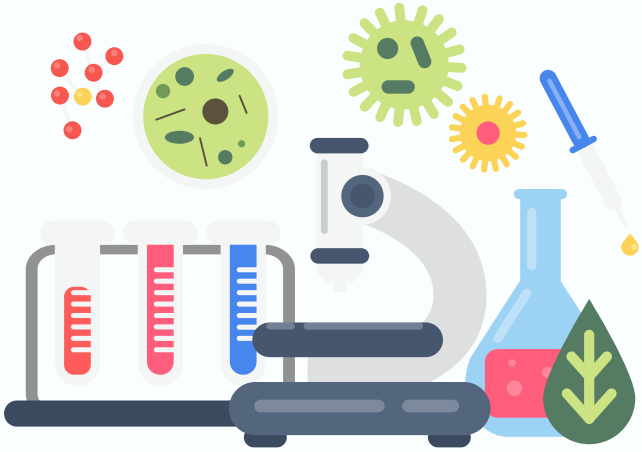
ARISTOTLE UNIVERSITY OF THESSALONIKI

aeth3r

# Activity Book



By iGEM Thessaloniki

A PUZZLE BOOK ABOUT THE GENETIC CODE

# The Amino Acid Code

Secret messages hidden inside proteins

| G | E | N | E | T | I | C | S |
|---|---|---|---|---|---|---|---|
| Gly | Glu | Asn | Glu | Thr | Ile | Cys | Ser |

Each amino acid has a one-letter abbreviation - and those letters spell words. This book turns that coincidence into puzzles.

# The twenty amino acids

Keep this page open while you work. Every puzzle inthe book uses it.

The one-letter code is what you write in the answer boxes.

| NAME | 3-LETTER | 1-LETTER | CODON | NAME | 3-LETTER | 1-LETTER | CODON |
|---|---|---|---|---|---|---|---|
| Alanine | Ala | **A** | GCU | Leucine | Leu | **L** | UUA |
| Arginine | Arg | **R** | CGU | Lysine | Lys | **K** | AAA |
| Asparagine | Asn | **N** | AAU | Methionine | Met | **M** | AUG |
| Aspartic acid | Asp | **D** | GAU | Phenylalanine | Phe | **F** | UUU |
| Cysteine | Cys | **C** | UGU | Proline | Pro | **P** | CCA |
| Glutamic acid | Glu | **E** | GAA | Serine | Ser | **S** | AGU |
| Glutamine | Gln | **Q** | CAA | Threonine | Thr | **T** | ACU |
| Glycine | Gly | **G** | GGA | Tryptophan | Trp | **W** | UGG |
| Histidine | His | **H** | CAU | Tyrosine | Tyr | **Y** | UAU |
| Isoleucine | Ile | **I** | AUU | Valine | Val | **V** | GUU |

**Letters you will never see**

B, J, O, U, X and Z are not standard amino acids - so no puzzle in this book can contain them. Try it: you cannot write JOB, BOX, QUIZ or YOU in protein. You can write LIFE, CELLS and GENES.

PUZZLE 1

# Decode the message

Write the one-letter code for eachamino acid in the box beside it, then copy theletters into the answerstrip at the bottom.

## WORD 1

Isoleucine



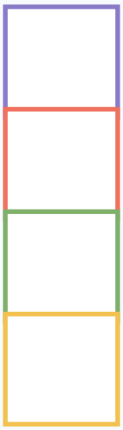
## WORD 2

Leucine

Isoleucine

Lysine

Glutamic acid



## WORD 3

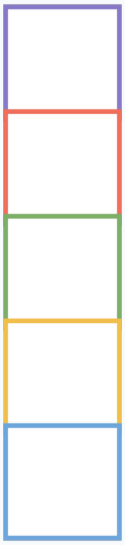
Glycine

Glutamic acid

Asparagine

Glutamic acid

Serine



## THE MESSAGE



PUZZLE 2

# Decode the message

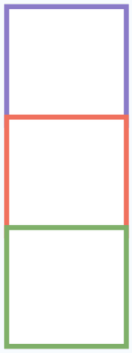
Write the one-letter code for eachamino acid in the box beside it, then copy theletters into the answerstrip at the bottom.

**WORD 1**

Aspartic acid

Asparagine

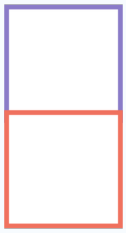
Alanine



**WORD 2**

Isoleucine

Serine



**WORD 3**

Threonine

Histidine

Glutamic acid

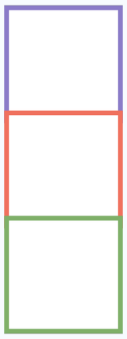


**WORD 4**

Lysine

Glutamic acid

Tyrosine



**THE MESSAGE**



PUZZLE 3

# Decode the message

Write the one-letter code for eachamino acid in the box beside it, then copy theletters into the answerstrip at the bottom.

**WORD 1**

Aspartic acid

Asparagine

Alanine



**WORD 2**

Aspartic acid

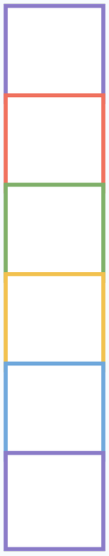
Arginine

Isoleucine

Valine

Glutamic acid

Serine



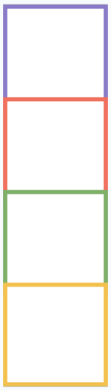
**WORD 3**

Leucine

Isoleucine

Phenylalanine

Glutamic acid



**THE MESSAGE**



PUZZLE 4

# Decode the message

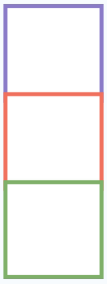
Write the one-letter code for eachamino acid in the box beside it, then copy theletters into the answerstrip at the bottom.

**WORD 1**

Aspartic acid

Asparagine

Alanine



**WORD 2**

Serine

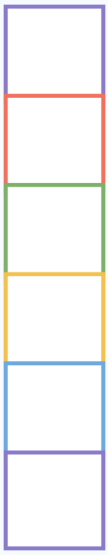
Histidine

Alanine

Proline

Glutamic acid

Serine



**WORD 3**

Threonine

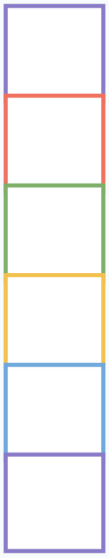
Arginine

Alanine

Isoleucine

Threonine

Serine



**THE MESSAGE**



PUZZLE 5

# Decode the message

Write the one-letter code for eachamino acid in the box beside it, then copy theletters into the answerstrip at the bottom.

**WORD 1**

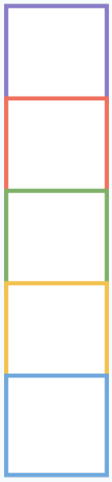
Cysteine

Glutamic acid

Leucine

Leucine

Serine



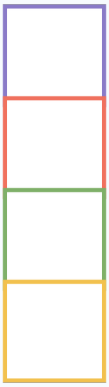
**WORD 2**

Arginine

Glutamic acid

Alanine

Aspartic acid



**WORD 3**

Serine

Isoleucine

Glycine

Asparagine

Alanine

Leucine

Serine



**THE MESSAGE**



PUZZLES 6-8

# Now do it backwards

This time you have the message.Write the fullname of the amino acid that matches each letter.Cover the decoder page if you dare.

PUZZLE 6

| |
|---|
| G |
| E |
| N |
| E |
| S |

PUZZLE 7

| |
|---|
| C |
| E |
| L |
| L |

PUZZLE 8

| |
|---|
| T |
| R |
| A |
| I |
| T |
| S |

PUZZLE 9

# From RNA to meaning

Each groupofthreebases is a codon,andeachcodon names one amino acid.
Use theCODONcolumnof the decoderpage.Three steps: codon, amino acid, letter.

**GAU**
amino acid

**AAU**
amino acid

**GCU**
amino acid

**AUU**
amino acid

**AGU**
amino acid

**ACU**
amino acid

**CAU**
amino acid

**GAA**
amino acid

**AAA**
amino acid

**GAA**
amino acid

**UAU**
amino acid

**Why three?**

Four bases taken one at a time give 4 options - not enough for 20 amino acids. Two at a time give 16, still not enough. Three at a time give 64, which is plenty - so most amino acids have several codons. The decoder page lists only one codon each, to keep these puzzles solvable.

PUZZLE 10

# One letter changes everything

A mutation is a single base swapped for another.Decode each strand below and see what the change did to the message.

### THE ORIGINAL

UUA AUU UUU GAA



*A four-letter word. Decode it first - everything below is a copy of this strand.*

### MUTATION 1 - the last base of codon 1 changed

***UUG*** AUU UUU GAA



*Did the message change at all? This kind of mutation is called silent.*

### MUTATION 2 - the first base of codon 3 changed

UUA AUU ***GUU*** GAA



*One letter of the word is now different. This kind is called missense.*

### MUTATION 3 - a different word, first base of codon 2 changed

GGA ***UAA*** AAU GAA AGU



*UAA is not an amino acid - it is a STOP. The cell stops reading here. Nonsense.*

PUZZLE 11

# Amino acid word search

Ten amino acid names are hidden across,down and diagonally.
Cross each one off the list as you find it.

| F | W | R | F | Y | Y | S | N | F | V | V | F | A | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | T | F | Q | H | L | V | A | L | I | N | E | H | A |
| H | K | H | L | T | E | S | I | W | M | K | V | Q | F |
| I | C | N | R | W | U | T | E | Q | T | F | V | F | T |
| S | T | A | R | G | C | G | Y | R | A | F | G | F | S |
| T | A | Y | E | V | I | L | C | M | I | T | T | V | S |
| I | L | E | V | C | N | Y | I | H | K | N | C | E | T |
| D | A | R | V | A | E | C | D | R | M | P | E | Y | T |
| I | N | Y | L | Y | S | I | N | E | T | R | H | K | R |
| N | I | T | V | S | T | N | I | T | K | O | V | H | R |
| E | N | F | Q | E | P | E | R | M | D | L | I | Q | D |
| H | E | L | E | F | T | Y | R | O | S | I | N | E | N |
| F | K | F | R | I | E | P | S | G | I | N | G | Q | T |
| P | M | Q | C | Y | S | T | E | I | N | E | H | N | M |

[ ] Serine
[ ] Glycine
[ ] Leucine
[ ] Histidine

[ ] Lysine
[ ] Alanine
[ ] Cysteine

[ ] Valine
[ ] Proline
[ ] Tyrosine

PUZZLE 12

# Write your own

Chooseaword or a short messageand translate it into amino acids.

Remember:no B, J, O,U, XorZ.Swap pages with someone and decode theirs.

YOUR MESSAGE

THE AMINO ACID CHAIN - WRITE ONE NAME PER LINE

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

NOW IN CODONS - THREE BASES PER AMINO ACID

_____

_____

_____

# Check your work

Puzzles 1 to 5, then the rest.

### Section one - decoding

1. I LIKE GENES
2. DNA IS THE KEY
3. DNA DRIVES LIFE
4. DNA SHAPES TRAITS
5. CELLS READ SIGNALS

### Section two - encoding

6. GENES = Glycine, Glutamic acid, Asparagine, Glutamic acid, Serine
7. CELL = Cysteine, Glutamic acid, Leucine, Leucine
8. TRAITS = Threonine, Arginine, Alanine, Isoleucine, Threonine, Serine

### Section three - codons

9. DNA IS THE KEY

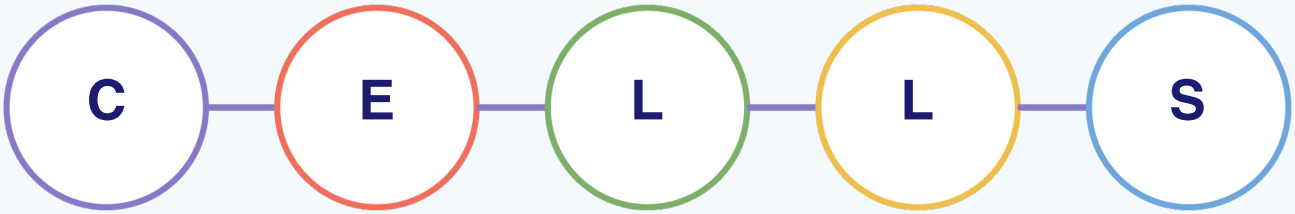
### Section four - mutations

Original: Leu-Ile-Phe-Glu = LIFE
Mutation 1: UUG is still leucine, so the word is still LIFE. Silent - the protein is unchanged.
Mutation 2: GUU is valine, so LIFE becomes LIVE. Missense - one amino acid is swapped.
Mutation 3: GGA is glycine, then UAA is a stop codon. GENES is cut down to G. Nonsense - the chain ends early and the protein is almost always useless.

### Section five - word search

Grid coordinates are given as row, column, counting from the top left.
Serine: starts at row 3, column 7; ends at row 8, column 12.
Lysine: starts at row 9, column 4; ends at row 9, column 9.
Valine: starts at row 2, column 7; ends at row 2, column 12.
Glycine: starts at row 5, column 7; ends at row 11, column 7. Alanine: starts at row 6, column 2; ends at row 12, column 2.
Proline: starts at row 8, column 11; ends at row 14, column 11. Leucine: starts at row 2, column 6; ends at row 8, column 6. Cysteine: starts at row 14, column 4; ends at row 14, column 11. Tyrosine: starts at row 12, column 6; ends at row 12, column 13. Histidine: starts at row 3, column 1; ends at row 11, column 1.

Colour it in - then crack the code!




a tiny protein - five beads long

Everything alive is built from proteins.
Proteins are chains of beads called amino acids.
Each bead has its own letter - so a protein can spell a word!

# Your code key

Twenty beads,twenty letters.Keep this page handy!

| | | | |
|---|---|---|---|
| A | Alanine | L | Leucine |
| R | Arginine | K | Lysine |
| N | Asparagine | M | Methionine |
| D | Aspartic acid | F | Phenylalanine |
| C | Cysteine | P | Proline |
| E | Glutamic acid | S | Serine |
| Q | Glutamine | T | Threonine |
| G | Glycine | W | Tryptophan |
| H | Histidine | Y | Tyrosine |
| I | Isoleucine | V | Valine |

**Six letters are missing!**

There is no bead for B, J, O, U, X or Z.

So you can spell CAT and FISH - but never DOG or BOX. Try it!

# Crack the code

Write each bead's letter in the box.Then draw the thing you found!

Cysteine | Alanine | Threonine

draw it here

Phenylalanine | Isoleucine | Serine | Histidine

draw it here

Threonine | Arginine | Glutamic acid | Glutamic acid

draw it here

# Crack the code again

Same game, three more words.

| Serine | Threonine | Alanine | Arginine | |
|---|---|---|---|---|
| | | | | draw it here |

| Cysteine | Alanine | Lysine | Glutamic acid | |
|---|---|---|---|---|
| | | | | draw it here |

| Serine | Glutamic acid | Glutamic acid | Aspartic acid | |
|---|---|---|---|---|
| | | | | draw it here |

# Join the pairs

Draw a line from each bead name to the right letter.



# Colour the chain

Every bead has a personality. Colour each one by its group, then read the letters to find the hidden word.

**YELLOW**
Water-hating

**GREEN**
Water-loving

**RED**
Sour (acid)

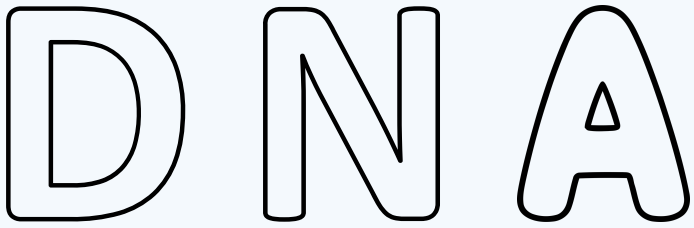
**BLUE**
Basic



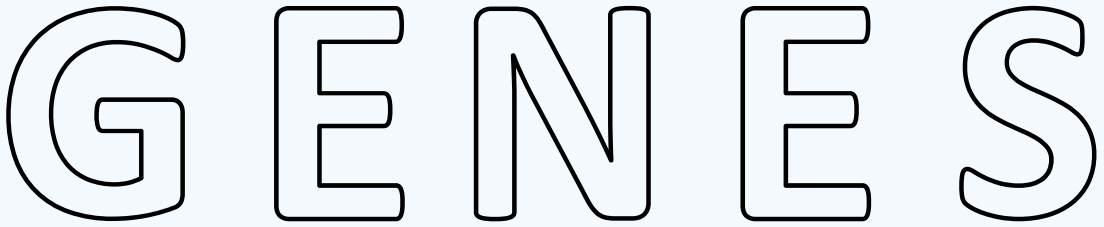

Now write the letters here:

# Trace and colour

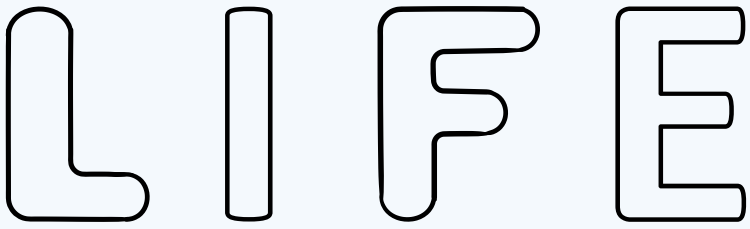
Go over the letters,then colour them in any way you like.




Aspartic acid - Asparagine - Alanine



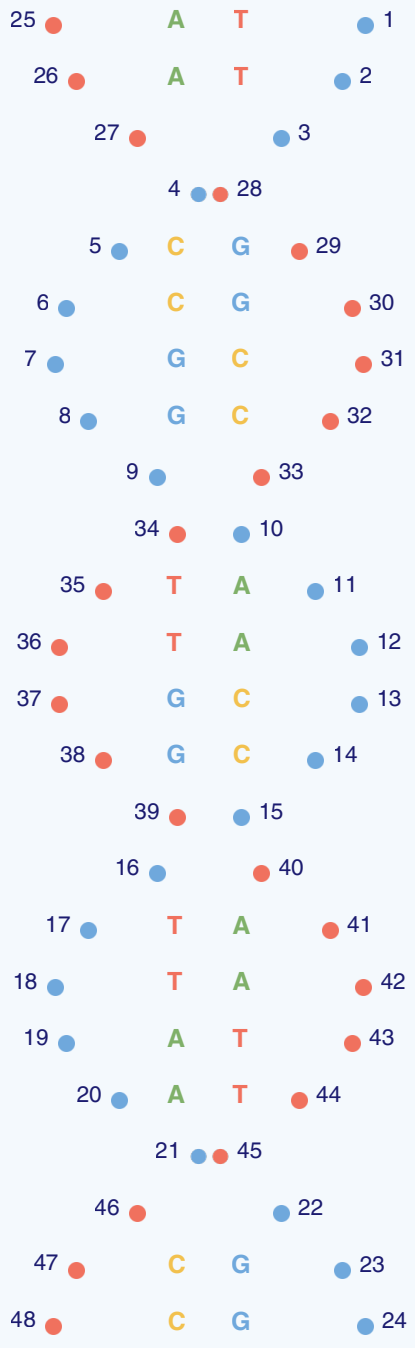

Glycine - Glutamic acid - Asparagine - Glutamic acid - Serine




Leucine - Isoleucine - Phenylalanine - Glutamic acid

# Dot to dot

Join the dots from 1 to the end to uncover the shape of DNA.
Then join each pair of matching letters across the middle.



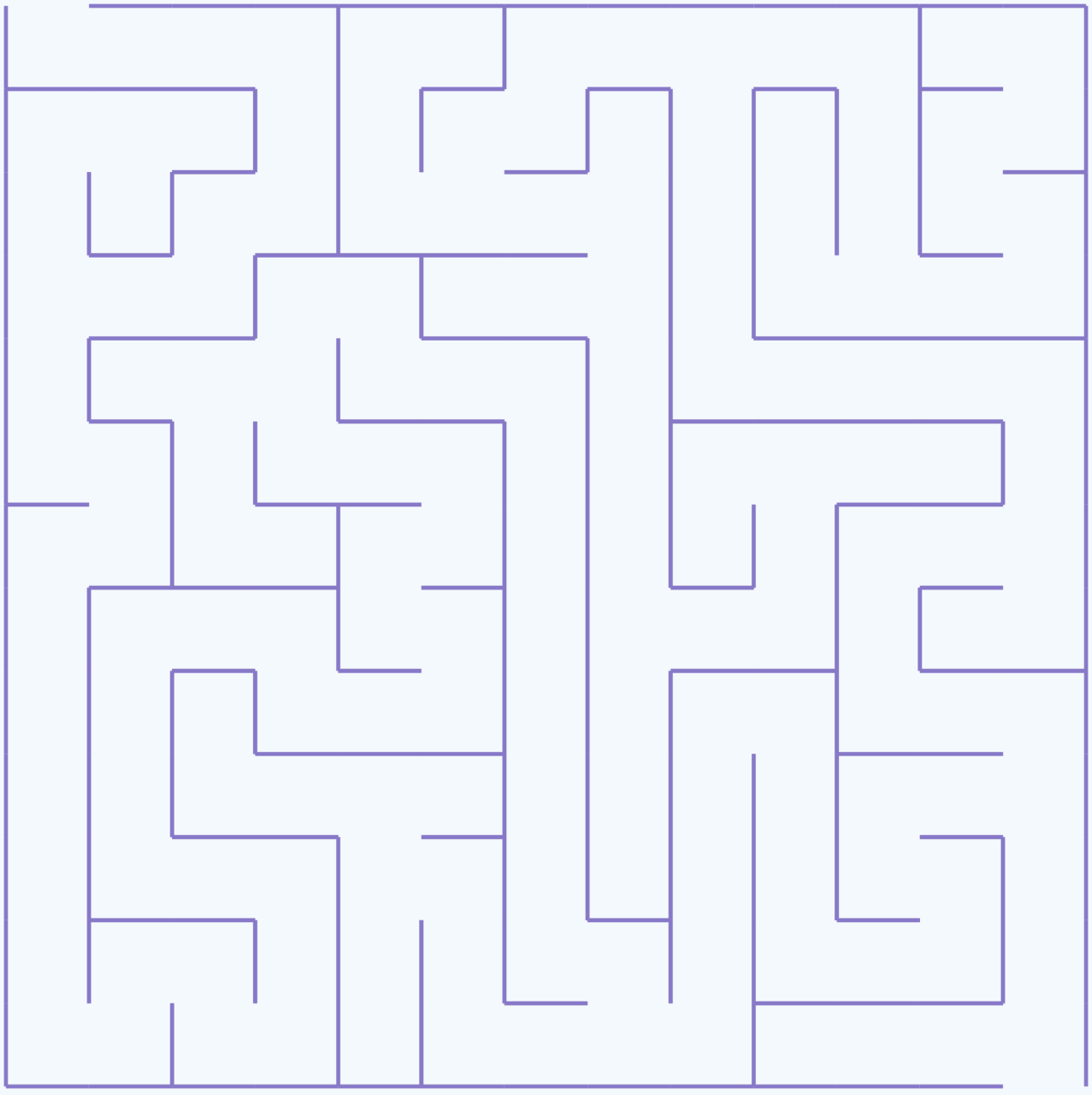

A always pairs with T, and G always pairs with C.

# Help the ribosome

The ribosome is the machine that reads the code and builds the protein.

Find the way from START to the finished protein.

START



PROTEIN!

# Spot the change

A mutation is one letter of DNA swapped for another.
Compare the two strands and circlethe letters that changed.

### THE ORIGINAL STRAND

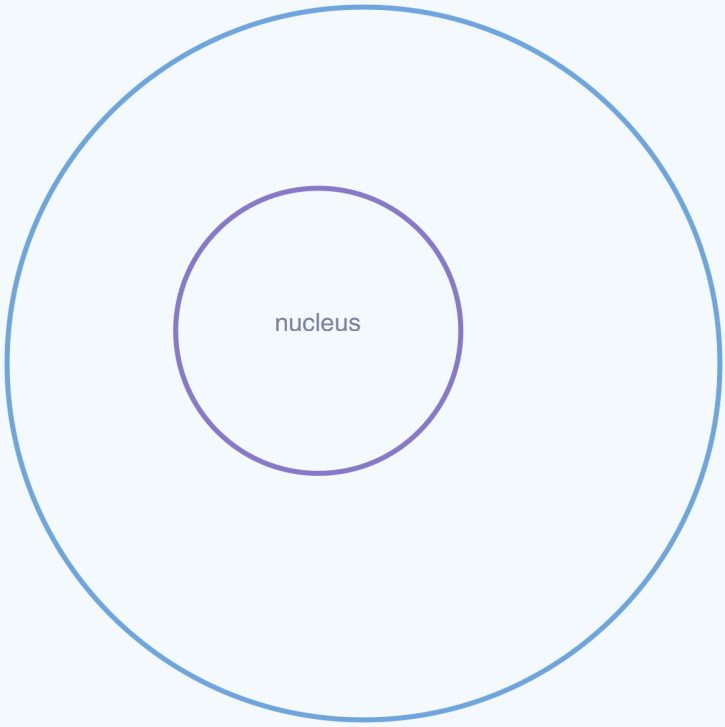
| A | T | G | C | C | T | G | A | A | G | C | T | T | A | C | G | G | A | T | C | C | A | A | G | T | T | G | C | A | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

### THE COPY - WITH MISTAKES

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

How many changes did you find? ☐

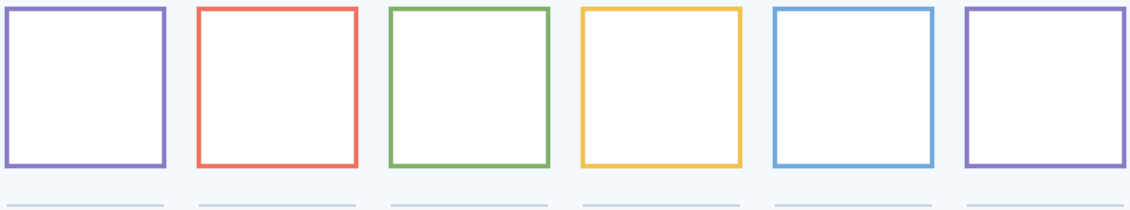
Your cells copy about three thousand million letters every time they divide.
They make very few mistakes - but not none. That is how living things change.

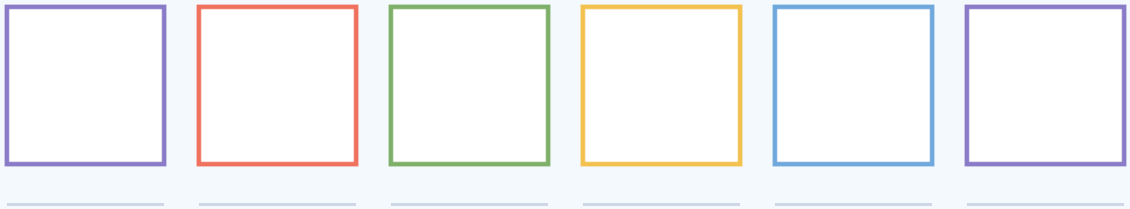



A cell to colour in. The DNA lives inside the nucleus.

# Write your own

Pick a short word. Write one letter in each box,
then write the bead names underneath. No B, J, O, U, X or Z!





Draw a picture of your word:

# Answers for grown-ups

Puzzle 1 CAT = Cysteine, Alanine, Threonine. FISH = Phenylalanine, Isoleucine, Serine, Histidine.

TREE = Threonine, Arginine, Glutamic acid, Glutamic acid.

Puzzle 2 STAR = Serine, Threonine, Alanine, Arginine. CAKE = Cysteine, Alanine, Lysine, Glutamic a
SEED = Serine, Glutamic acid, Glutamic acid, Aspartic acid.

Puzzle 3 Glycine G, Lysine K, Serine S, Threonine T, Alanine A, Cysteine C, Isoleucine I, Proline P.

Puzzle 4 The chain spells GENES. Glycine yellow, Glutamic acid red, Asparagine green,
Glutamic acid red, Serine green.

Spot the change Three letters differ, at positions 7, 16 and 24 counting from the left.

A note on the colours: the four groups are the standard way chemists sort amino acids - hydrophobic, polar, acidic and basic. Those properties are what make a protein fold into its shape.