Genetic Experiments Phenotype and Genotype

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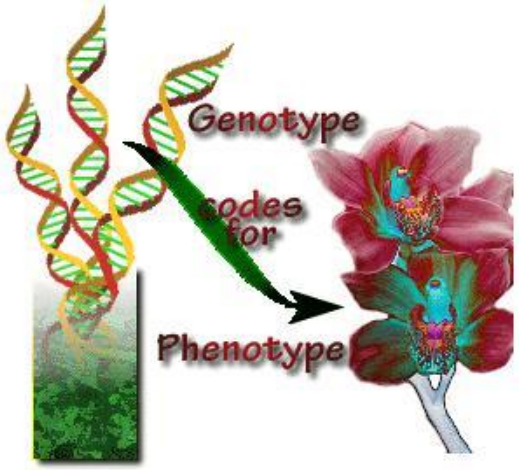
- Every living organism is a physical entity combining internally coded information with the influence of the environment on how that information is expressed.
- Phenotype means the matter that is produced and often the behaviors (internal and external) that are observed.
  - The atoms, molecules, cells, body structures
  - The metabolism, processes, functions
  - The responses to stimuli
- Genotype means the inheritable information encoded in the genetic material (usually DNA, sometimes RNA).
  - Genes to make RNAs and proteins
  - Regulatory elements

Genes code for traits that can be measured

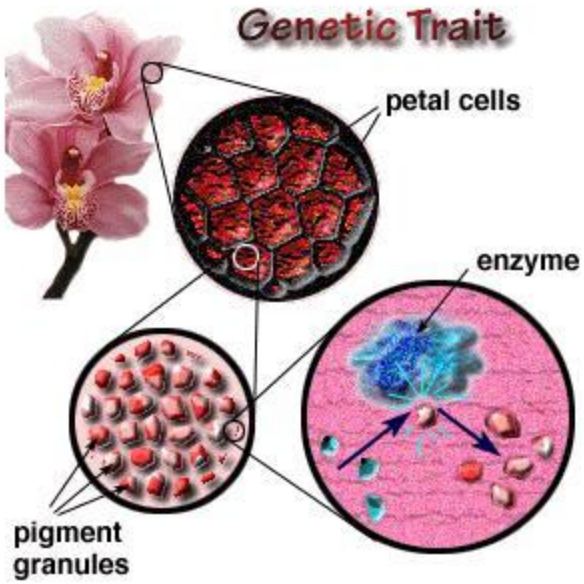
- A gene is a coded set of instructions for making a molecule
  - The cellular machinery decodes the gene, combines it with other gene products, sends those products to the right place
  - The Phenotype can be measured



http://www.brooklyn.cuny.edu/bc/ahp/BioInfo/GP/Relationship.html

Genetic traits are small, measurable, inheritable characters

- In plants, flower color and leaf shape are examples of genetic traits.
- Where does the red color come from?
- There are red grains inside the cells in the flower petal
  - Why red? They reflect red wavelengths of light.
  - Where do they come from? They could be minerals the flower gets from the soil or something the plant makes for itself.

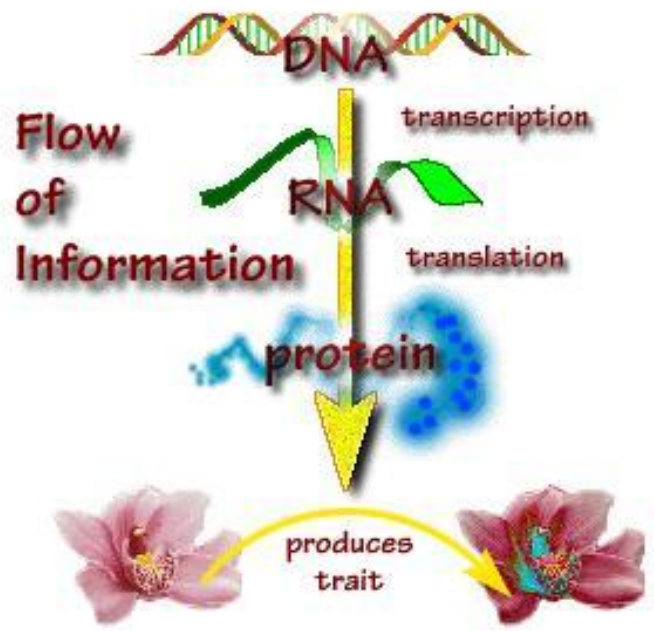


Molecular Phenotype is still a phenotype

- Characters seen at a large scale may be due to events at the molecular scale.
  - In the cytoplasm of a cell there is a chemical reaction – a colorless compound is converted to a colored compound.
    - In cells many chemical reactions are helped to go faster (catalyzed) by proteins (Enzymes).
    - If the cell does not have the enzyme, can it make the red compound?
      - Why would a cell not have this enzyme?
      - What else could stop the cells from making the red pigment?

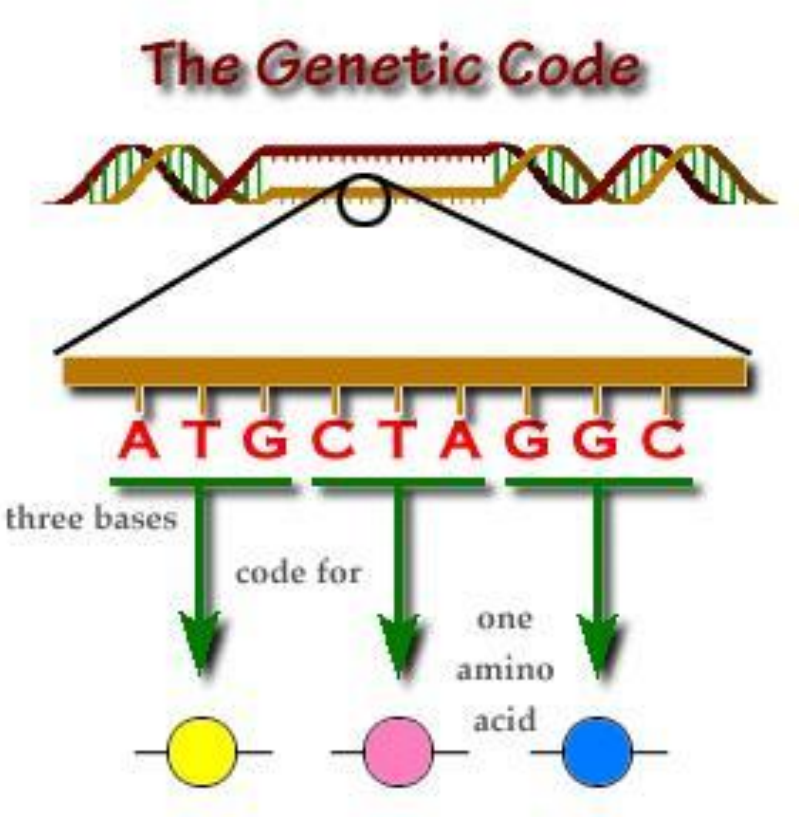
Information that has to be decoded follows a path of expression

- Encoded information is passive – a path for expressing it is required before it becomes active.
- In cells there is a common set of decoding tools.
  - The Central Dogma of Molecular Biology



The genetic code provides the rules for turning information into action.

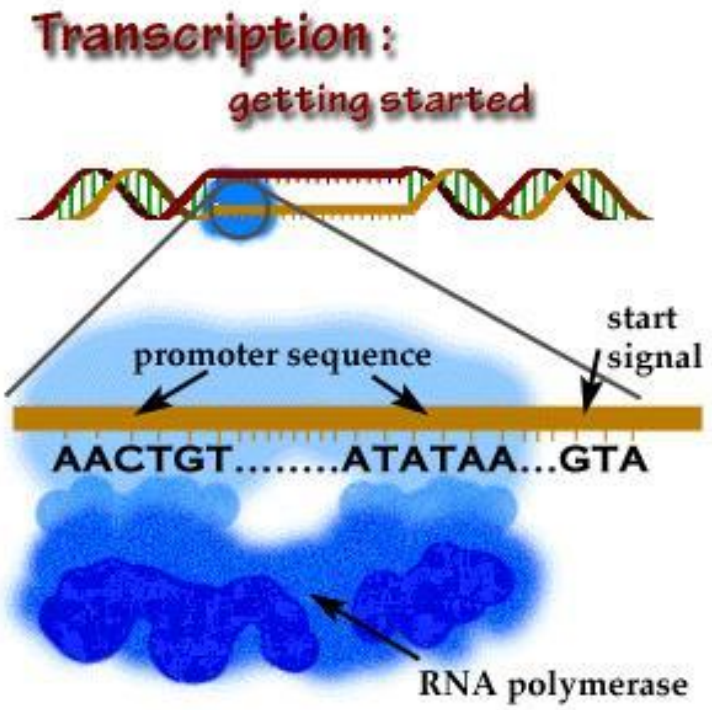
- The genetic code is stored on the strands of DNA
  - One is the 'coding strand and the other is the complementary copy that makes the system self-contained.
  - The DNA code is linear and non-overlapping, with only 4 letters in its alphabet. The letters are …..
  - DNA → RNA, which also has 4 letters
  - RNA → protein, which has 20 letters, the amino acids.



Triplets (3 RNA letters to one amino acid) Four letters taken 3 at a time gives 64 possibilities, not 20. Some are used for regulation.

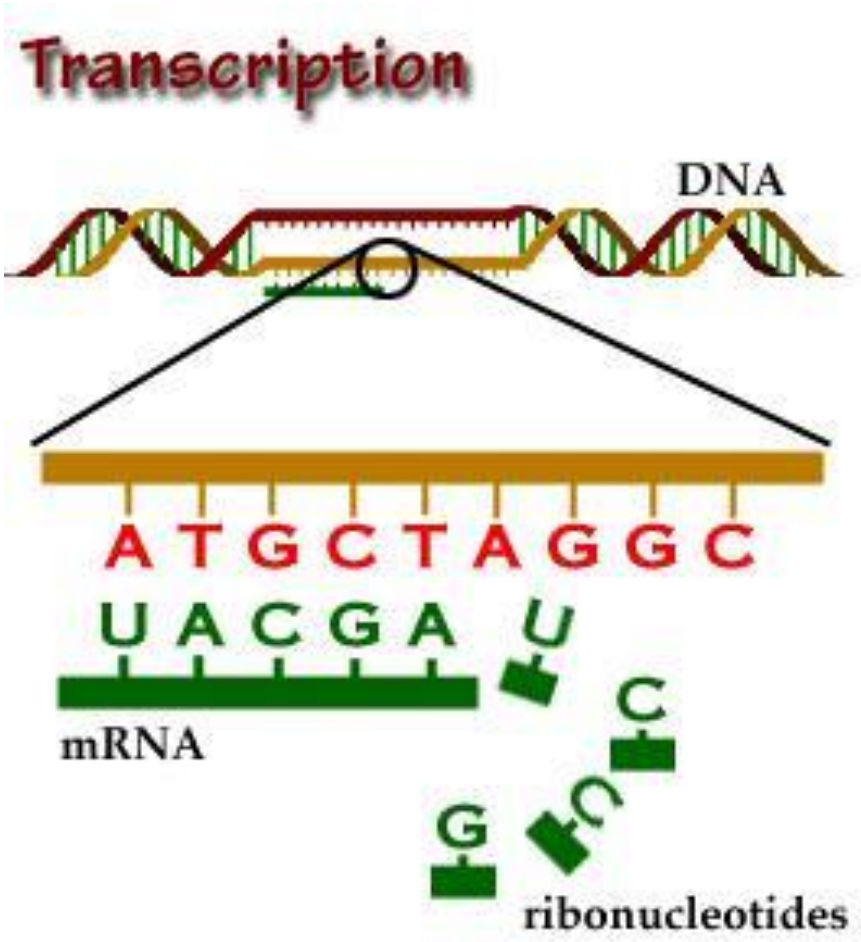
The first step of decoding the DNA is called transcription.

- A protein called RNA polymerase converts the DNA into RNA.
  - It makes polymers from individual subunits
  - Subunits are represented by letters AUCG
  - The copy is complementary to the DNA coding strand – opposite direction and opposite letters.
  - The polymerase requires a signal for starting (the promoter) and stopping (terminator).



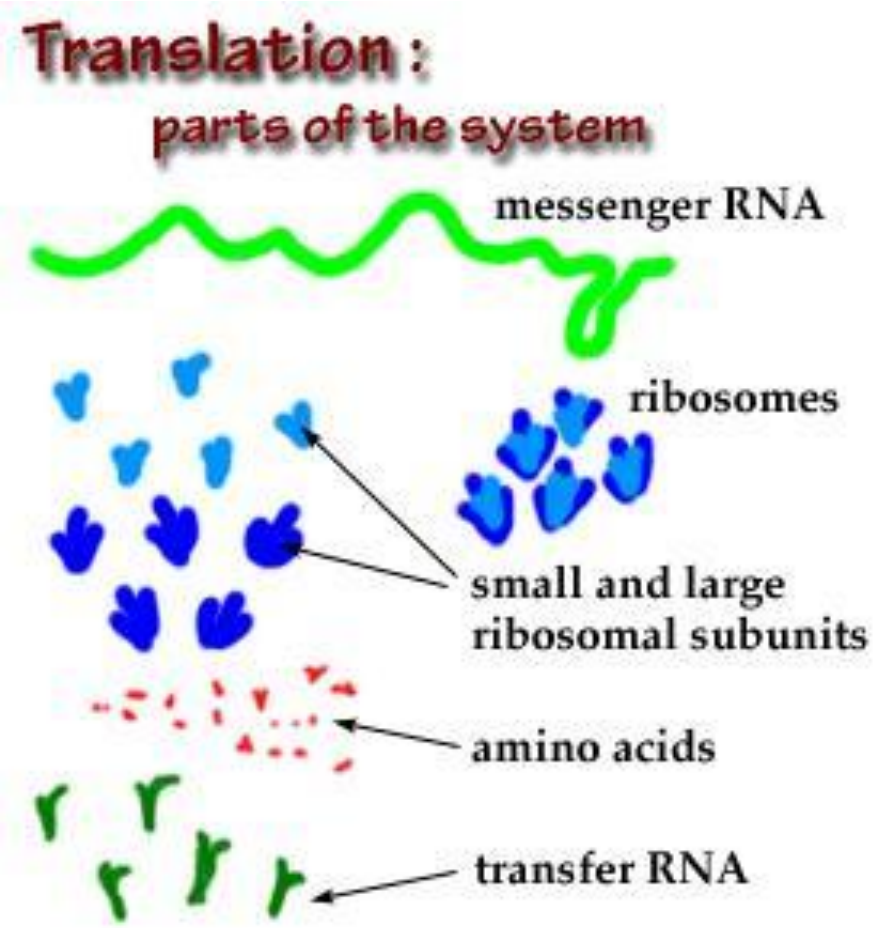
Some RNA is functional and some RNA is an intermediate for making proteins.

- Only one strand of RNA is made
  - It has a short life and does not have to make more of itself.
- The double-stranded DNA is unwound, to expose the coding (sense, template) strand.



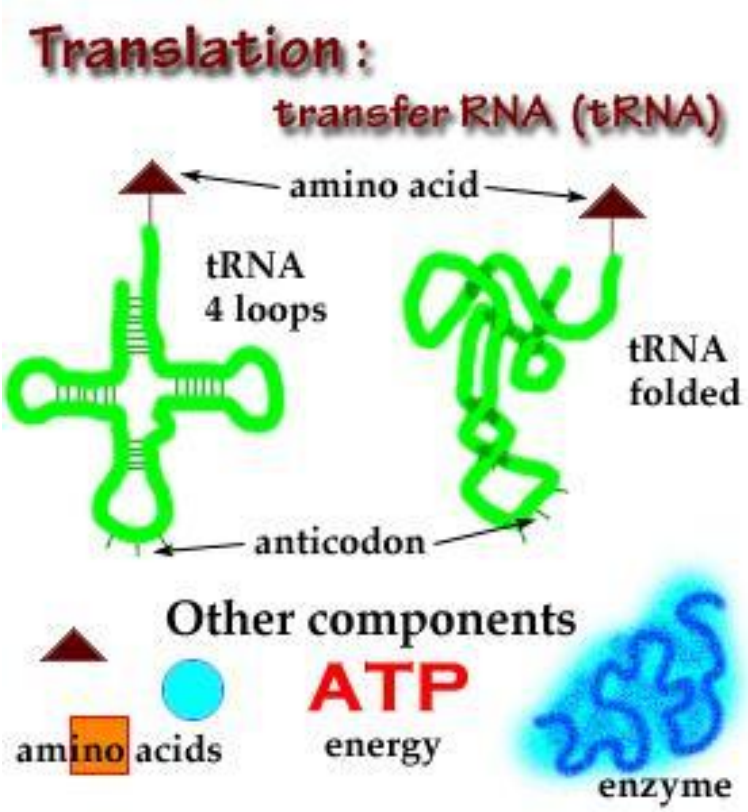
When a gene is making a protein, a second decoding event has to happen.

- The ssRNA polymer must be converted to an amino acid polymer.
- The mRNA is carried to a ribosome, the decoding factory. The triplet code, or codon, is the conversion element.
- A tRNA matches the codes 1:3
- Energy is required, from ATP



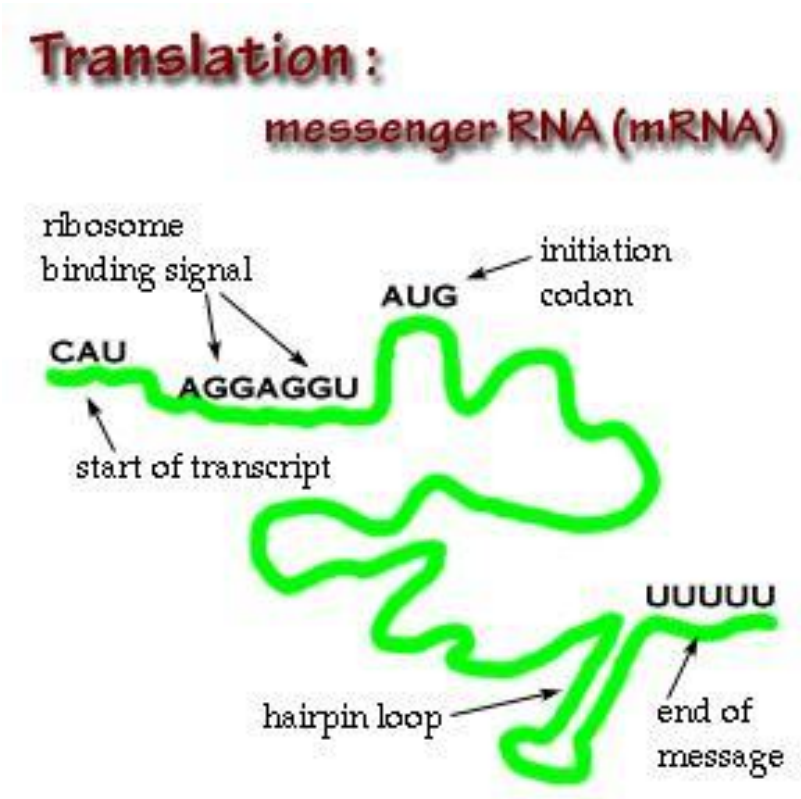
The ribosome is a factory, processing mRNA and using the tRNA to convert to amino acids.

- The tRNA converting units can be charged with an amino acid, or uncharged.
  - Charging happens off-ribosome.
  - Charging required energy
  - The code for some of the amino acids is redundant (more than one way to skin the car).



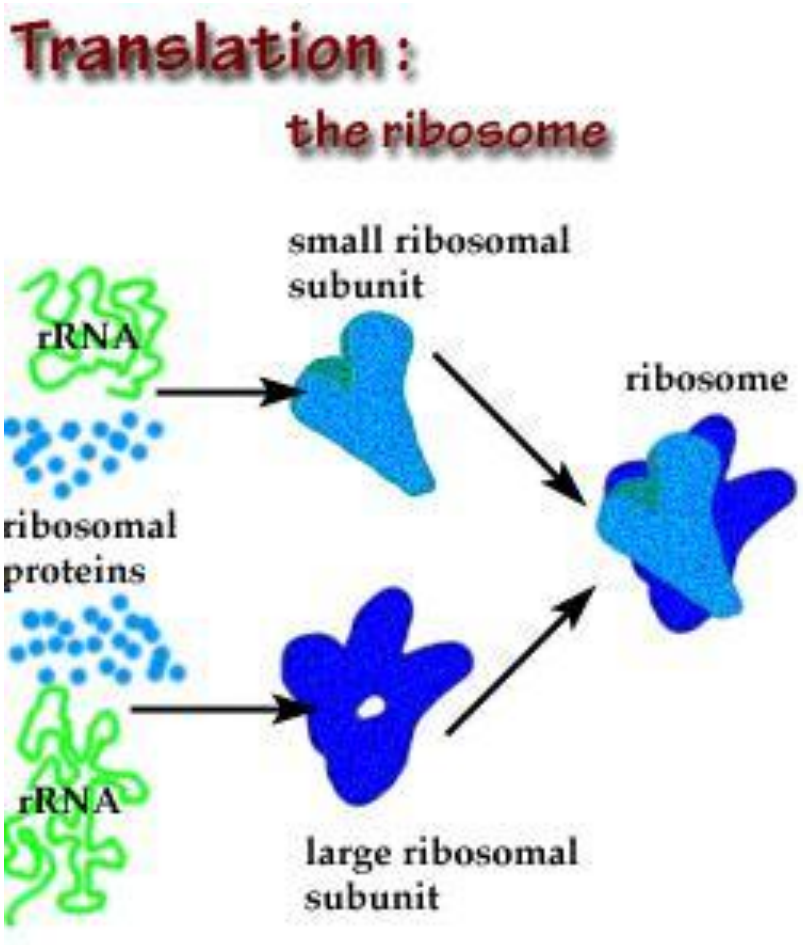
The mRNA has some signals to help the cell trouble-shoot, detecting junk molecules.

- Signals are different in nucleated and non-nucleated cells but both have sequences that are used only to show rbs, start and stop locations.
- One the mRNA there will be a CAU and the an AGGAGGU rbs signal. The first amino acid is always Met.
- In bacteria a region that makes an internal ds region (hairpin loop) stops the ribosome.

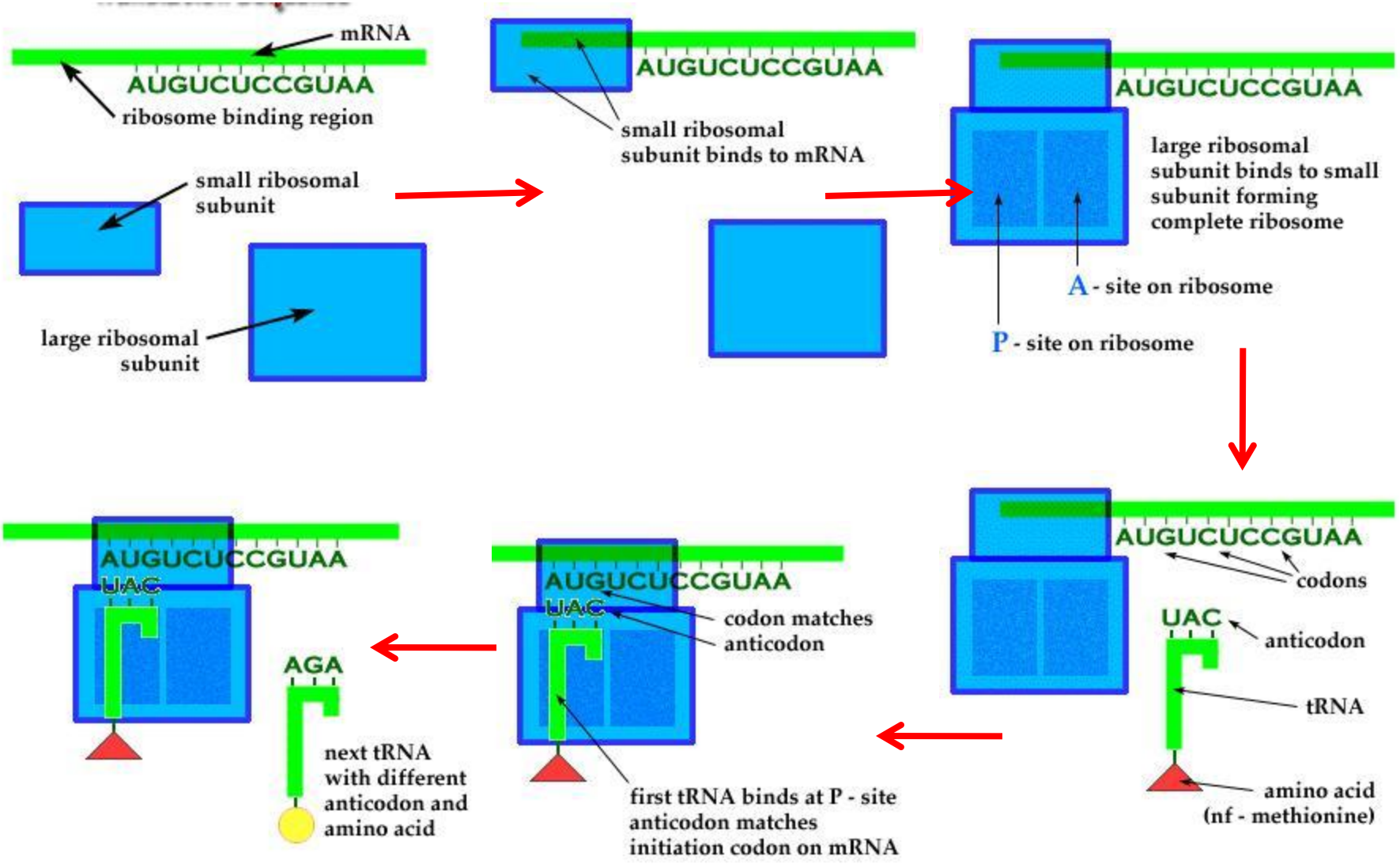


The ribosome is a complicated factory for making proteins.

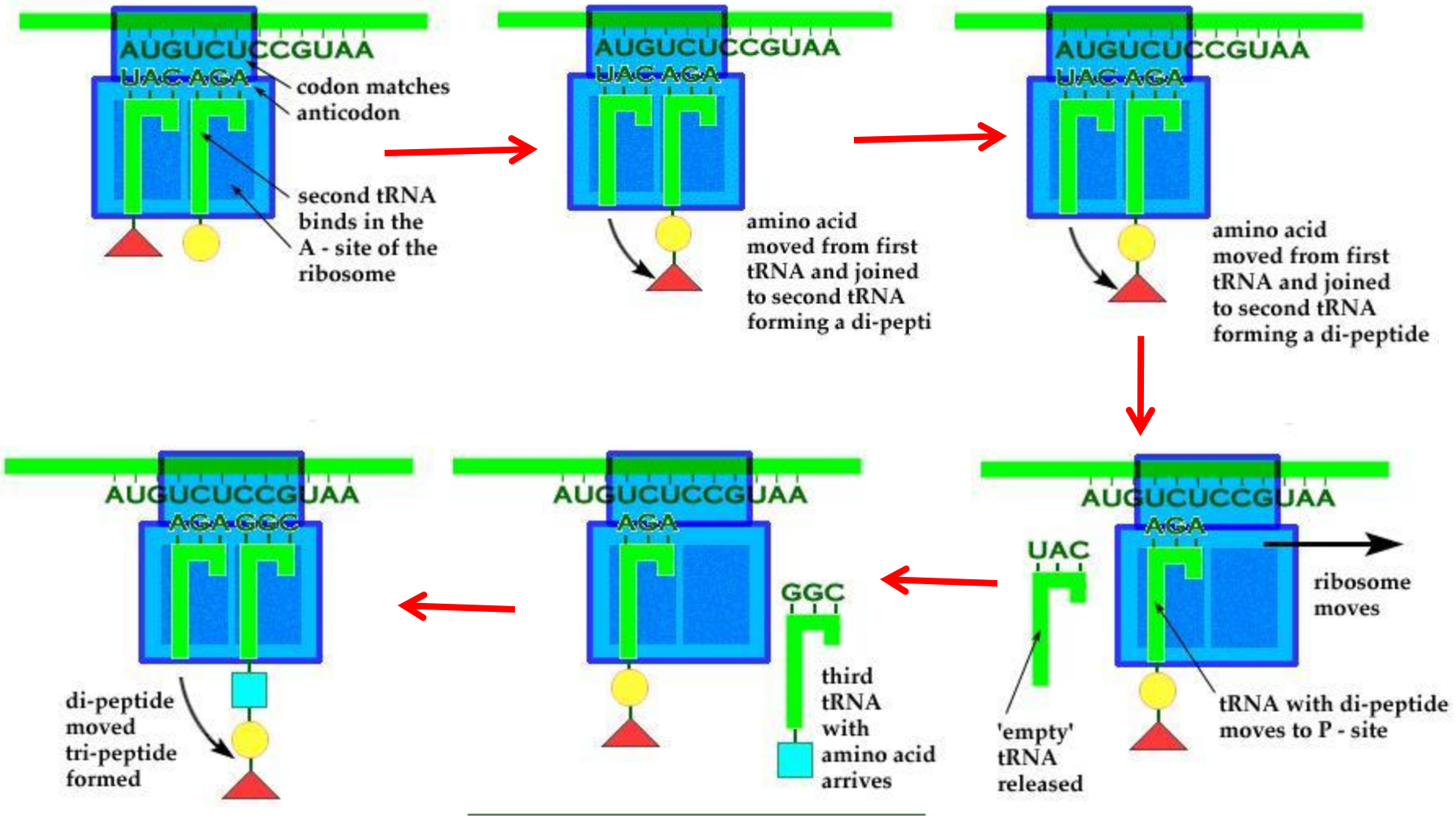
- Translation occurs at the ribosome, where mRNA meets charged tRNA.
- In bacteria the ribosome has two subunits, one is the 30S (21 proteins, and one long rRNA) and one is the 50S (31 proteins and a long protein)
  - The 30S subunit bind the mRNA, recognizing the AGGAGGU sequence



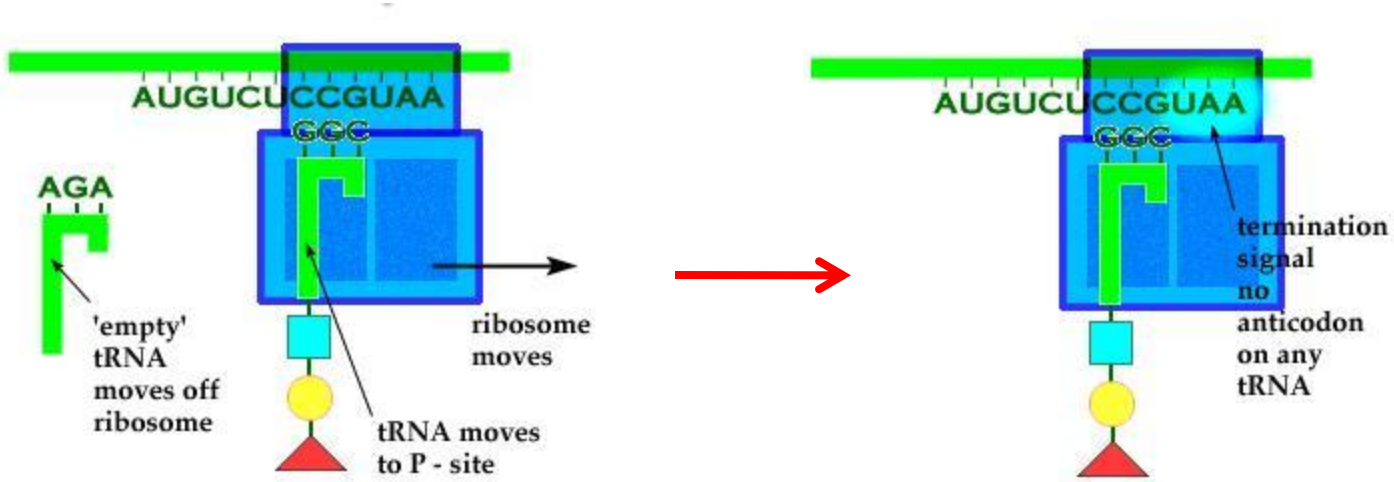
Translation steps



More translation



Final steps in translation



Mutations

- A mutation means a change in the information code at the primary level, the gene.
  - The DNA is damaged or altered. The information may or may not be changed at the level of the protein. Why?
  - In the example the sequence of the DNA has one letter exchanged for another that changes one of the amino acid letters in the protein polymer that makes a colored pigment in the flower.