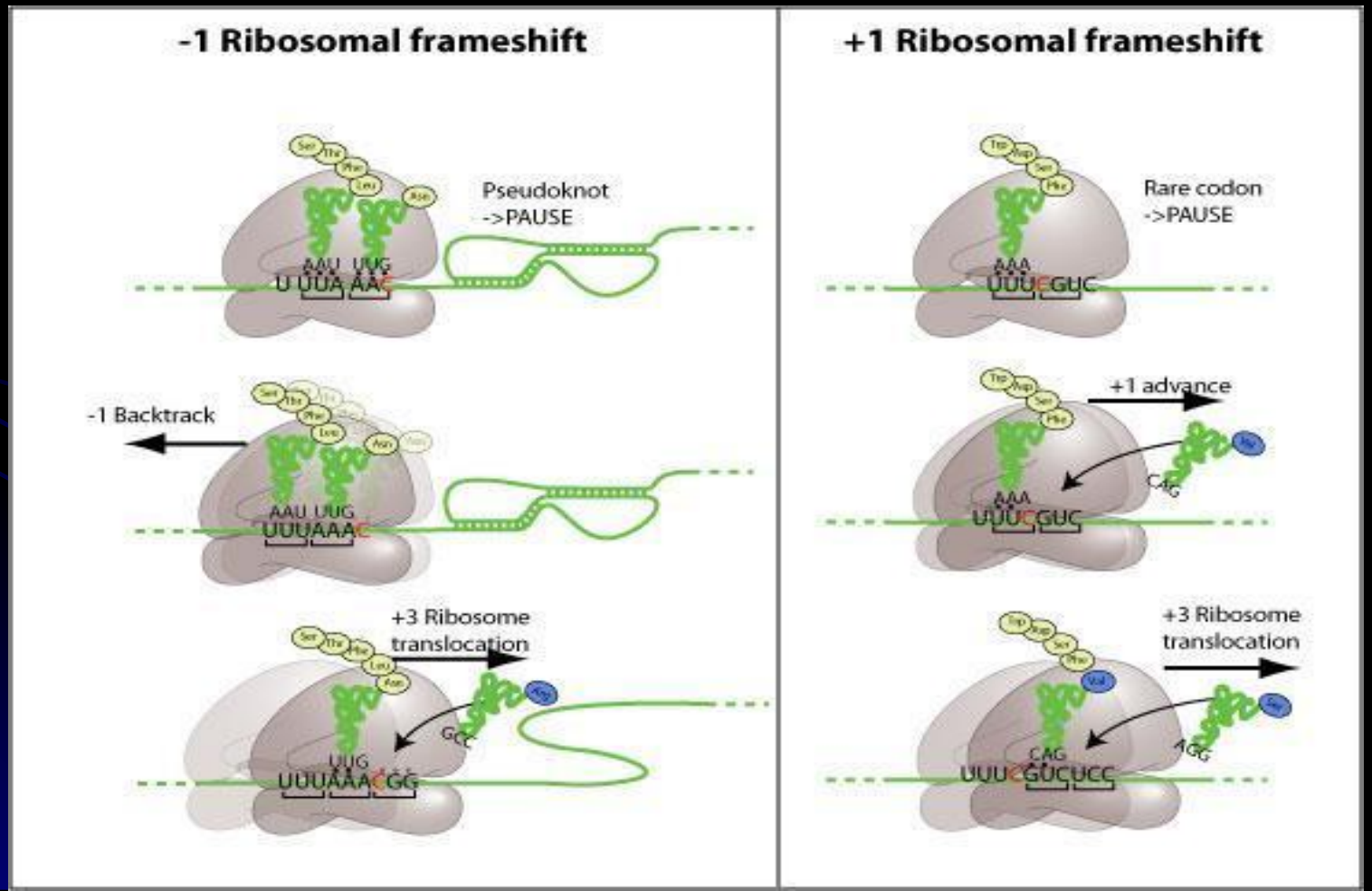


# Пост-трансляционное формирование структуры белка

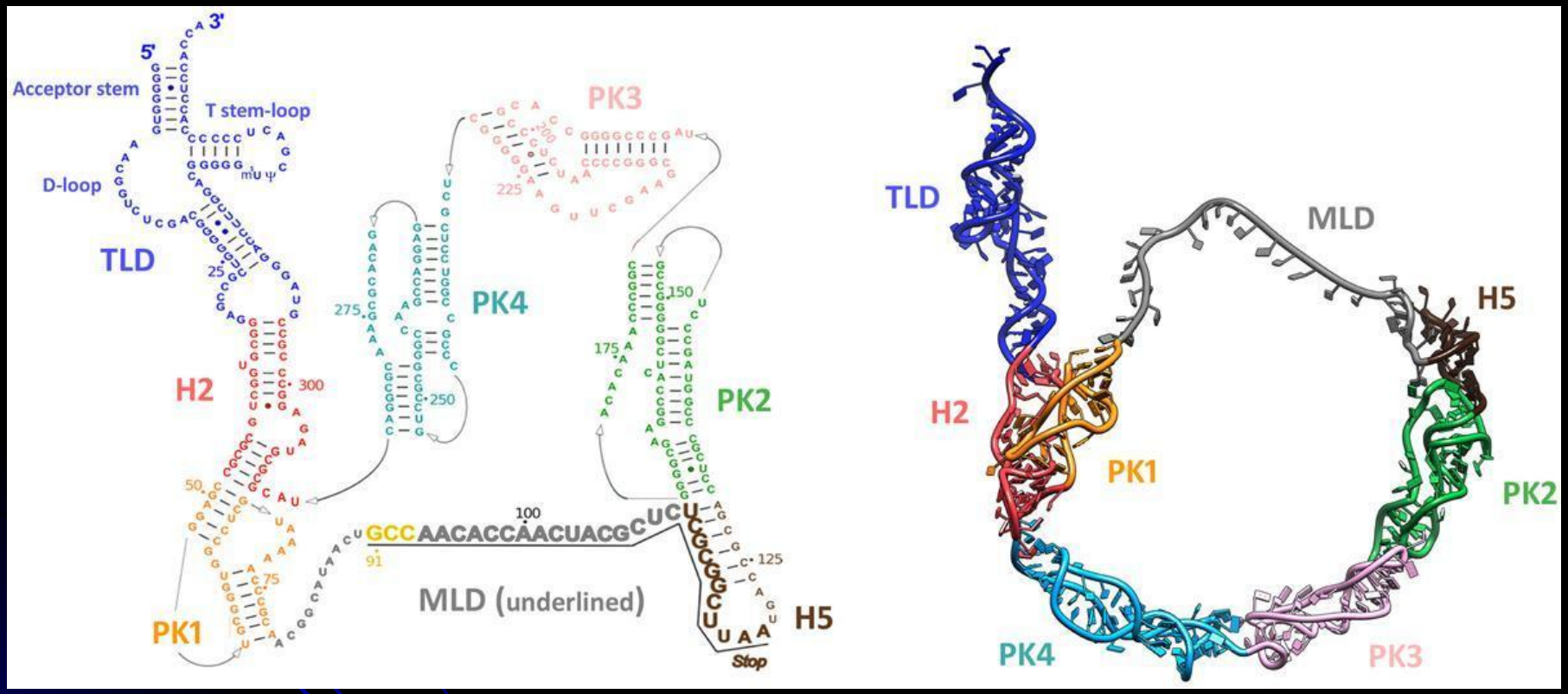


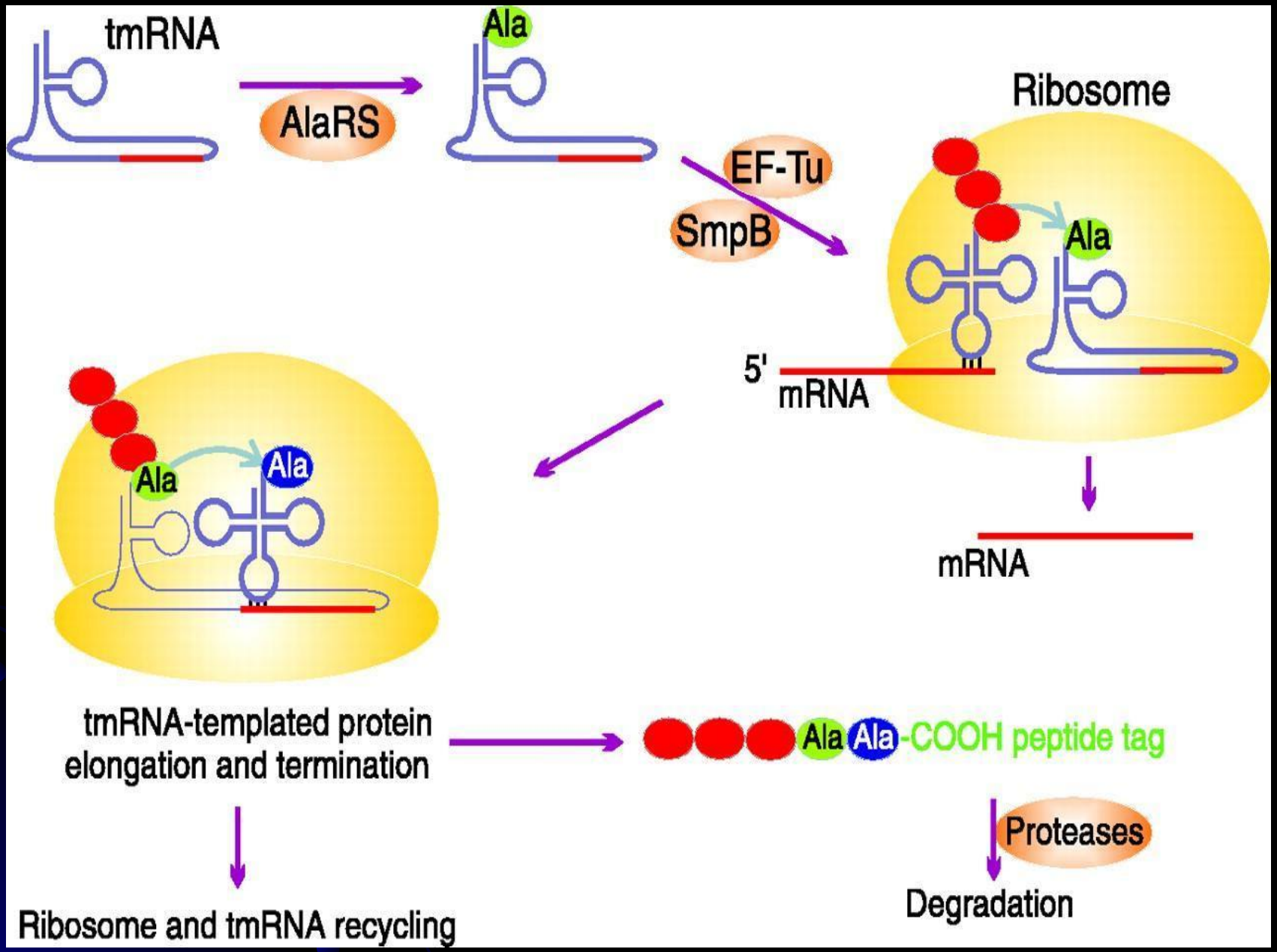
# Сдвиг рамки считывания



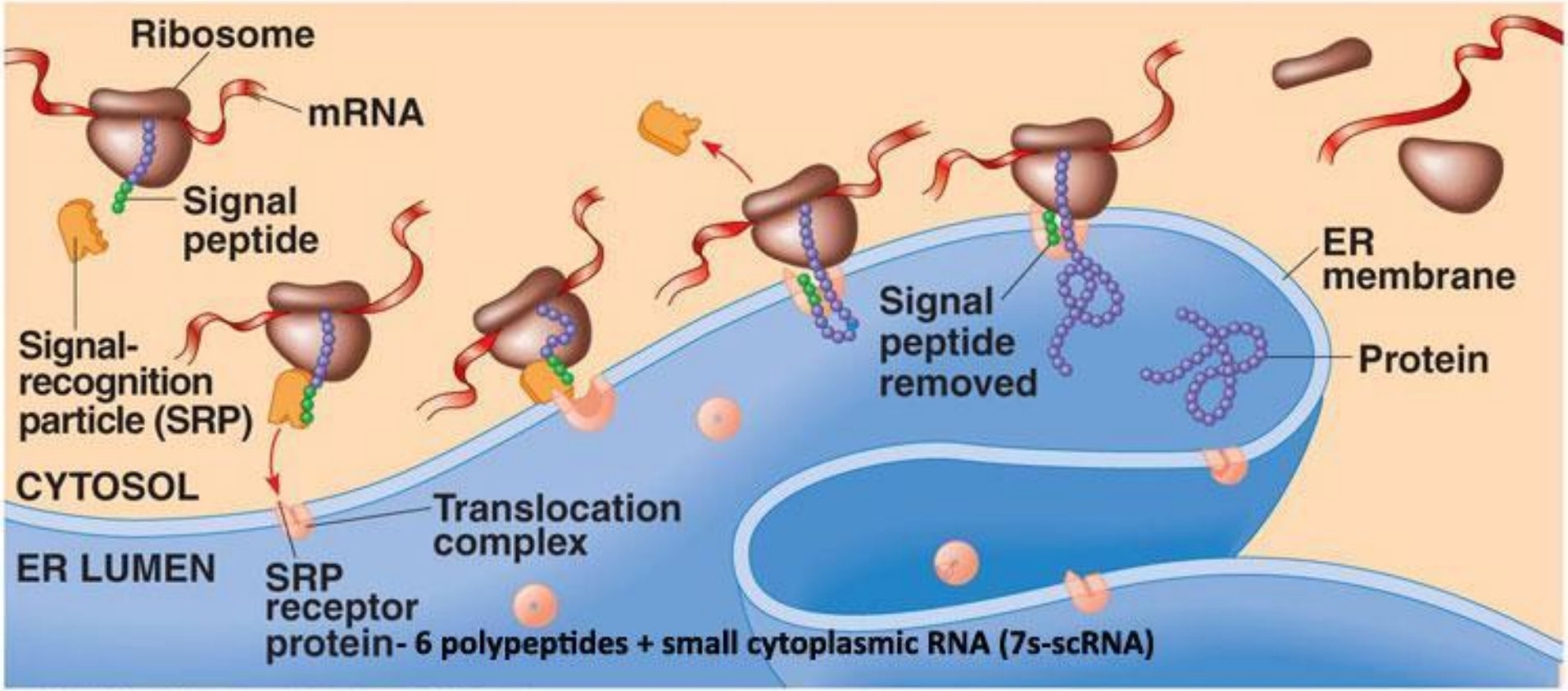



# тмРНК (транс-трансляция)




tmRNA
AlaRS
Ala
Ribosome
EF-Tu
SmpB
Ala
5'
mRNA
mRNA
Ala
Ala
tmRNA-templated protein
elongation and termination
Ala Ala -COOH peptide tag
Proteases
Ribosome and tmRNA recycling
Degradation

# Трансляция, SRP

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