DNA Function

DNA →

Heredity and Protein Synthesis

Review

- DNA made of
- Nucleotide bases

- Proteins made of
- Amino acids

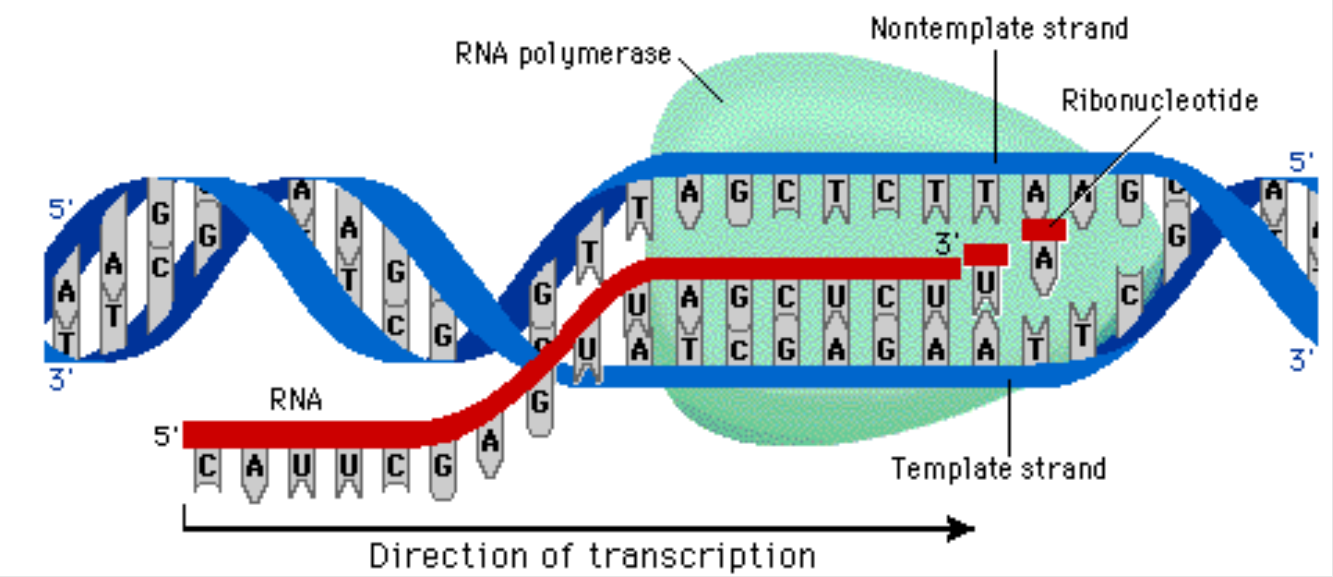
- Describe how DNA is involved in protein synthesis
- DNA base sequence codes for amino acid sequence in proteins

Protein synthesis

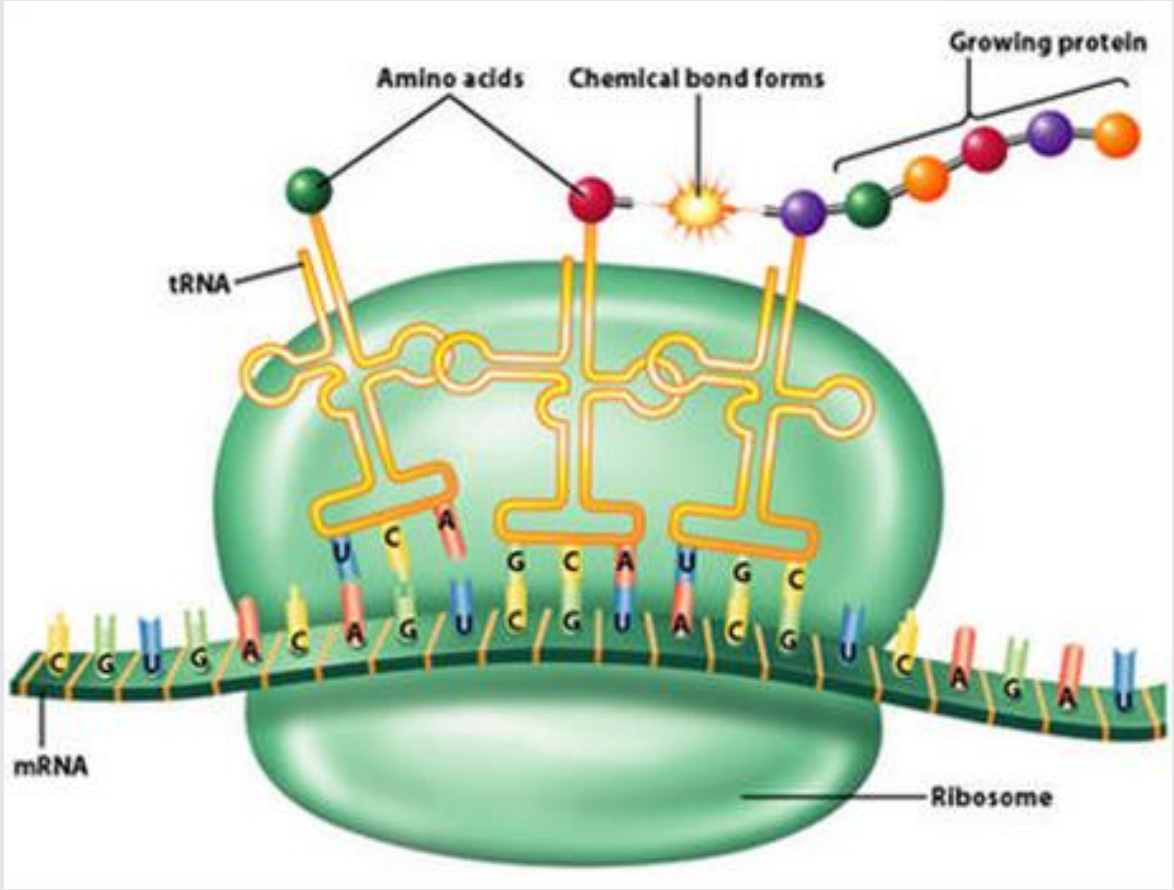
- DNA →RNA→ amino acid sequence
- Occurs in ribosomes
- DNA = template, code, instructions

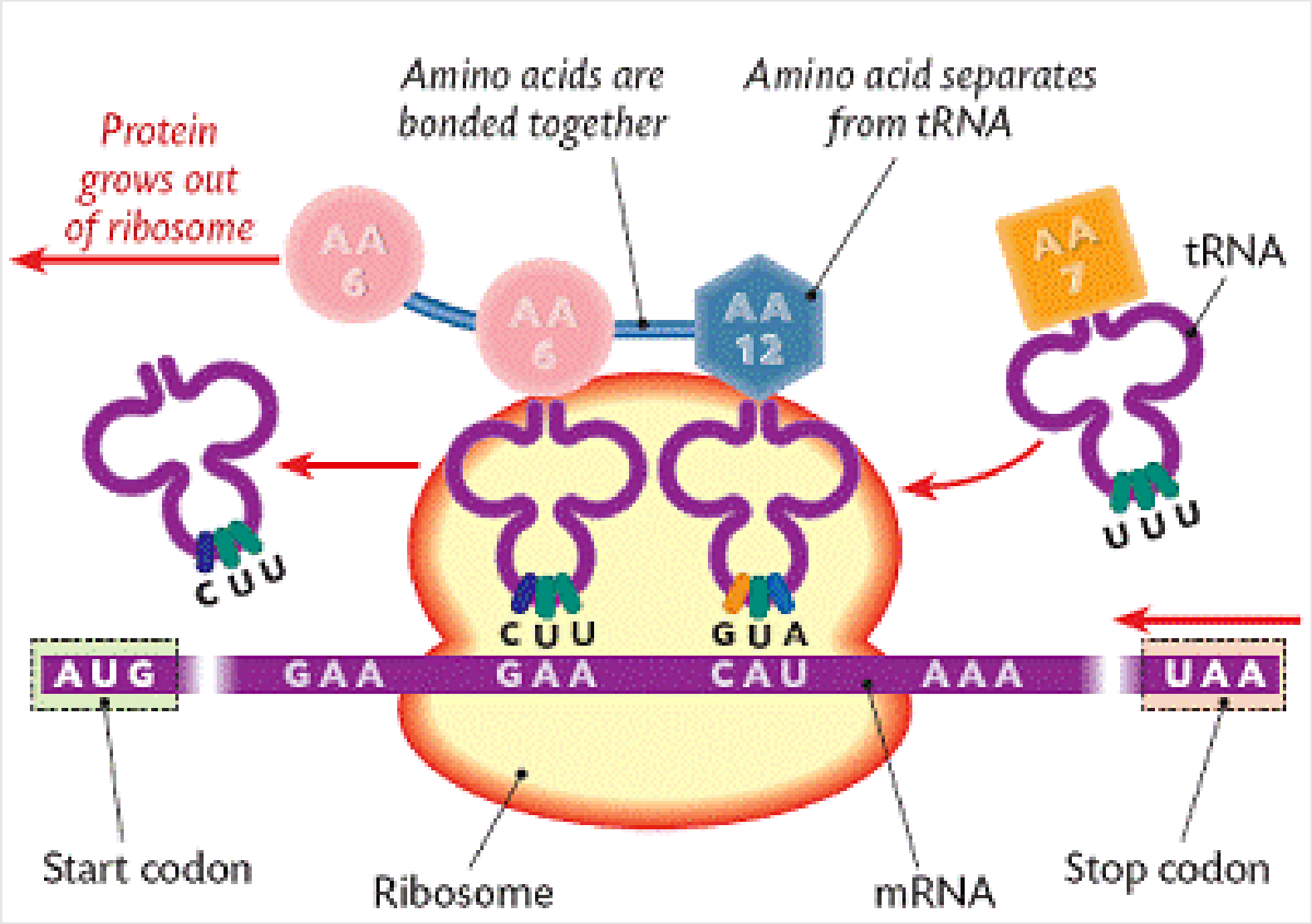
RNA

- mRNA = carries DNA message from nucleus to ribosome

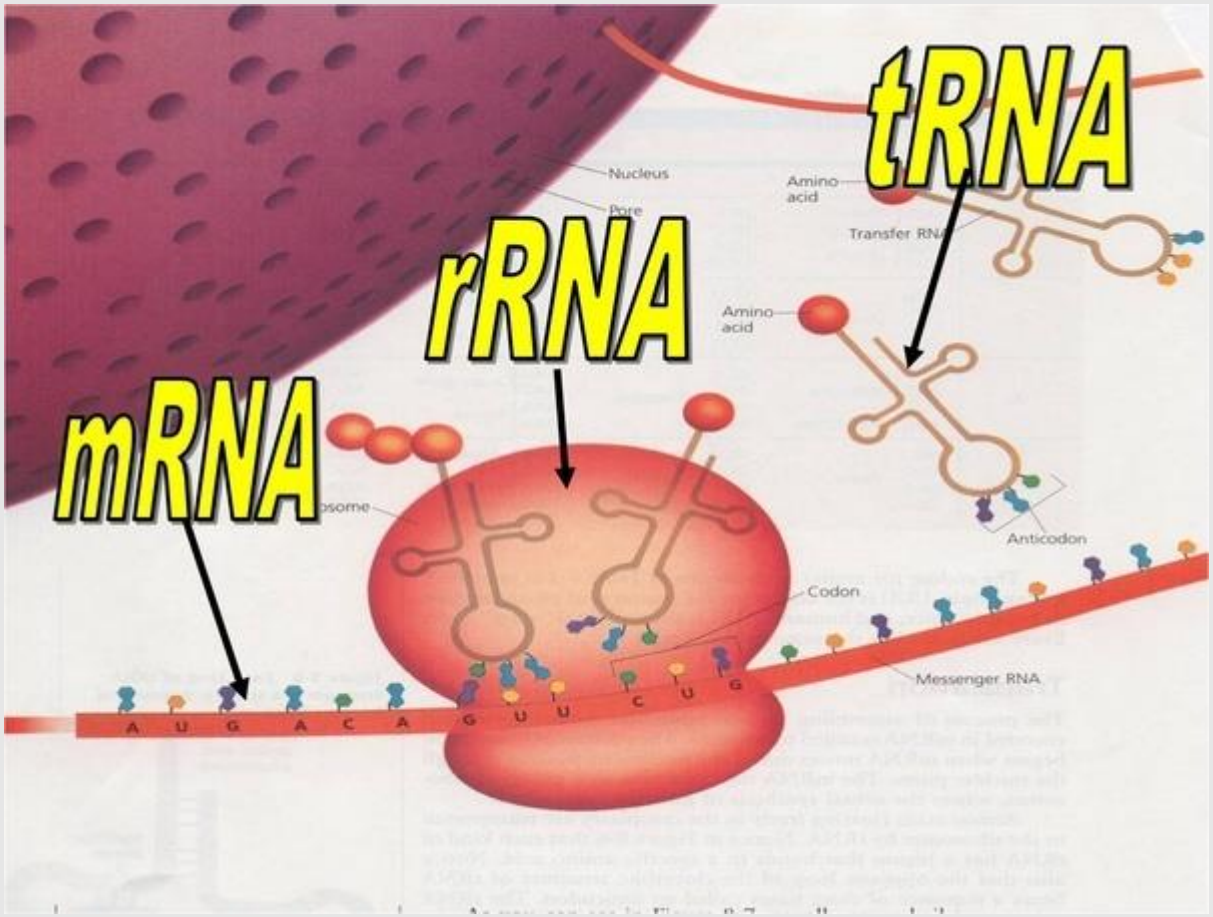


tRNA = carries amino acids to ribosomes




Protein grows out of ribosome
Amino acids are bonded together
Amino acid separates from tRNA
AA 6
AA 6
AA 12
AA 7
tRNA
C U U
C U U
G U A
U U U
AUG
GAA
GAA
CAU
AAA
UAA
Start codon
Ribosome
mRNA
Stop codon

rRNA = make up ribosomes



DNA vs RNA

- Involved in heredity and protein synthesis
- Made of nucleotides
- Deoxyribose sugar
- ATCG

- Involved in protein synthsis
- Made of nucleotides
- Ribose sugar
- AUCG

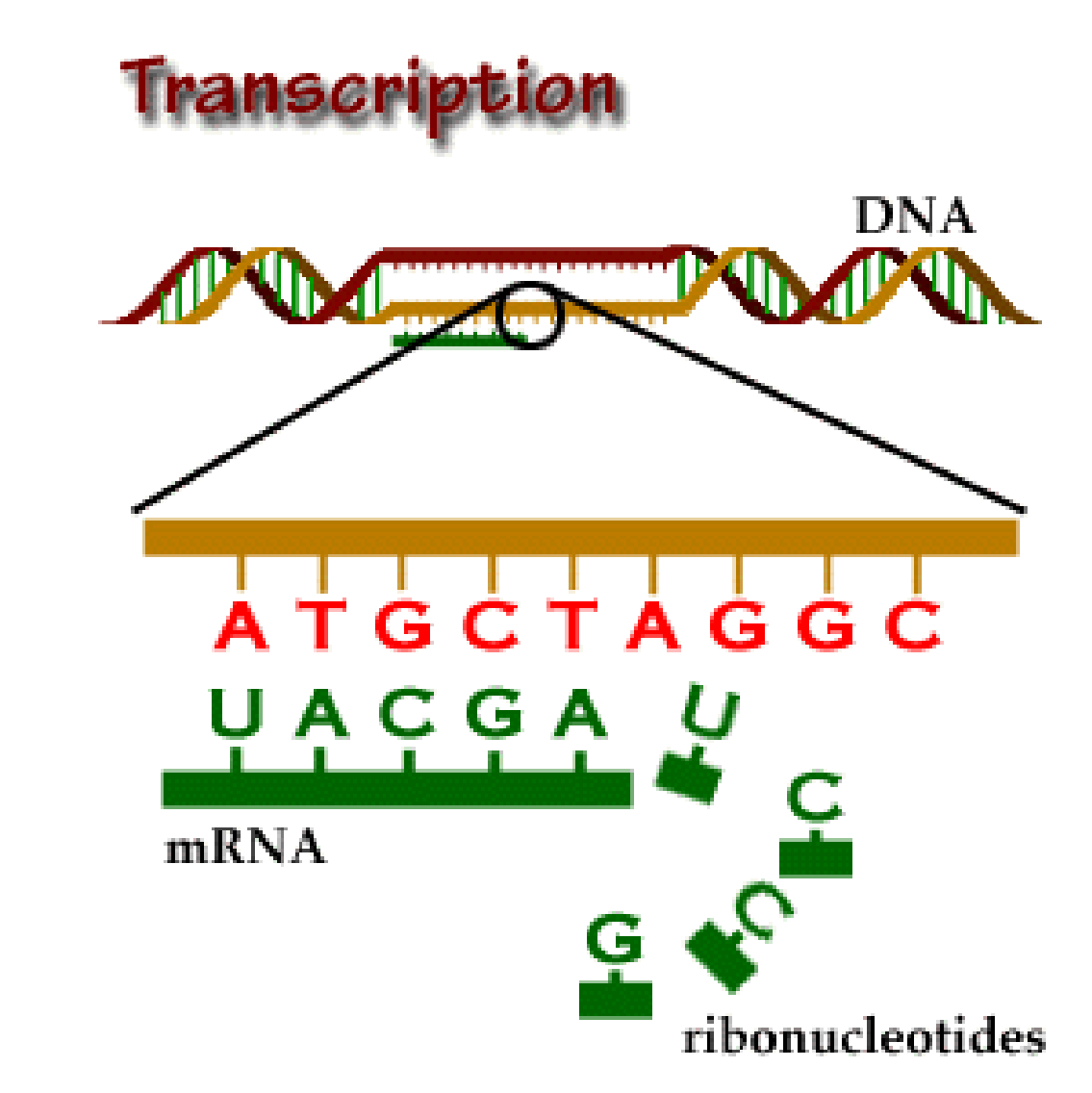
Protein Synthesis Step 1 = <u>Transcription</u>

- <u>DNA converted to mRNA</u>

·What would be the complementary mRNA strand for the following DNA sequence?

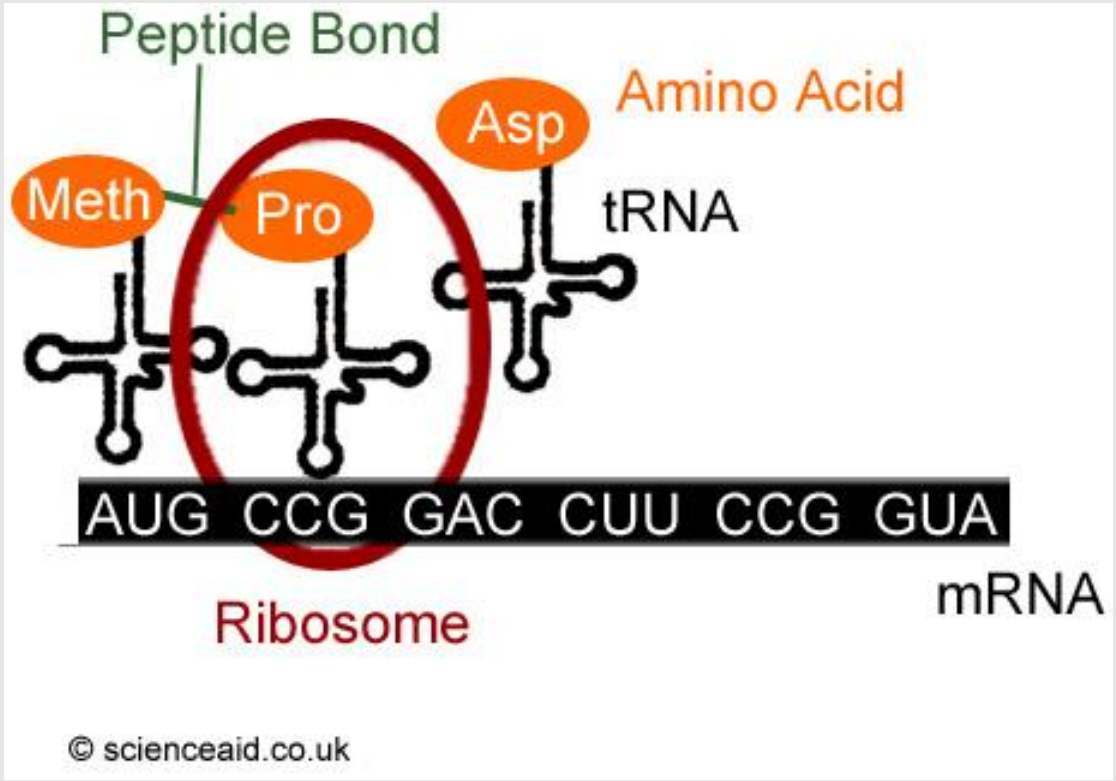
DNA CGTATGAACG

mRNA GCAUACUUGC


Transcription
DNA
A T G C T A G G C
U A C G A U
mRNA
G
C
ribonucleotides

Step 2 = Translation

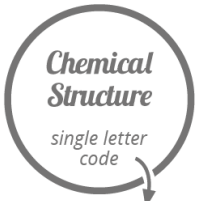
- tRNA carries amino acids to the mRNA
- 3 bases = 1 codon
- 1 codon → 1 amino acid



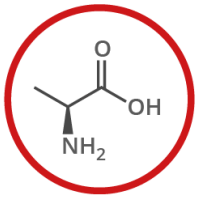
A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.

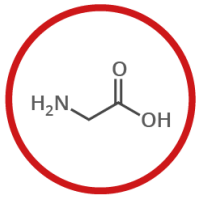
Chart Key: ALIPHATIC · AROMATIC · ACIDIC · BASIC · HYDROXYLIC · SULFUR-CONTAINING · AMIDIC · NON-ESSENTIAL · ESSENTIAL



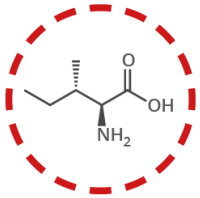
NAME (A)
three letter code
DNA codons



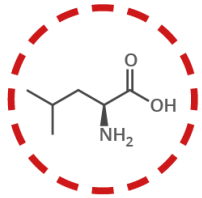
ALANINE (A)
Ala
GCT, GCC, GCA, GCG



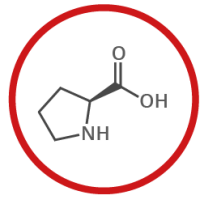
GLYCINE (G)
Gly
GGT, GGC, GGA, GGG



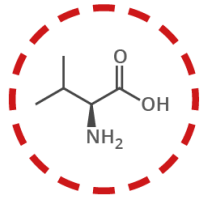
ISOLEUCINE (I)
Ile
ATT, ATC, ATA



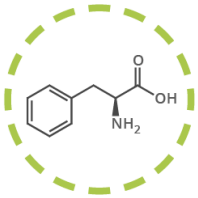
LEUCINE (L)
Leu
CTT, CTC, CTA, CTG, TTA, TTG



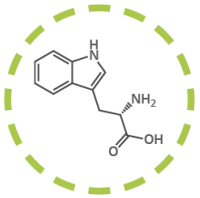
PROLINE (P)
Pro
CCT, CCC, CCA, CCG



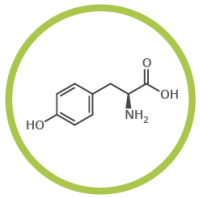
VALINE (V)
Val
GTT, GTC, GTA, GTG



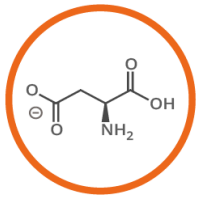
PHENYLALANINE (F)
Phe
TTT, TTC



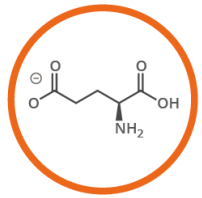
TRYPTOPHAN (W)
Trp
TGG



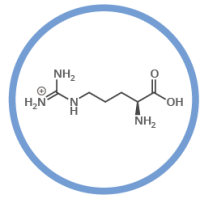
TYROSINE (Y)
Tyr
TAT, TAC



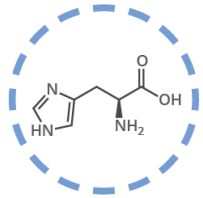
ASPARTIC ACID (D)
Asp
GAT, GAC



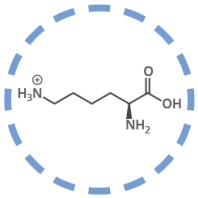
GLUTAMIC ACID (E)
Glu
GAA, GAG



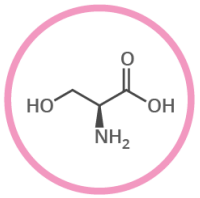
ARGININE (R)
Arg
CGT, CGC, CGA, CGG, AGA, AGG



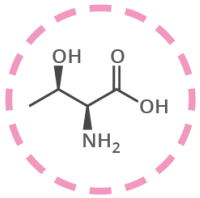
HISTIDINE (H)
His
CAT, CAC



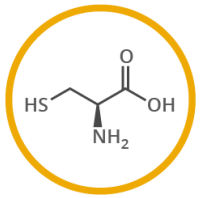
LYSINE (K)
Lys
AAA, AAG



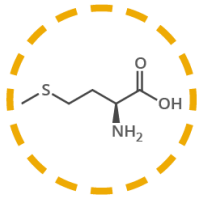
SERINE (S)
Ser
TCT, TCC, TCA, TCG, AGT, AGC



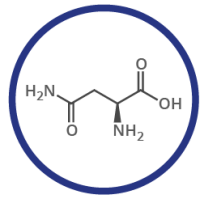
THREONINE (T)
Thr
ACT, ACC, ACA, ACG



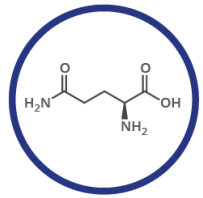
CYSTEINE (C)
Cys
TGT, TGC



METHIONINE (M)
Met
ATG



ASPARAGINE (N)
Asn
AAT, AAC



GLUTAMINE (Q)
Gln
CAA, CAG

Note: This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.

Making Proteins

- Sequence of DNA bases →
- Sequence of amino acids in proteins →
- Specific shape →
- Protein function

Lots of different types of proteins

- **<u>Examples:</u>**
- Enzymes
  - Speed up chemical reactions (control cell function)
- Structural proteins
  - Ex: hemoglobin in red blood cells, muscles made of proteins…
- Chemical messengers (Hormones)
- Antibodies = proteins made by white blood cells

DNA mutations = change in DNA

- Mutations in genes sometimes →
- Wrong amino acid → wrong shape → protein won't work

Causes of Mutations

- Random changes
- Caused by toxins & radiation
- Some mutations → <u>cancer = uncontrolled cell division</u>

Knowledge of Genetics →

- Medical advances
  - Diagnose and treat disease, develop new medicines and vaccines
- Advances in Agriculture
  - Develop new varieties of plants for agriculture
- Created many ethical questions

Genetic Engineering

GMO's

Genetically Modified Organisms

GENETICALLY MODIFIED ORGANISM

Biotechnology

http://www.cnq.ca/Storage.asp?StorageID=88800&SiteLanguageID=1

Knowledge of Genetics →

- Medical advances
  - Diagnose and treat disease, develop new medicines and vaccines

- Changes in agriculture
  - Develop new varieties of plants for agriculture

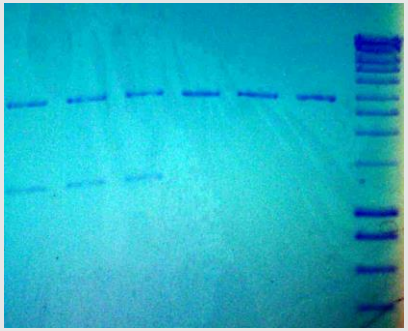
3 Lab Techniques

- Electrophoresis
- PCR
- Genetic engineering

All require use of Restriction enzymes

- Enzymes cut DNA → fragments
- Enzymes are very specific
- Different enzymes → different fragments

Gel Electrophoresis

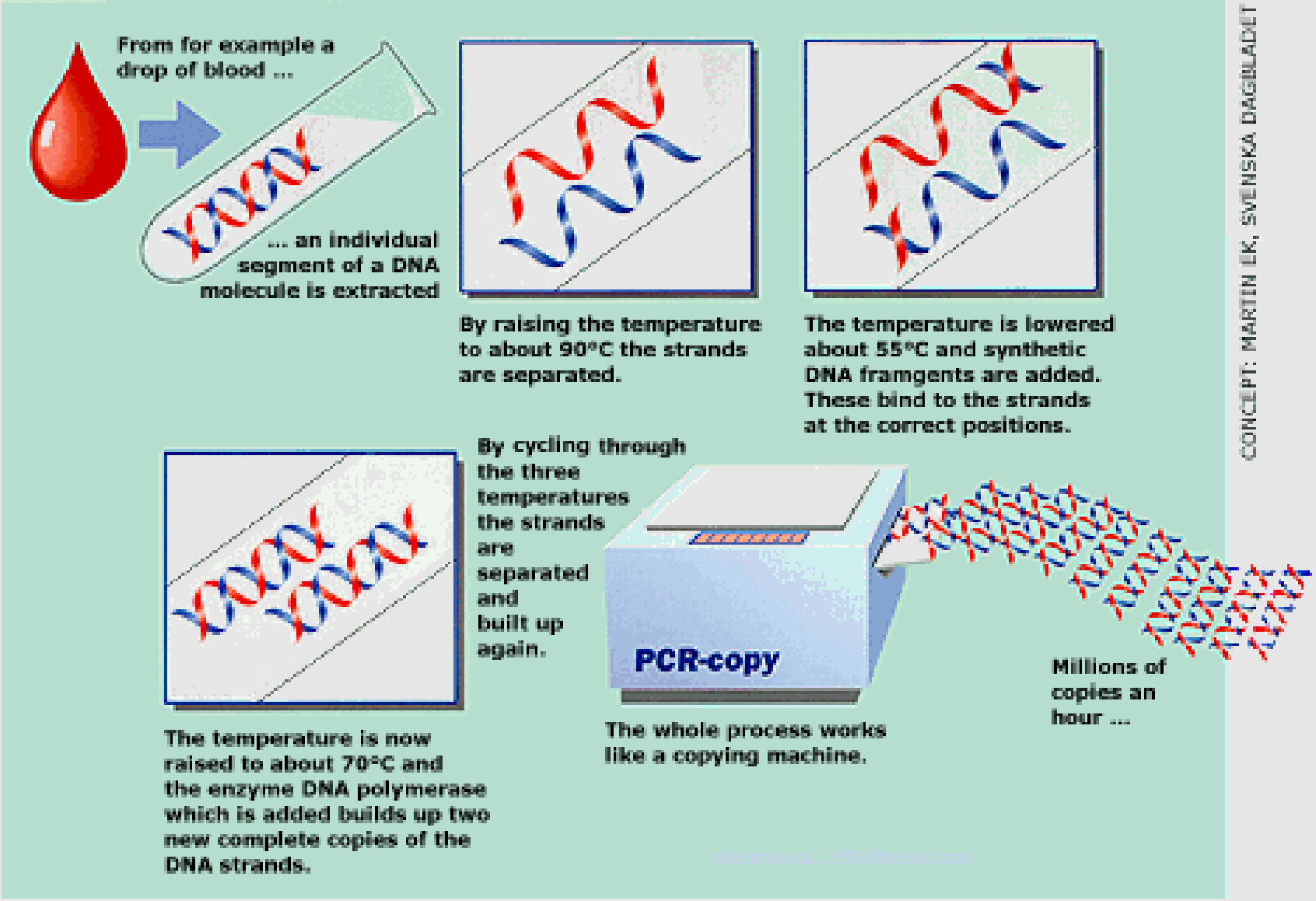


- Electricity → separates DNA fragments
- → banding patterns
- Most similar banding patterns = most closely related
- Used to:
  - Determine evolutionary relationships
  - Diagnose disease
  - Solve crimes
  - Paternity testing

PCR

- Polymerase chain reaction
- Makes lots of copies of DNA
- Replication
- Useful for crime scene evidence
- Might allow us to make lots of copies of DNA from extinct species (ex: wooly mammoth)

PCR


From for example a drop of blood ...
... an individual segment of a DNA molecule is extracted
By raising the temperature to about 90°C the strands are separated.
The temperature is lowered about 55°C and synthetic DNA framgents are added. These bind to the strands at the correct positions.
By cycling through the three temperatures the strands are separated and built up again.
PCR-copy
Millions of copies an hour ...
The temperature is now raised to about 70°C and the enzyme DNA polymerase which is added builds up two new complete copies of the DNA strands.
The whole process works like a copying machine.
CONCEPT: MARTIN EK, SVENSKA DAGBLADET
nobelprize.org/.../1993/illpres/pcr.html

Genetic Engineering

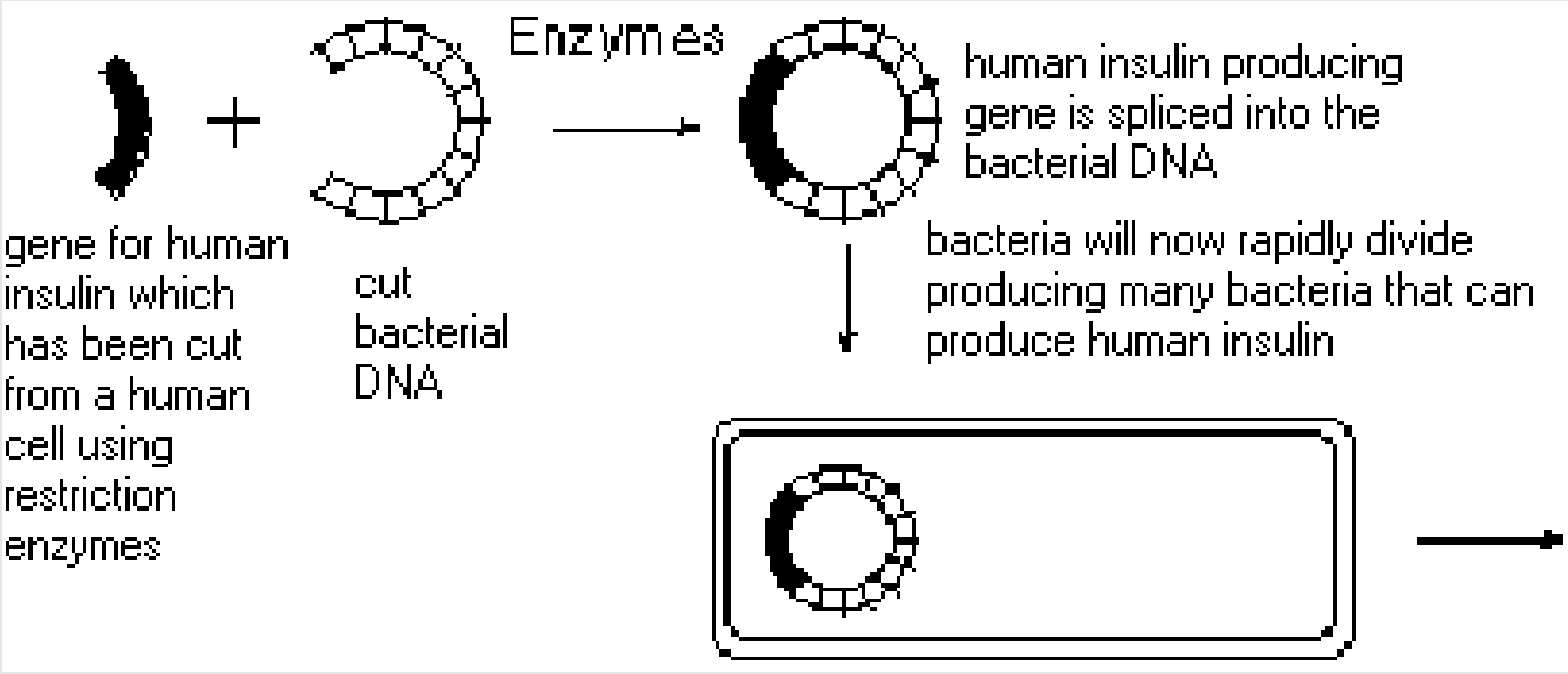
- Genes = pieces of DNA→ traits

- Genetic engineering = Genes transferred from one organism to another
  - → transgenic organisms

Example:

- Cut out human insulin gene with restriction enzymes
- Open bacterial DNA with same enzymes
- Insert human insulin gene into bacterial chromosome
- New bacteria can make human

Genetic engineering → <u>new traits</u>



Pros and cons of genetic engineering

PROS:

- New medicines
- → pest and drought resistant crops
- → more nutritious

CONS:

- Might → human health effects (ex: cause allergies)
- Can harm native plant and animal species
- Expensive to

Technical problem

- Inserting a gene is one thing getting it to be expressed is another.

At harvest time Ted's ethical objections to the use of frog genes in potato breeding were conveniently forgotten.

Genetic Engineering

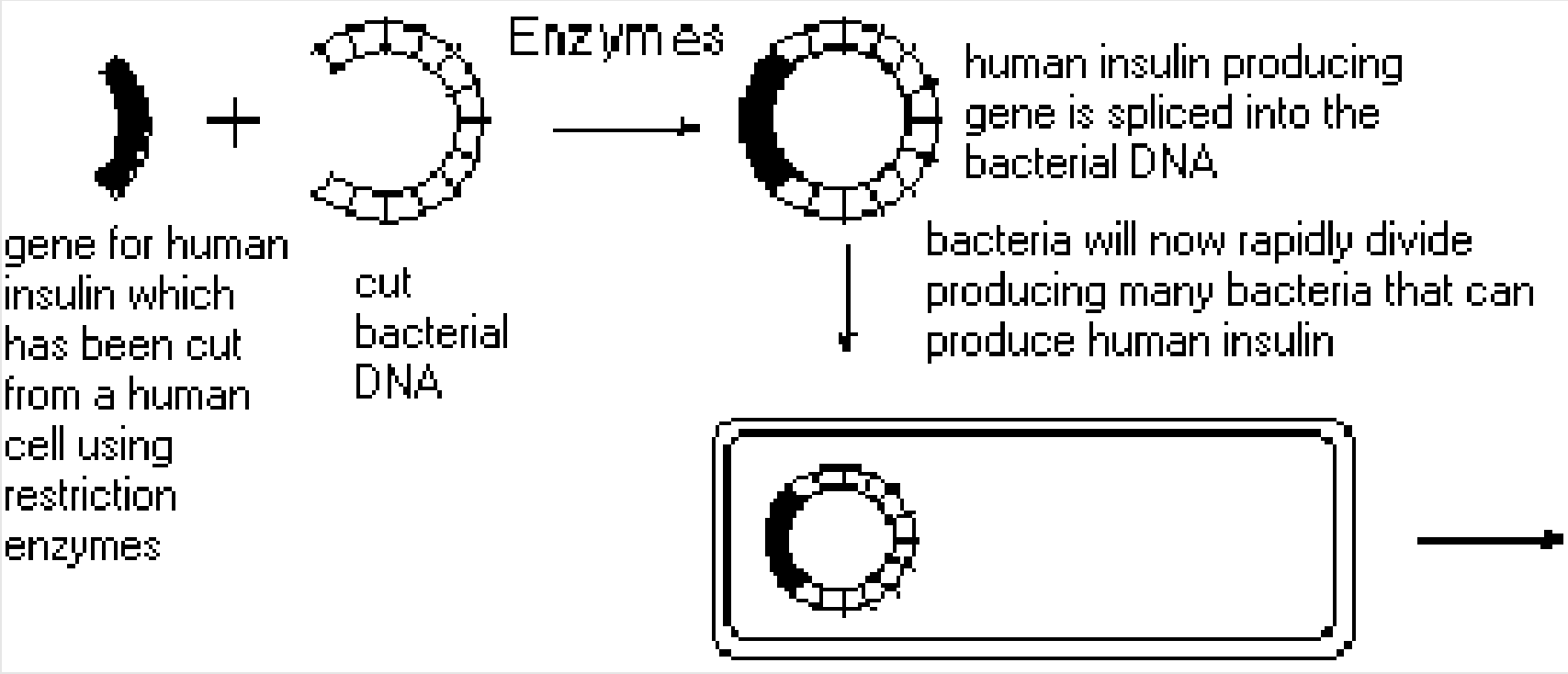
- Genes = pieces of DNA→ traits

- Genetic engineering = scientists transfer genes from one organism to another
  → Transgenic organisms (GMOs)

Example:

- Cut out human insulin gene with restriction enzymes
- Open bacterial DNA with same enzymes
- Insert human insulin gene into bacterial chromosome
- New bacteria can make human insulin

Genetic engineering → <u>new traits</u>



Transgenic Mice

Pros and cons of genetic engineering

PROS:

- New medicines
- → pest and drought resistant crops
- → more nutritious foods

CONS:

- GMOs might → might cause allergies or harm humans
- Can harm native plant and animal species
- Expensive to develop
- Ethical concerns

Technical problem

- Inserting a gene is one thing getting it to be expressed is another.

- Genetically modified organisms → new and different traits

At harvest time Ted's ethical objections to the use of frog genes in potato breeding were conveniently forgotten.

Step 1 Transcription

DNA Nucleotide	Complementary nucleotide in RNA
G	
C	
T	
A	

Start the Hemoglobin Lab

Hemoglobin Lab Background

- Hemoglobin =
  - Protein in red blood cells
  - Carries oxygen
- Proteins are made of amino acids
- Protein synthesis occurs in the ribosomes
- DNA contains the information for making proteins
- The instructions for making proteins are found in the nucleus