

Topics

geroncs

DNA, gene. protein.

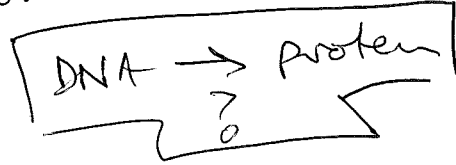
History

* structure. & .

Rephreat.

Cenove

central concept - \rightarrow flow of information.



große & kleine

rRNA, mRNA

Forme MARKET

amino
acids
bases
etc.

Label exercise

Trosperph & Trosperph

Dictionery

Translation . (2nd) exercise .

Transcript (1st).

Temple & Tree.

INTRONS & EXONS. (coding / non coding)

Trendelenburg

tRNA

Trephane process .

rotlung

Pointing
structural
Mutation - types: $\left. \begin{array}{l} \text{substitution} \\ \text{deletion} \end{array} \right\} \text{more dang.}$

Discrete example ✓

Part I

①

Genomics

OMICS

} "whole" }

~~DNA~~ DNA / genetic material.
genes
functions
interaction with other parts
expression of body etc

Genetics — individual genes &
passing bet. gen. (inherit.).
↳ eg track a single gene.

Many diseases involve many genes etc.
some single gene.

DNA (of genes etc).

~~Nucleus~~

* Nucleus

↑
Ribosomes:
assemble
proteins

Also: mitochondrial
DNA.

From mother

(trading lineage).
→ see also Y-chrom. for patriline.

Separate origin
derived from
bacteria engulfed
by ana. of
eukary. cells?

Why? Not entirely known.
accident?

Male XY
Female XX.

DNA history

1953 1962

Other notes

DNA

Deoxyribo Nucleic Acid

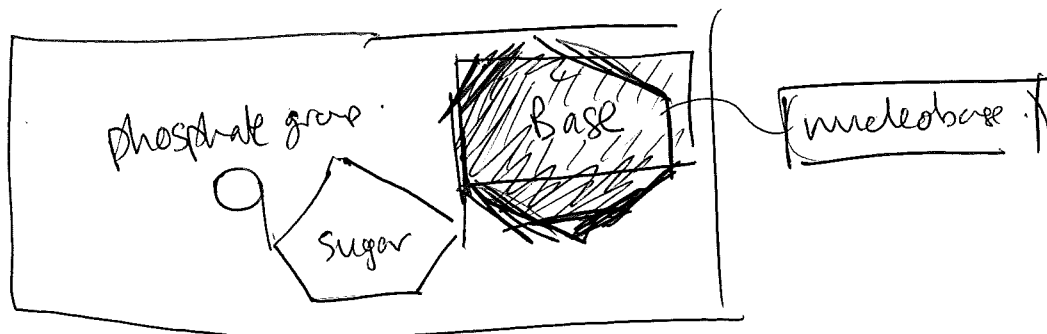
6.5 Bill. base
pairs of DNA
in a cell.

Polymers: large molecules made
up of smaller units
many parts.
monomers
one part

DNA molecule / polymer / chain.
made of
nucleotide monomers

DNA: string of letters → nucleotide
A C G T

Nucleotide: nitrogenous base → varies
+ 5-carbon sugar (deoxy...)
+ phosphate groups (acid...)



Central dogma

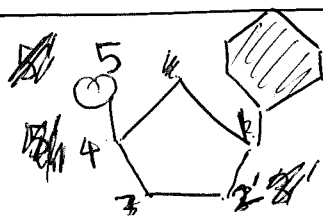
DNA → RNA → Protein

46
Chromosomes

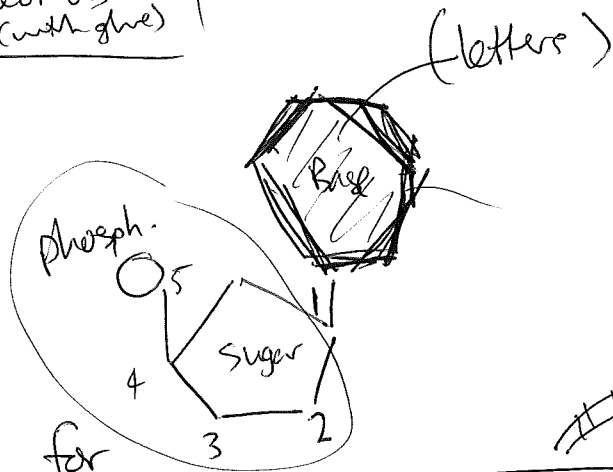
1000
genes

~~genes~~
DNA

Atoms → molecules



DNA: string of letters
Letters: Nucleotides.
(with glue)



multiple nitrogen atoms.

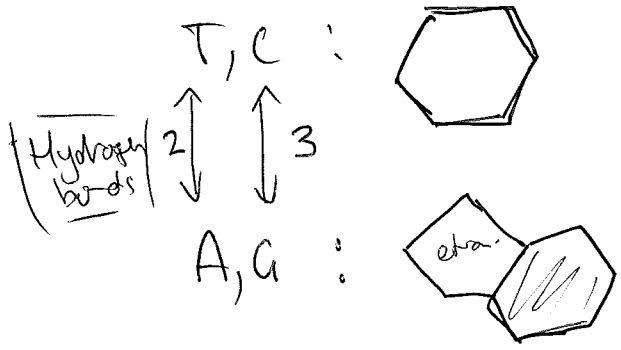
for 'sticking' → Sugar-phosphate backbone.
covalent → molecule is strong of electrons.

Bases (letters): A } nucleotides (overall).
C }
G }
T }

ATC: ~~ATC~~

For { Adenine } Bases
Thymine }
Guanine }
Cytosine }

TA, AC.



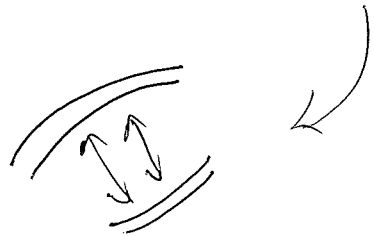
Base Pairs

For pairing opposite.

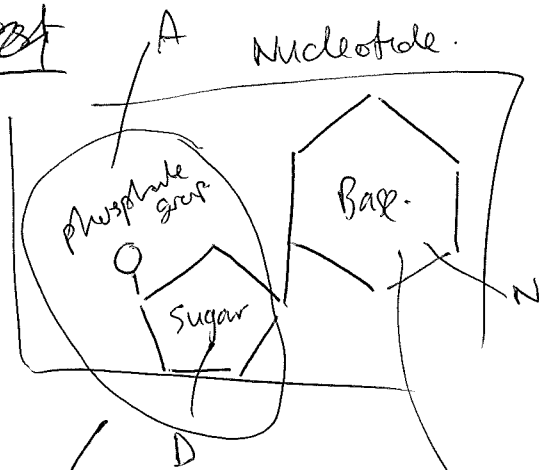
Hydrogen

Weak bond based on electrostatic forces

% A ~ % T
% C ~ % G



Test



unit : nucleotide

"monomer"

↓ ↓
one part.

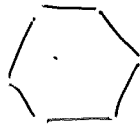
Sticking

Letters

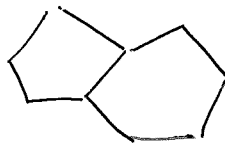
4 types

A C G T

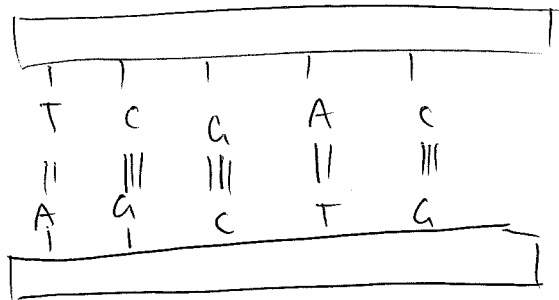
T, C :
2 ↑ 3 ↑
↓ ↓
A G



TA GC



→



sugar phos back.

→

Chromosomes:

DNA → 2 strands → one chromosome.

(one chromosome
mother
one chromosome
father } pair

(combine & express: det. genetic intent.)

"homologs"
Same
shape & size.

Same general
purpose but
diff. details.

(22 + X + (X or Y))

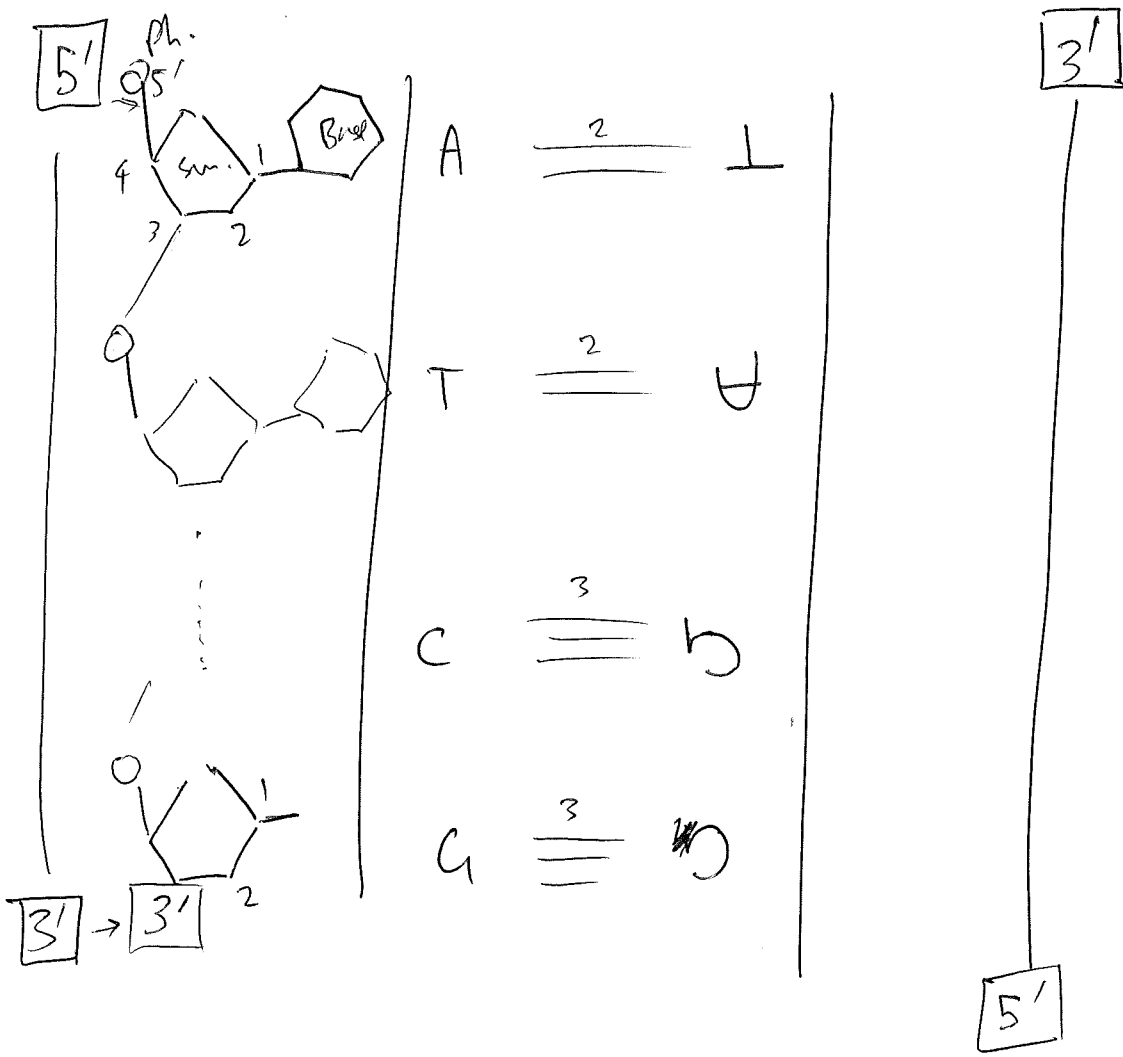
Reproduction! info store.

1 chromosome → split
↓
Duplicate.

DNA
polymerase
enzyme!

During (reproduction)

Antiparallel



why?
can understand themselves!
low energy state

Twist up: Helix (x2)

Double Helix

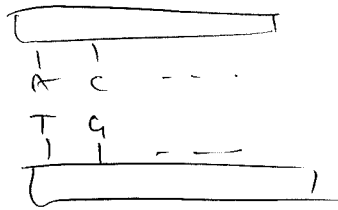
→ gives "Chromosomes"

↳ 2 DNA squares twisted up

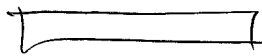
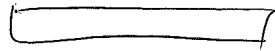
cells

More pairing... : 22 copies of "body" chromosomes → 44
2 individual "sex" chromosomes (Total: 46)

DNA strand
DNA strand



Type 1 / x2.
23 of these
pairs.

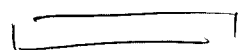
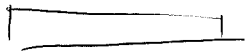
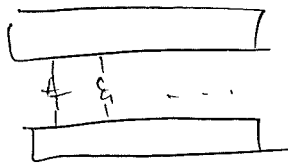


Type 2.

⋮

21/22.

Chromosome
(Type I)



Type 1

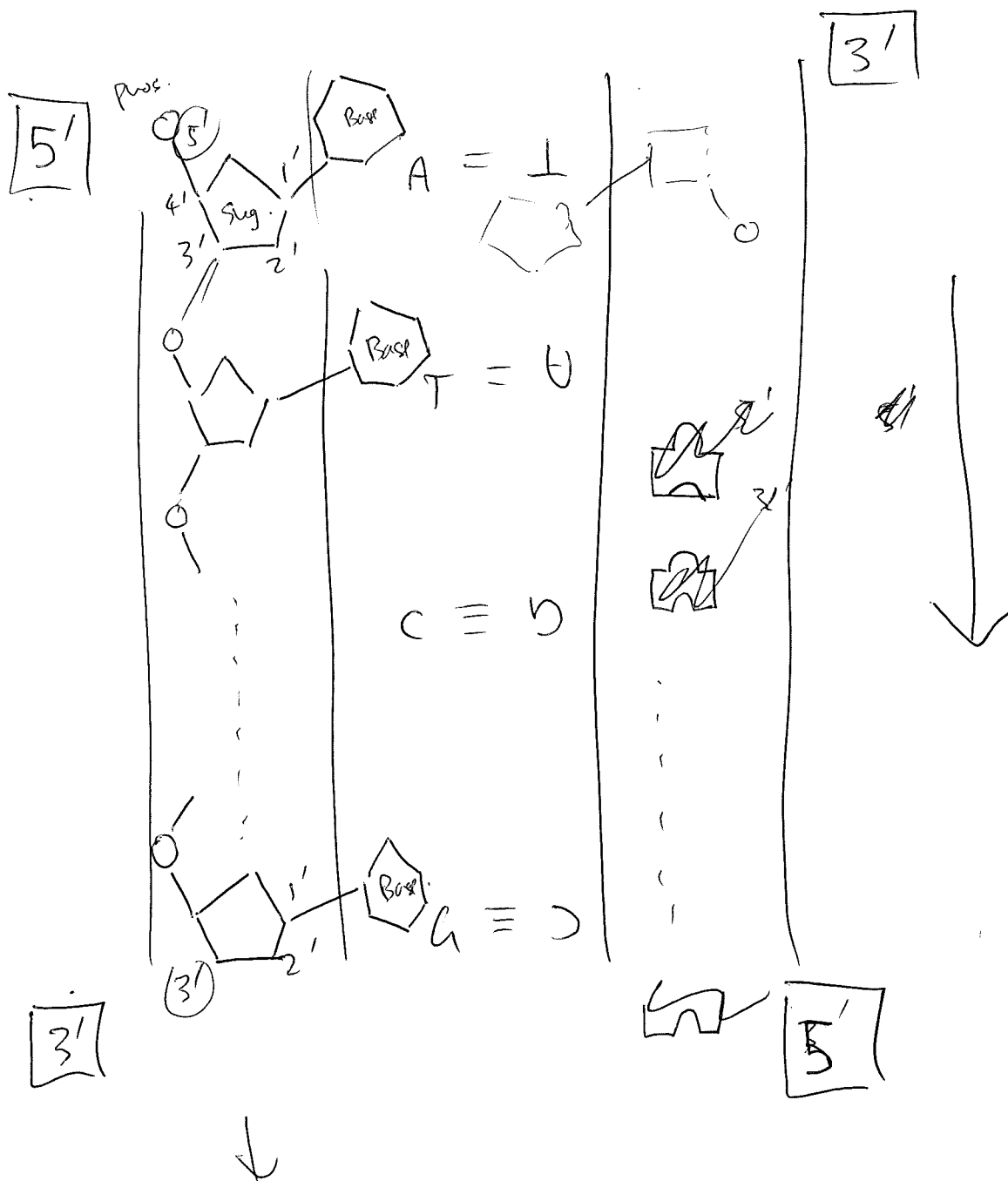
Father

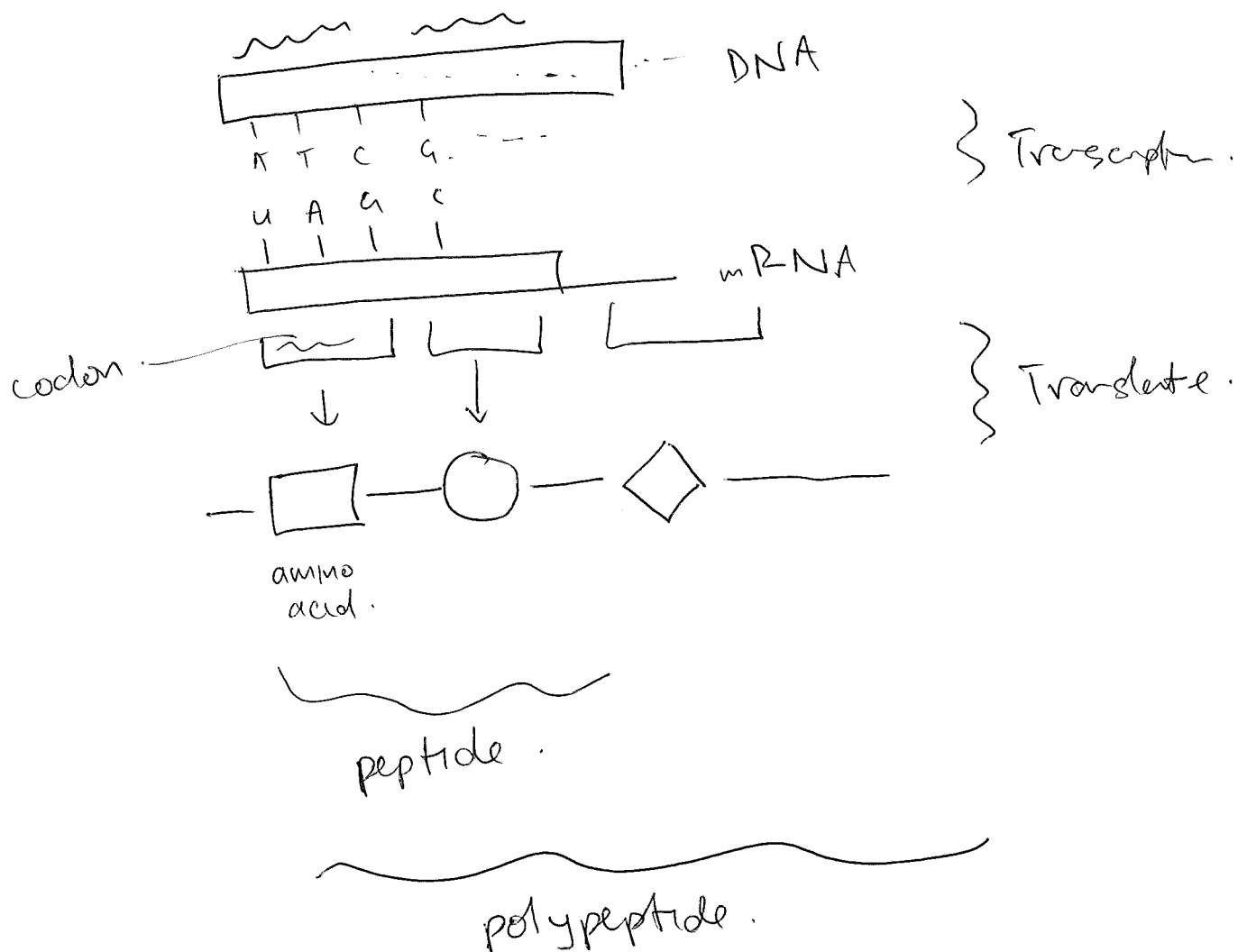
Type 1

Mother

23 pairs

= 46





genetic → organism

genotype

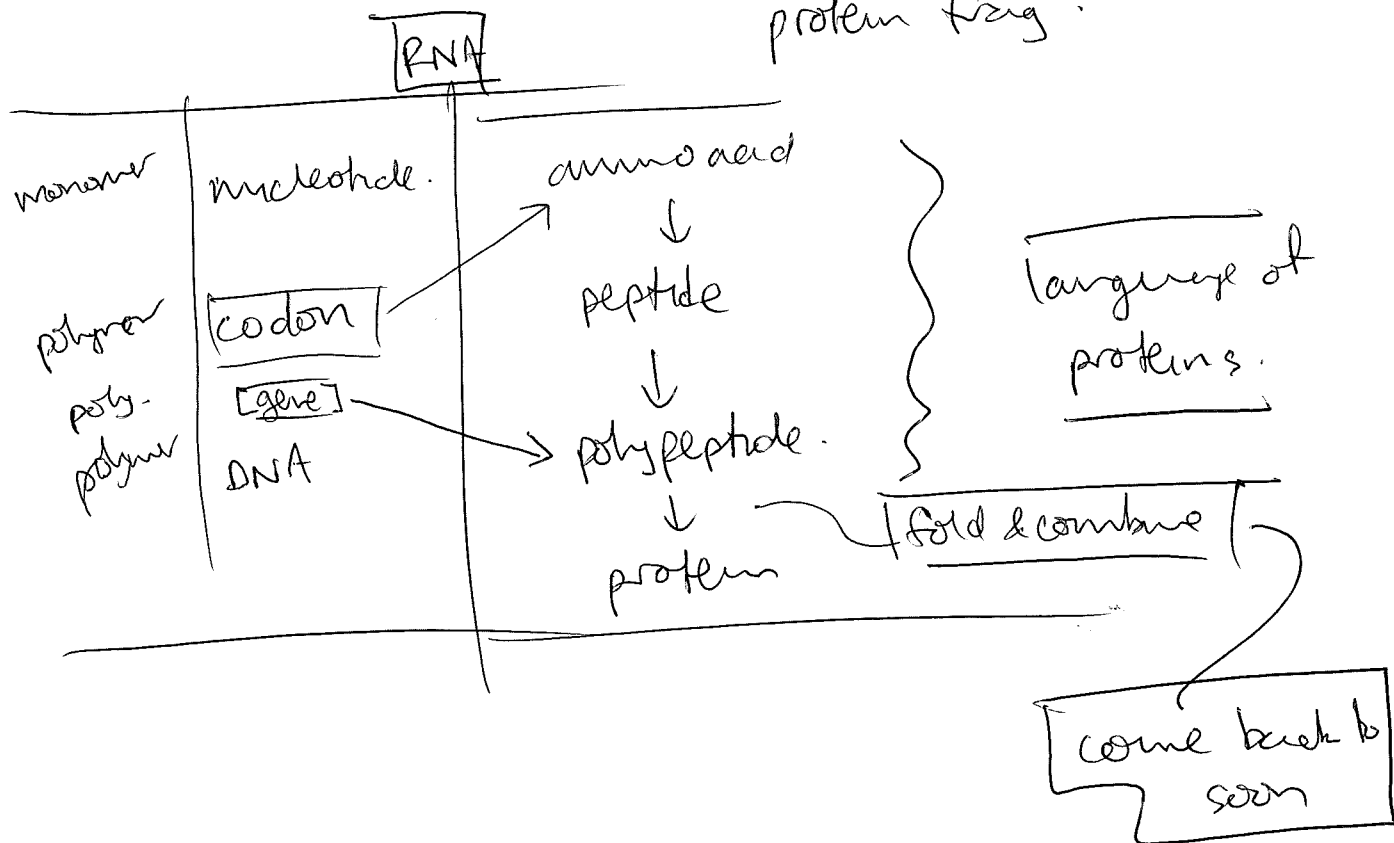
~~~~~> **phenotype**

pheno: "to show"  
 observable  
 interact with  
 environment

geno:  
 "kind", "one",  
 offspring...

genes: sentences coding for  
~~water gap~~ poly peptides

↑  
 protein frag.



1992

DNA: nucleus

Proteins: made on ribosomes (in cytoplasm)

Solutes: RNA. (<sup>esp.</sup> messenger RNA: mRNA)Two steps① Copy to RNA: transcribe transcription② Translate to protein language: translate translation.RNA: similar to DNA• replace deoxyribose sugar with ribose sugarRNA vs DNA.• replace Base ~~the~~ T with U

|    |      |
|----|------|
| TA | GC   |
| vs |      |
| U  | A GC |

also • typically single-stranded (though often folds on itself)

• multiple forms/uses/stages

|      |                                |
|------|--------------------------------|
| mRNA | ← message (for proteins)       |
| tRNA | ← transfer (helps build later) |
| rRNA | ← ribosome.                    |

Sugar  
+  
nucleobase  
+  
phosph.

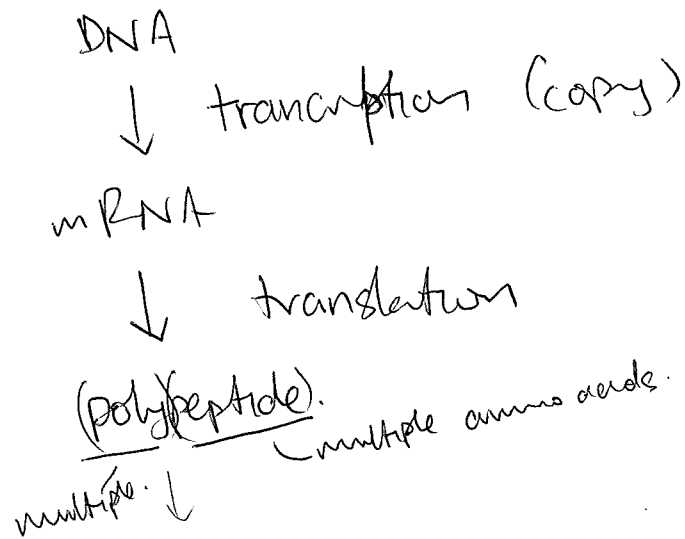
## Base pairing

(3)

|     | (pair) | (pair) |
|-----|--------|--------|
| DNA | DNA    | RNA    |
| T   | A      | A      |
| A   | T      | U      |
| G   | C      | C      |
| C   | G      | G      |

|       |       |
|-------|-------|
| T → A | G → C |
| U → A | C → G |

## Diagram



multiple (multiple letters)  
 multiple (words)  
 sentence.

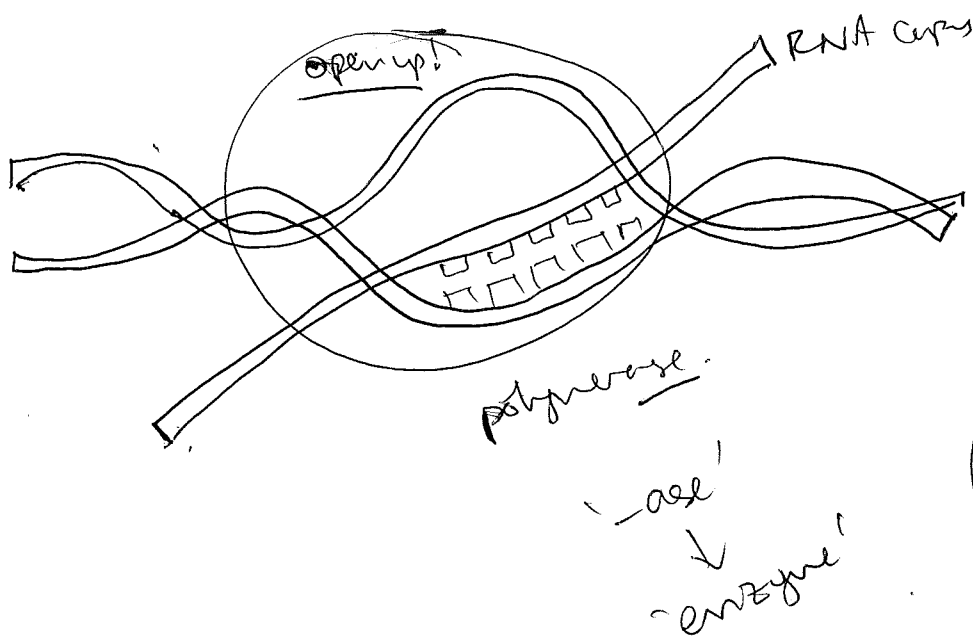
Codon : { triplets of DNA  
triplets of RNA } equiv.

(4)

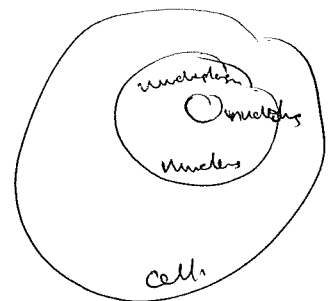
| DNA |   | RNA |   | AA |
|-----|---|-----|---|----|
| ACG | → | ACG | → | □  |
| TAA | → | UAA | → | ○  |

CDNAS  
genetic language  
to  
protein language  
(AA)  
via  
RNA & codons

[ Copy DNA during replication : DNA polymerase ] enzymes!  
[ Copy DNA to RNA : RNA polymerase ] enzymes!  
during transcription



(in Nucleus)



letters & strings of letters

(5).

"Inbetween state" ?

→ words !

Triplets

Q: what do we want to say ?

Amino acids & Proteins

Triplets, Amino acids, Proteins  
genes.

DNA letters  
(nucleotides)  
(4) → triplets  
(words)  
Codons. → amino acids → proteins  
(20).

Genetic code:

convert sequence  
of letters  
in DNA

Codons  
triplets

sequence of  
amino  
acids  
in proteins

ACGT

20 AAs.

# Dictionary.

5

64 possible triplets

20 amino acids

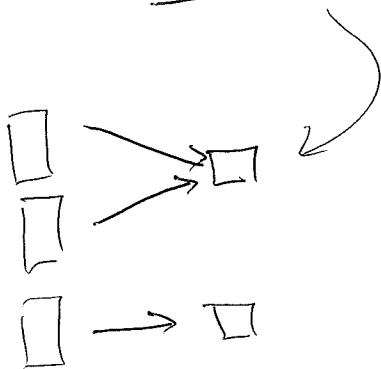
~~20~~

+ start

+ 3x stop.

|   |   |   |
|---|---|---|
| T | A | A |
| A | T | U |
| G | C | C |
| C | G | G |

Redundancy!



more fault tolerant?

AUG : start.

UAG, UAA, UGA : stop.

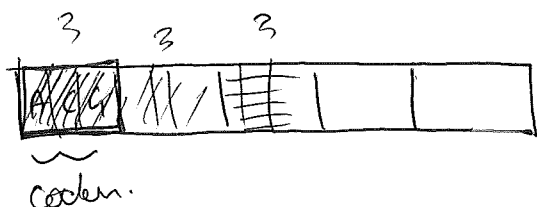
U(A G), U(G A), U(A A)



# Part II

6.

DNA  $\xrightarrow{?}$  Protein

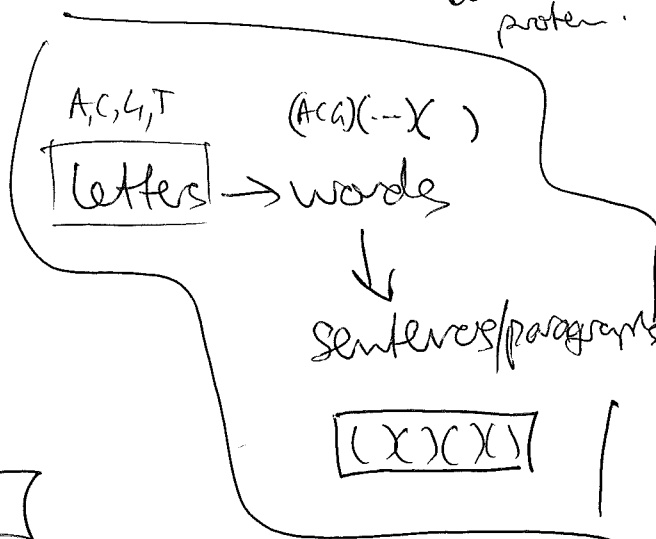


Gene.



gene : sentence.

polypep part or whole of protein.



Amino acids!  
the other great  
"polymer language"

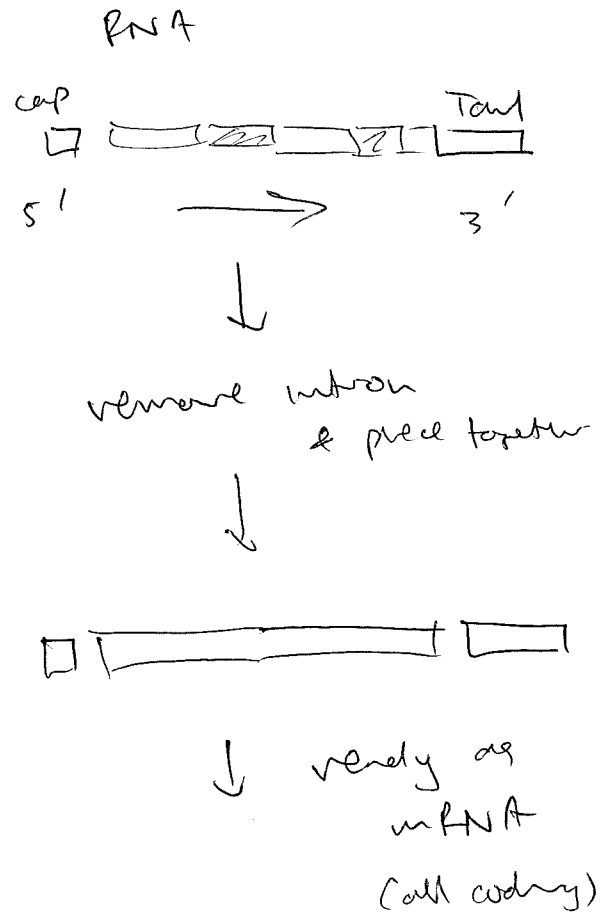
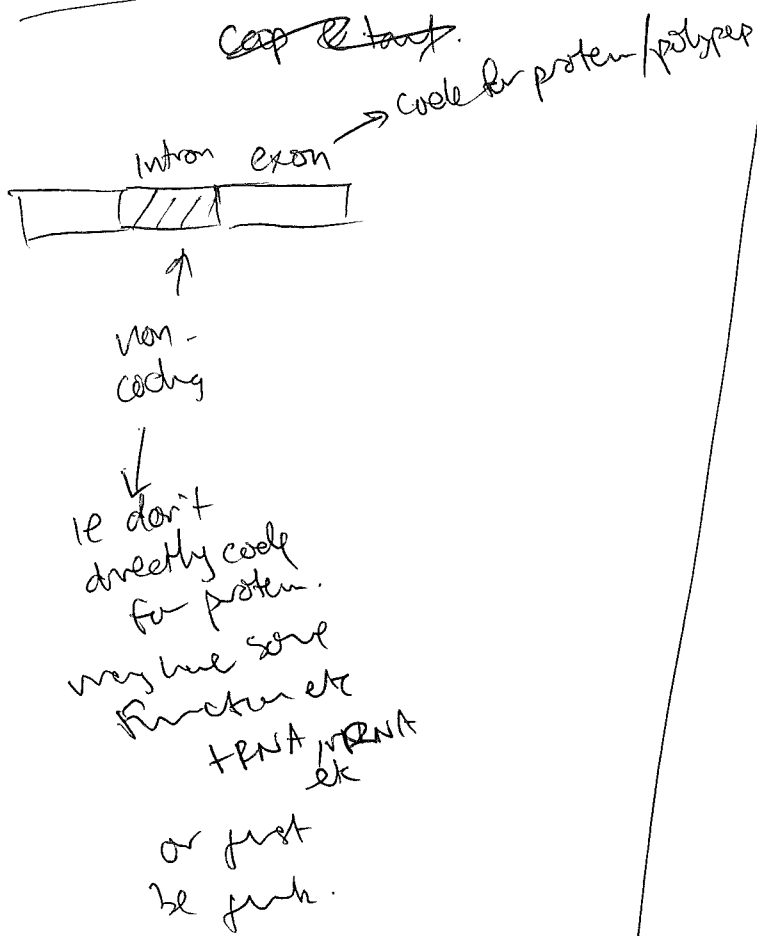
$\alpha$ -helix  
 $\beta$  strand.

Nucleotides  
Base : letter  
Codon/Triplet : word  
Gene : sentences

{ Amino acid } letter  
 $\downarrow$   
{ peptide } word  
 $\downarrow$   
{ polypeptide } sentence  $\rightarrow$  { protein } (sentence/paragraph)

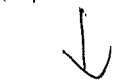
\* Protein : sentence/paragraph. \*

DNA  $\rightarrow$  RNA  $\rightarrow$  mRNA



Genetic language ~~code~~ → Protein ~~code~~ language.

A, C, G, T  
4 letters



Word.



Letters :

Amino acids : 20

$$\boxed{\phantom{0}} = 4$$

$$\boxed{\phantom{0}}\boxed{\phantom{0}} = 16$$

4 x 4

$$\boxed{\phantom{0}}\boxed{\phantom{0}}\boxed{\phantom{0}} = 64$$

4 x 4 x 4

3 genetic letters → 1 amino acid.

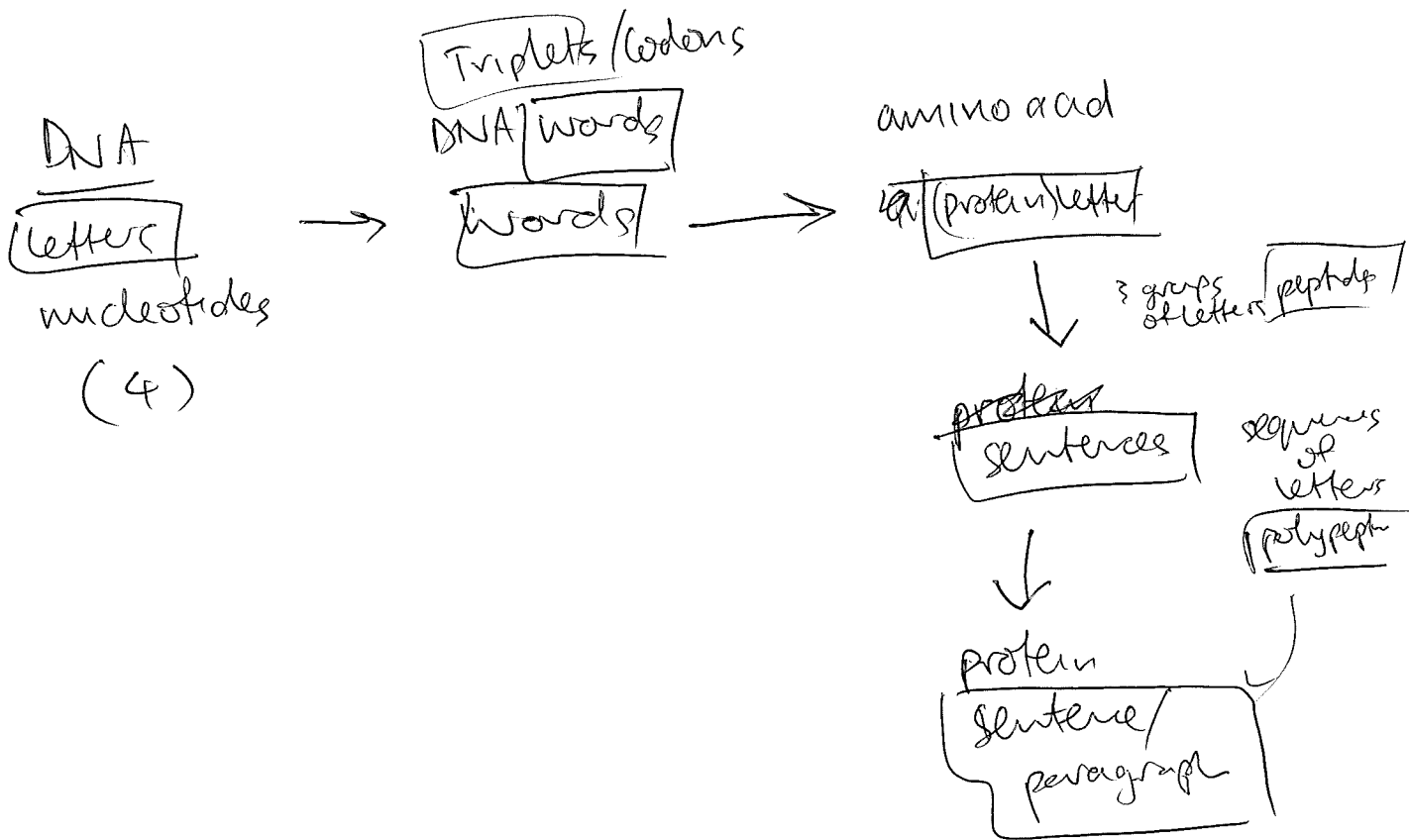
64

20

redundant



3 letters  
= "Codon"



| DNA | DNA Pairs | RNA Pair |
|-----|-----------|----------|
| A   | T         | U        |
| C   | G         | G        |
| G   | C         | C        |
| T   | A         | A        |

~~RT~~

|    |    |
|----|----|
| TA | GC |
| UA | GC |

# Translation

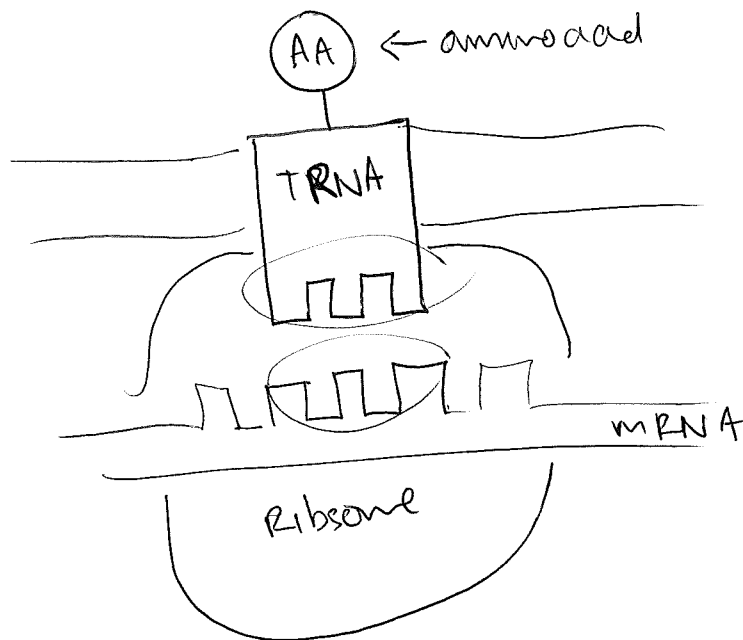
7.

mRNA out of nucleus, in cytoplasm

Want to translate & make a polypeptide / protein!

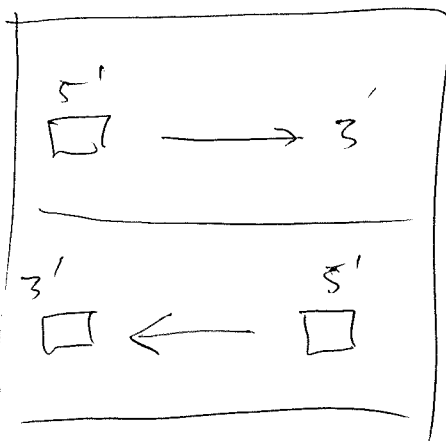
Interpreter : tRNA

(tech. transfer  
not translation  
RNA → )



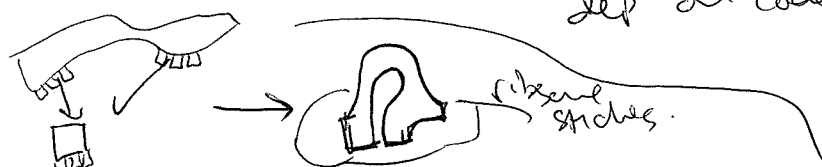
tRNA 'anticodon'  
↑  
mRNA codon  
Same rules

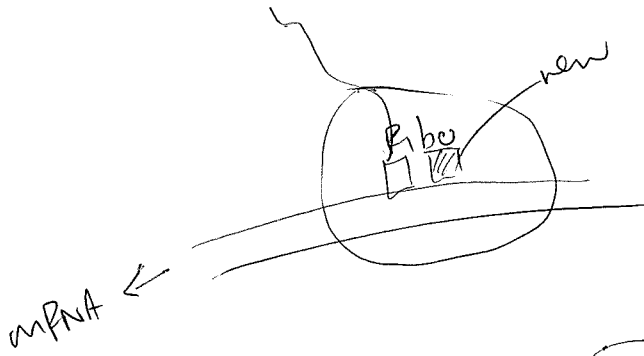
eg  
mRNA : GCC  
tRNA CGC



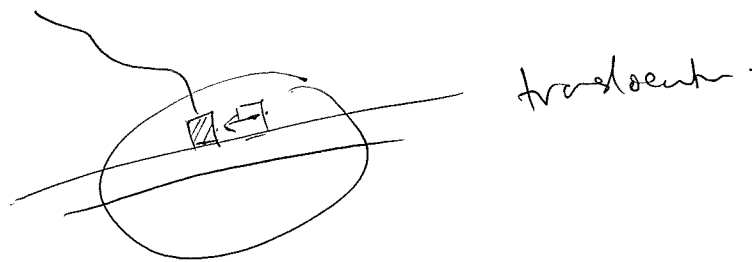
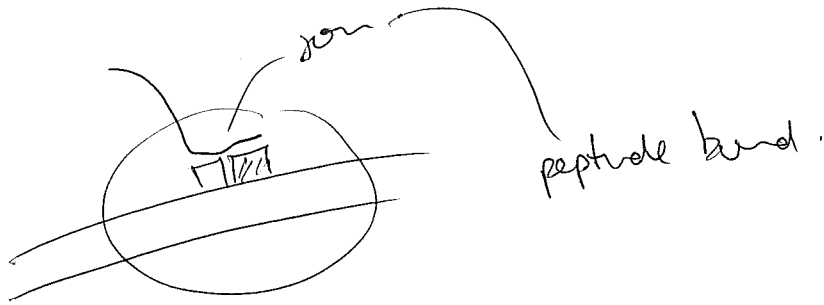
(Just like  
DNA double helix)

Long string needs to use  
dep on code.



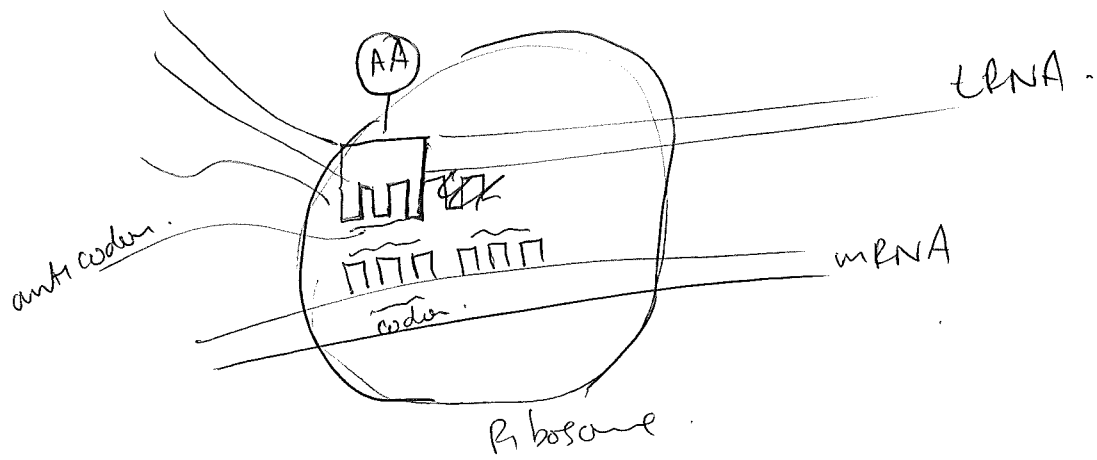


peptide: multiple AA.



"Elongation" → growing polypep./AA chain.





ICGG tRNA

GCC  
mRNA



Protein ?

9.

Almost !

polypeptide chain (long seq. of AA).

---

Now : twist, fold & stretch

to make proper protein

} structure.  
(3D)

---

a) primary structure } long polypep. chain.

↓ b) - secondary } twist & fold

c). tertiary } combination of twists & folds

---

d). Quaternary } stitch together.

---

letters → words → sentences → paragraphs

---

~~AA~~ primary → ~~2~~ secondary → tertiary → quaternary.

# Mutations

Base substitution → "local" effect.

10.

{ Base insertion/deletion → typically more disastrous.  
messes up reading of others → "global" effect.

Inherited!

---

Sickle cell: Base substitution.

~~then~~ Hemoglobin  
↓ inside. } stick together.  
Red blood cells  
↓  
misshapen.

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