

# Alive and Fluorescing!

# Opener

- In teams of 4 you have 5 minutes to read through the sheet and try and work out some of the answers
- We will then collect your answers using the zappers

*Chemistry*

# Please select a Team.

1. Team A

2. Team B

3. Team C

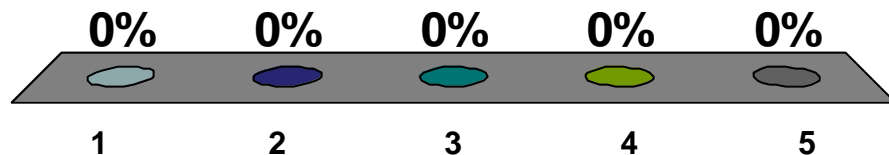
4. Team D

5. Team E



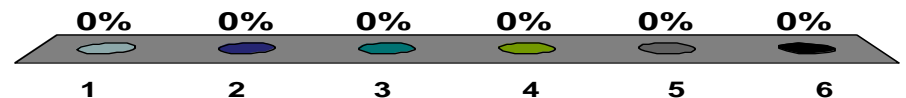
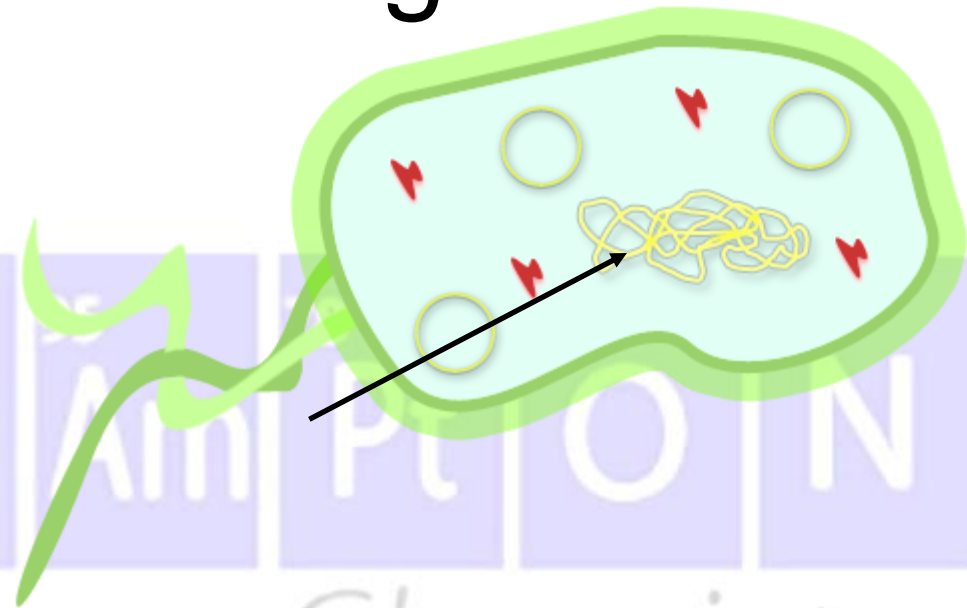
[www.rsc.org/education/chemistry](http://www.rsc.org/education/chemistry)

*Chemistry*



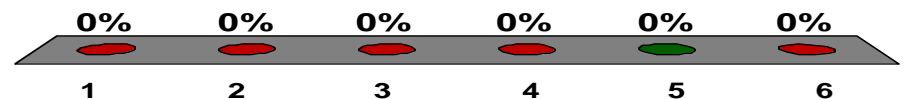
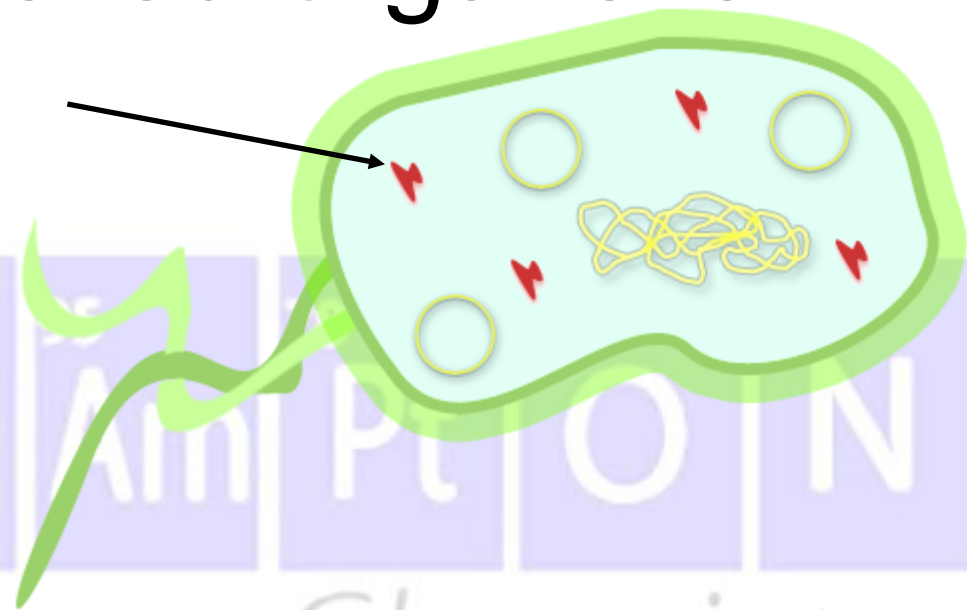
# What is the labelled organelle?

1. Cell Wall
2. Cell Membrane
- ✓ 3. Super coiled DNA
4. Plasmid DNA
5. Ribosome
6. Flagellum



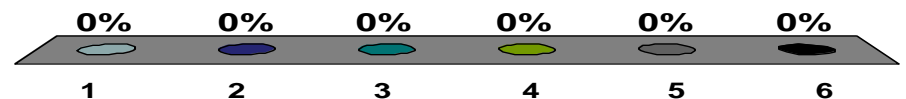
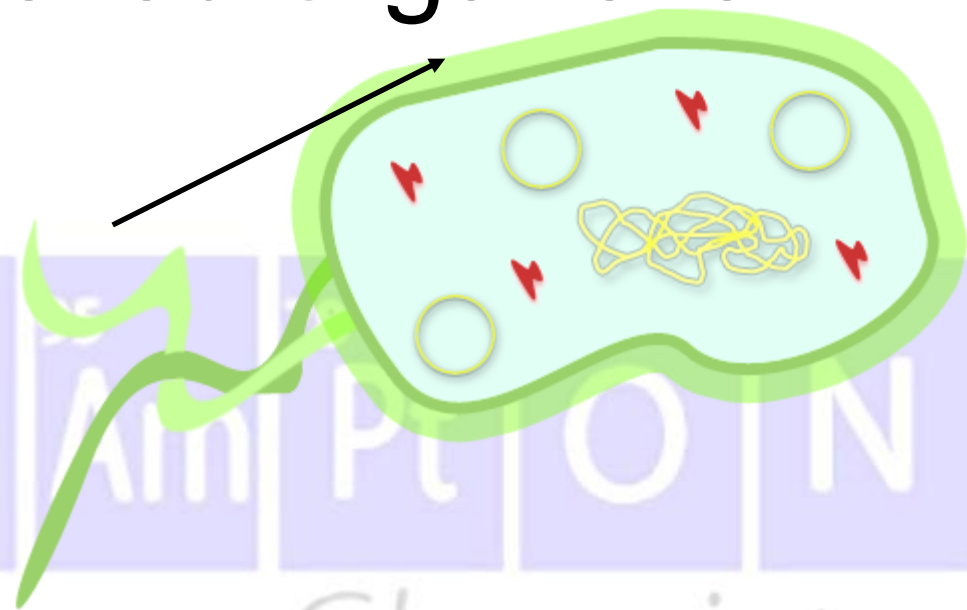
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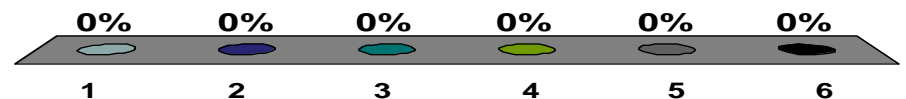
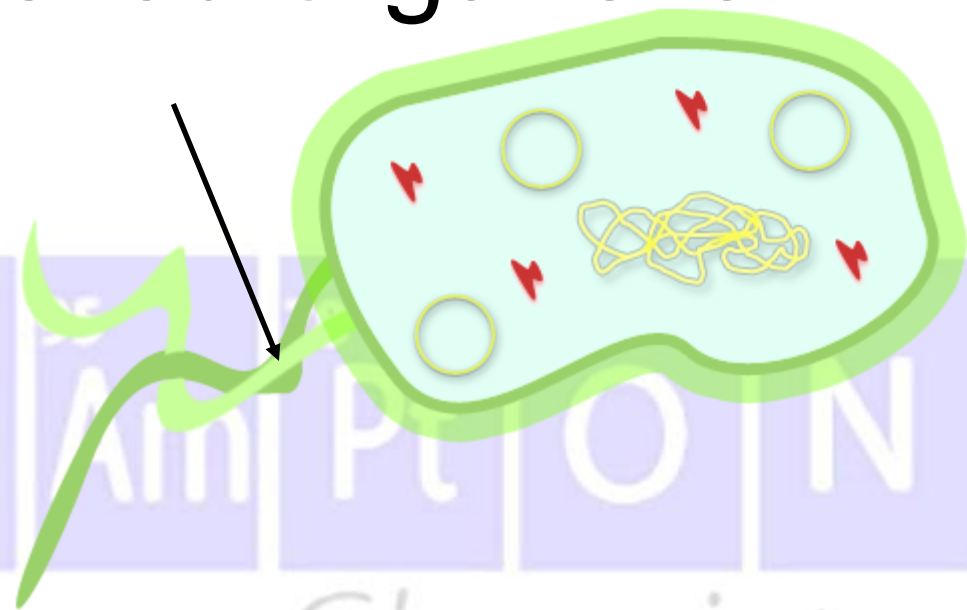
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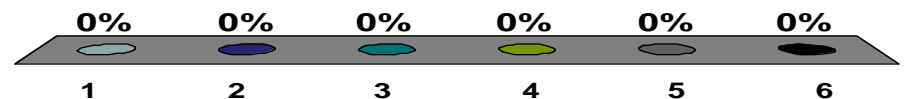
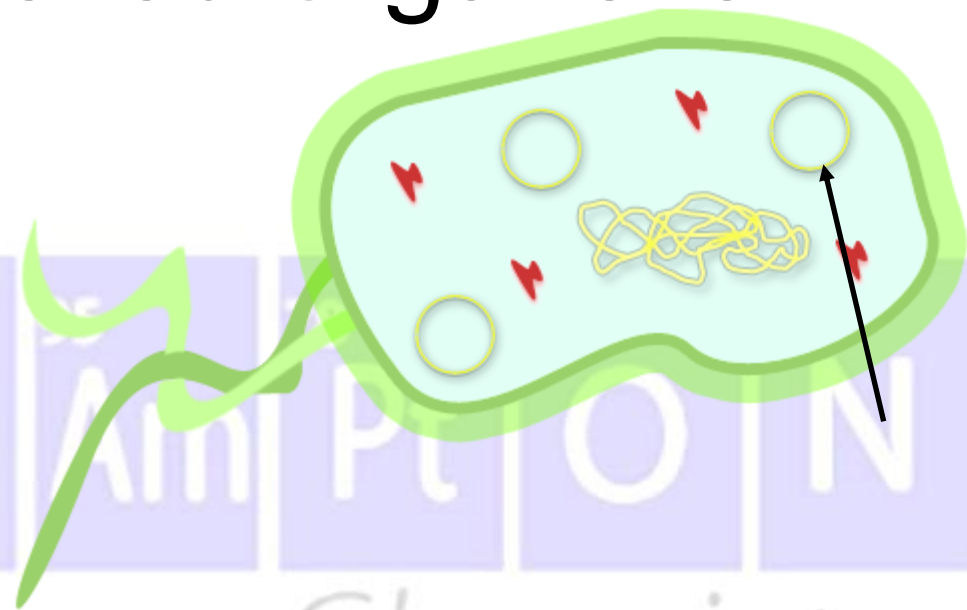
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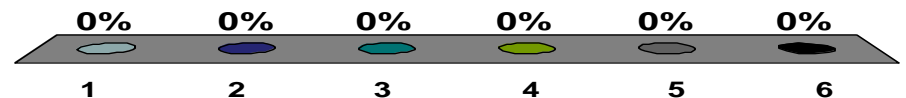
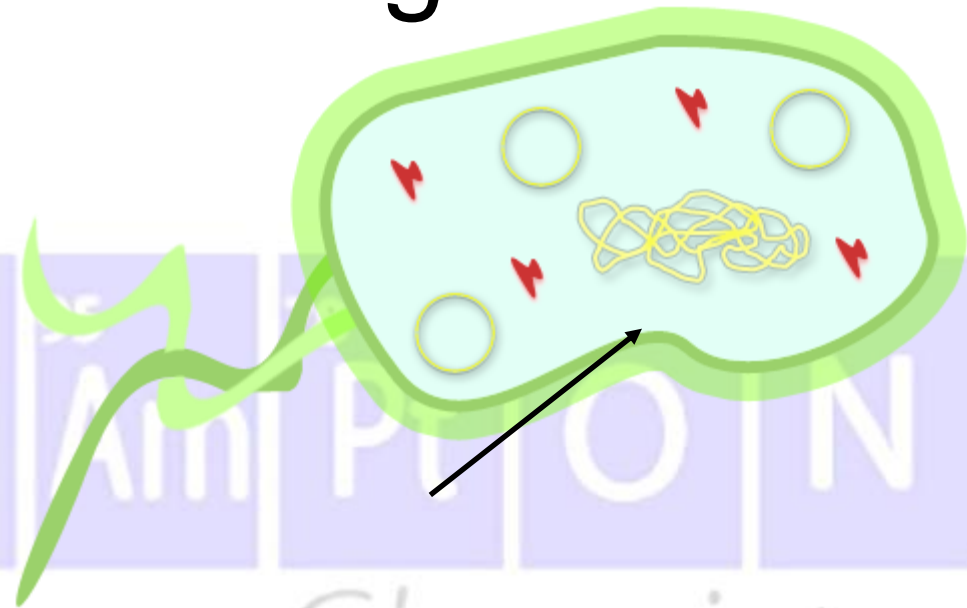
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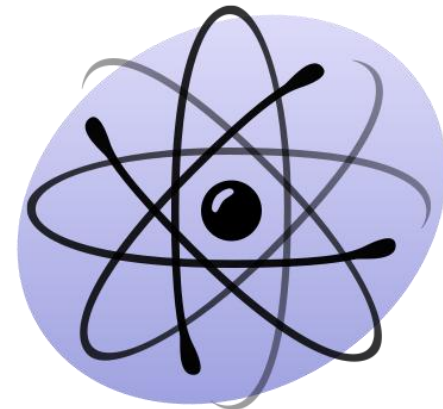
# Some key questions

- Do the branches of science overlap?
- Can we change living organisms to benefit ourselves?
- Should we change living organisms to benefit ourselves?

Chemistry

# Inter discipline

- Although the sciences all have different specialities they are tied together
- Collaboration on projects is very common at university and in industry
- Chemistry, biology, physics, maths and medicine frequently work together
- Synthetic biology is an example of a inter discipline subject can you think of any others?



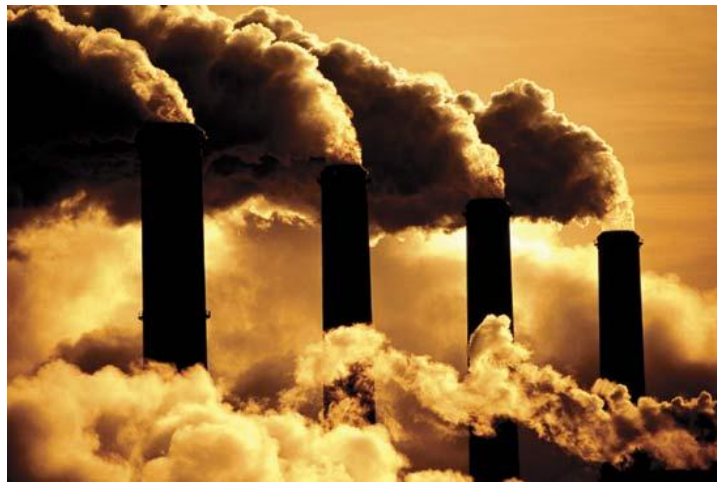
# What is Synthetic Biology?

- Defined as:
  - A) the design and construction of new biological parts, devices, and systems
  - B) the re-design of existing, natural biological systems for useful purposes.
- So basically tinkering with organisms to make them do useful things



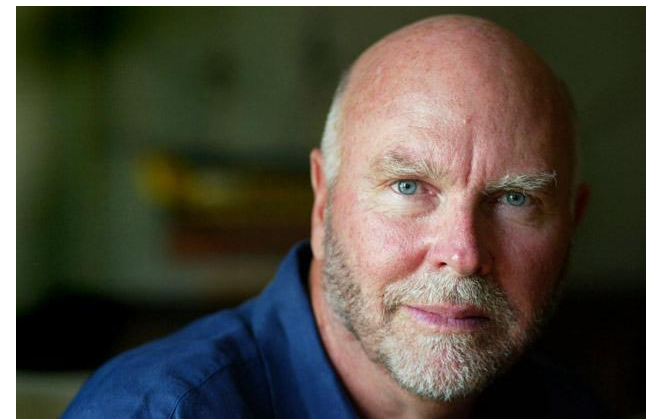
# Why Synthetic Biology?

- It could be used to replace fossil fuels
- It can be used to synthesize almost anything
- There is huge investment in the field: The University of California recently received \$600 million from BP and the US Government
- Its new and exciting, huge leaps are being made every day which could change the world



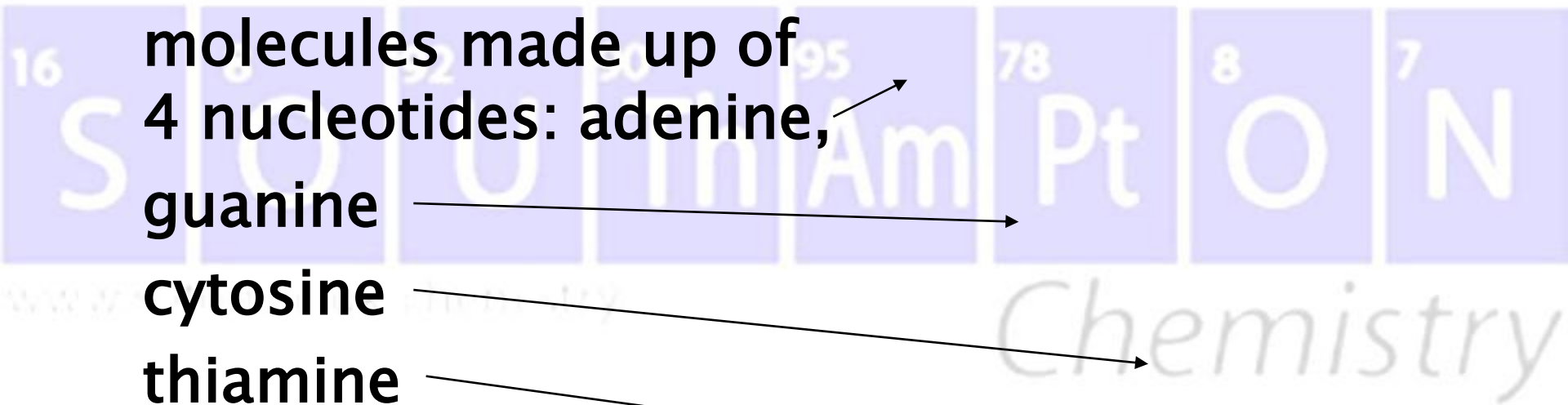
# Dr Craig Venter

- Decoded the human genome in 2001
- The world leader in synthetic biology
- Created the first artificial genome in 2008
- Aims to create a bacterium that turns carbon dioxide straight into usable fuels
- Also a world leader in education and ethics



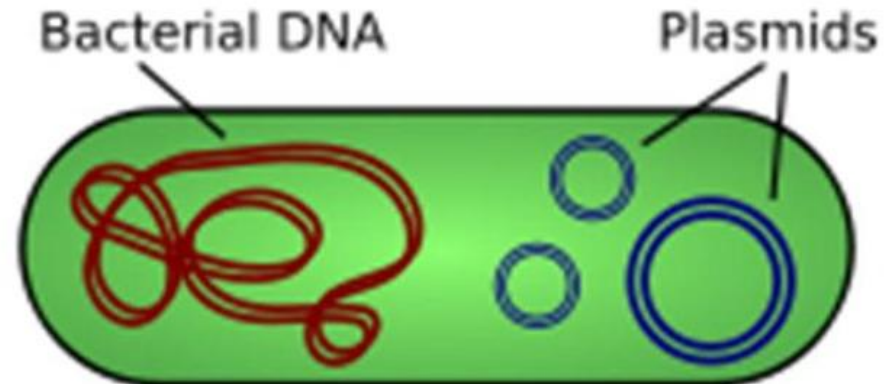
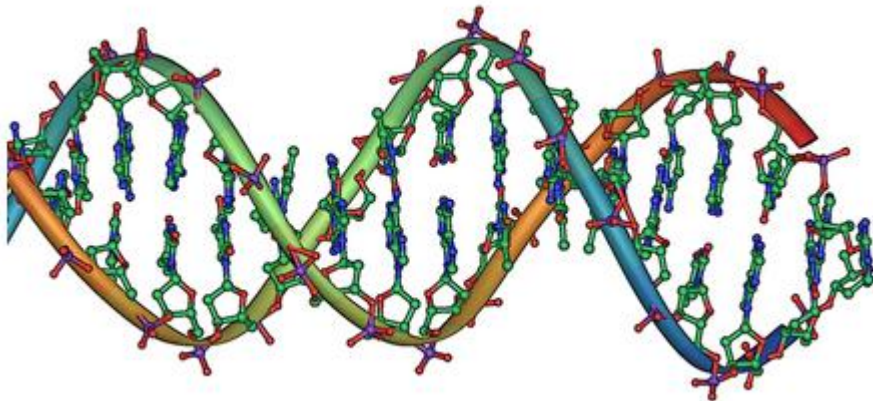
# DNA and Plasmids

- 'The building blocks of life'
- Strands of code molecules made up of 4 nucleotides: adenine, guanine, cytosine, thiamine
- Which are coded for by the letters a, g, c and t
- DNA carries a net negative charge



# DNA structure

- In eukaryotic cells such as human cells DNA forms a double helix inside a nucleus
- In prokaryotic cells it forms closed supercoiled loops and plasmids
- Plasmids are very useful to synthetic biology



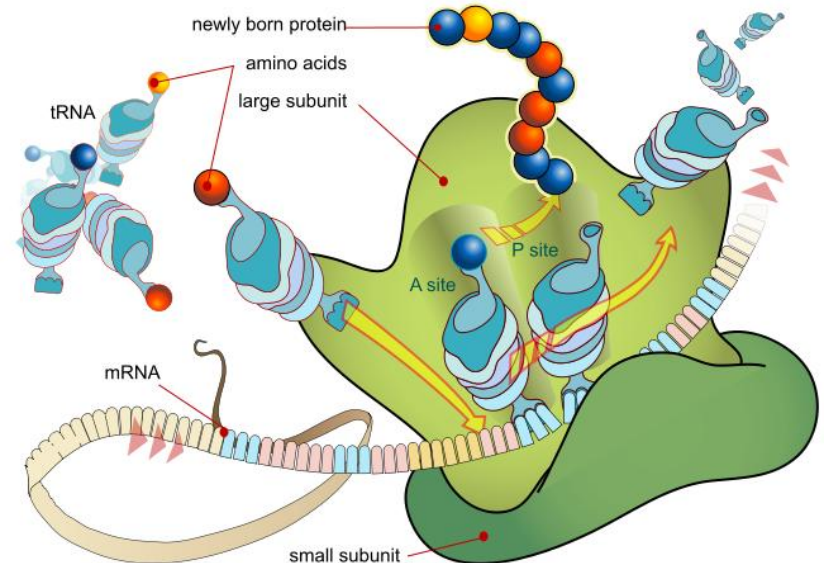
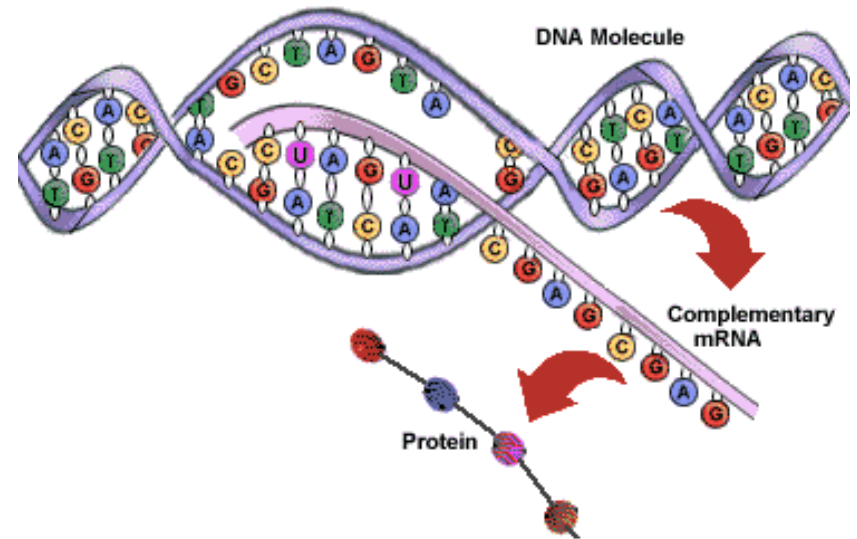
# Transcription and translation

DNA is copied (transcribed) onto RNA

RNA joins together in groups of 3 called codons

Each codon codes for a different amino acid which attaches to the RNA

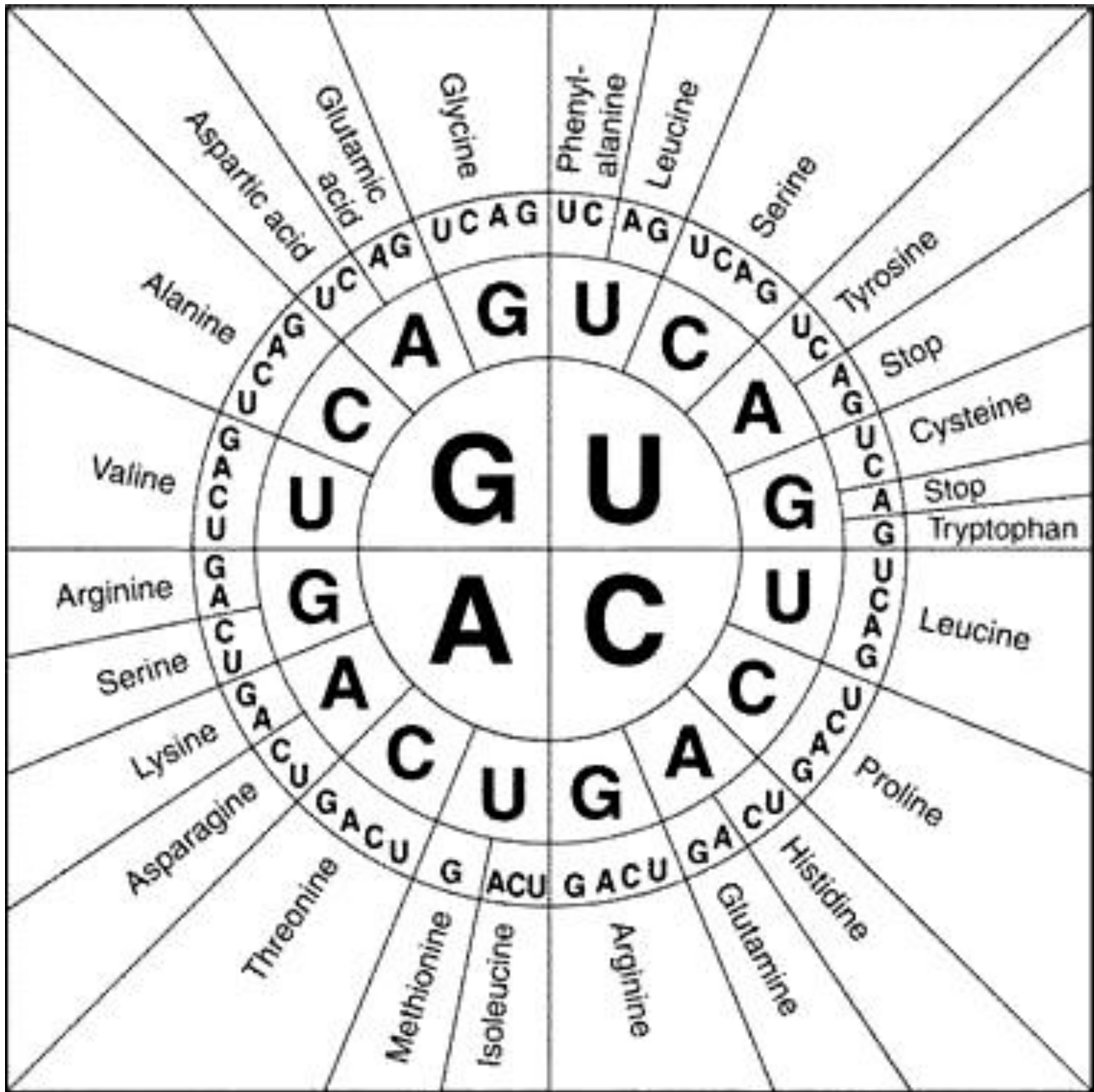
The amino acids join together in a chain and break away from the RNA

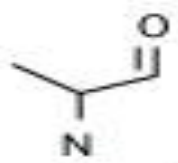


# Protein structures

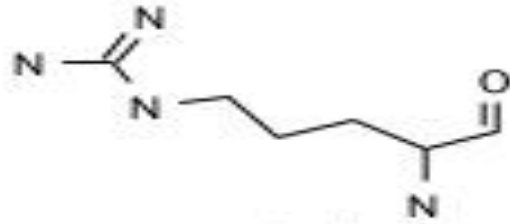
- Proteins are made up of amino acids
- Each DNA codon codes for a separate amino acid
- Amino acids have the same basic form including the peptide bond
- Variation occurs by having different 'R' groups

*Chemistry*

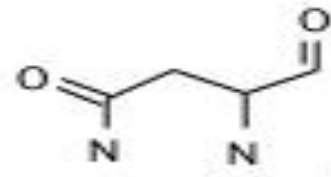




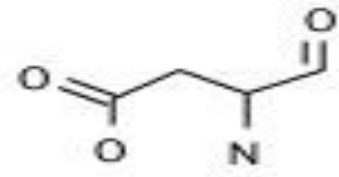
Alanyl  
[Ala]



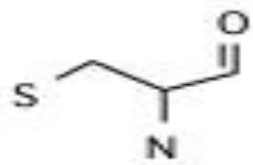
Arginyl  
[Arg]



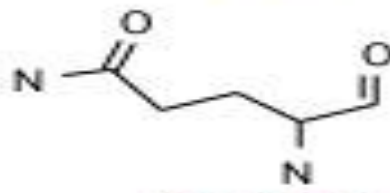
Asparaginyl  
[Asn]



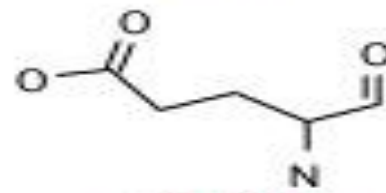
Aspartyl  
[Asp]



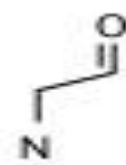
Cysteinyl  
[Cys]



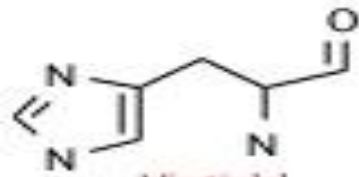
Glutaminyl  
[Gln]



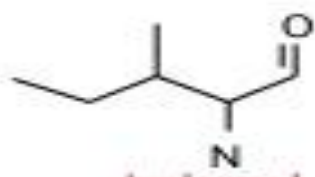
Glutamyl  
[Glu]



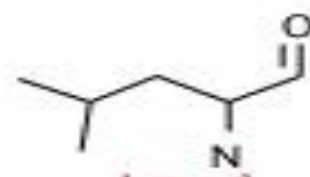
Glycyl  
[Gly]



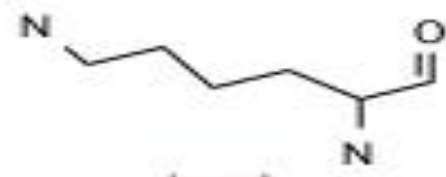
Histidyl  
[His]



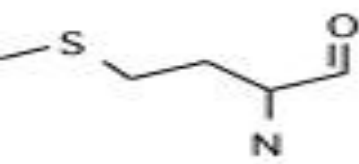
Isoleucyl  
[Ile]



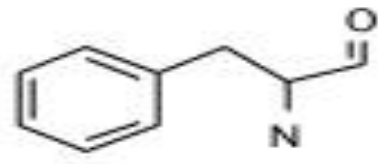
Leucyl  
[Leu]



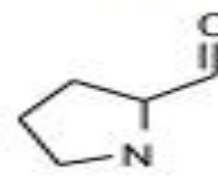
Lysyl  
[Lys]



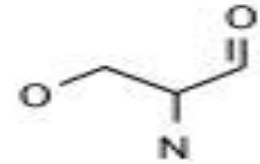
Methionyl  
[Met]



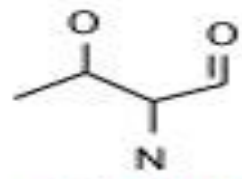
Phenylalanyl  
[Phe]



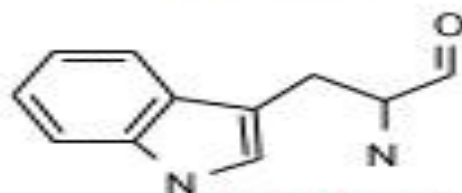
Prolyl  
[Pro]



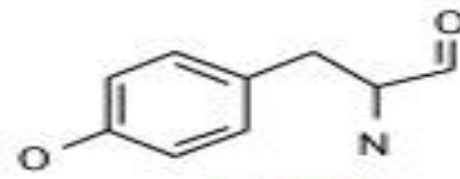
Seryl  
[Ser]



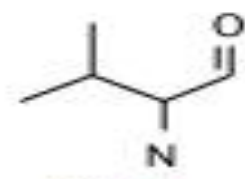
Threonyl  
[Thr]



Tryptophanyl  
[Trp]



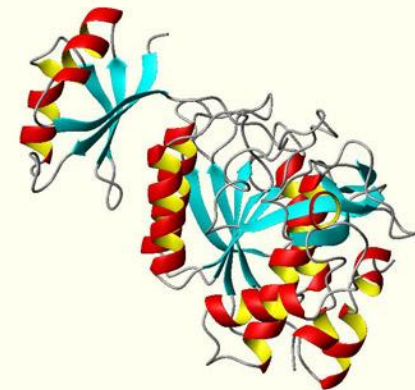
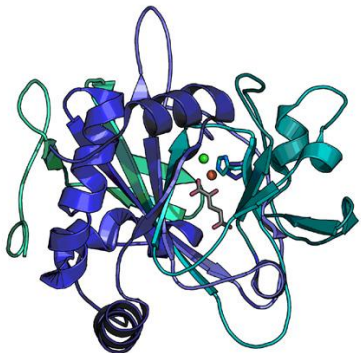
Tyrosyl  
[Tyr]

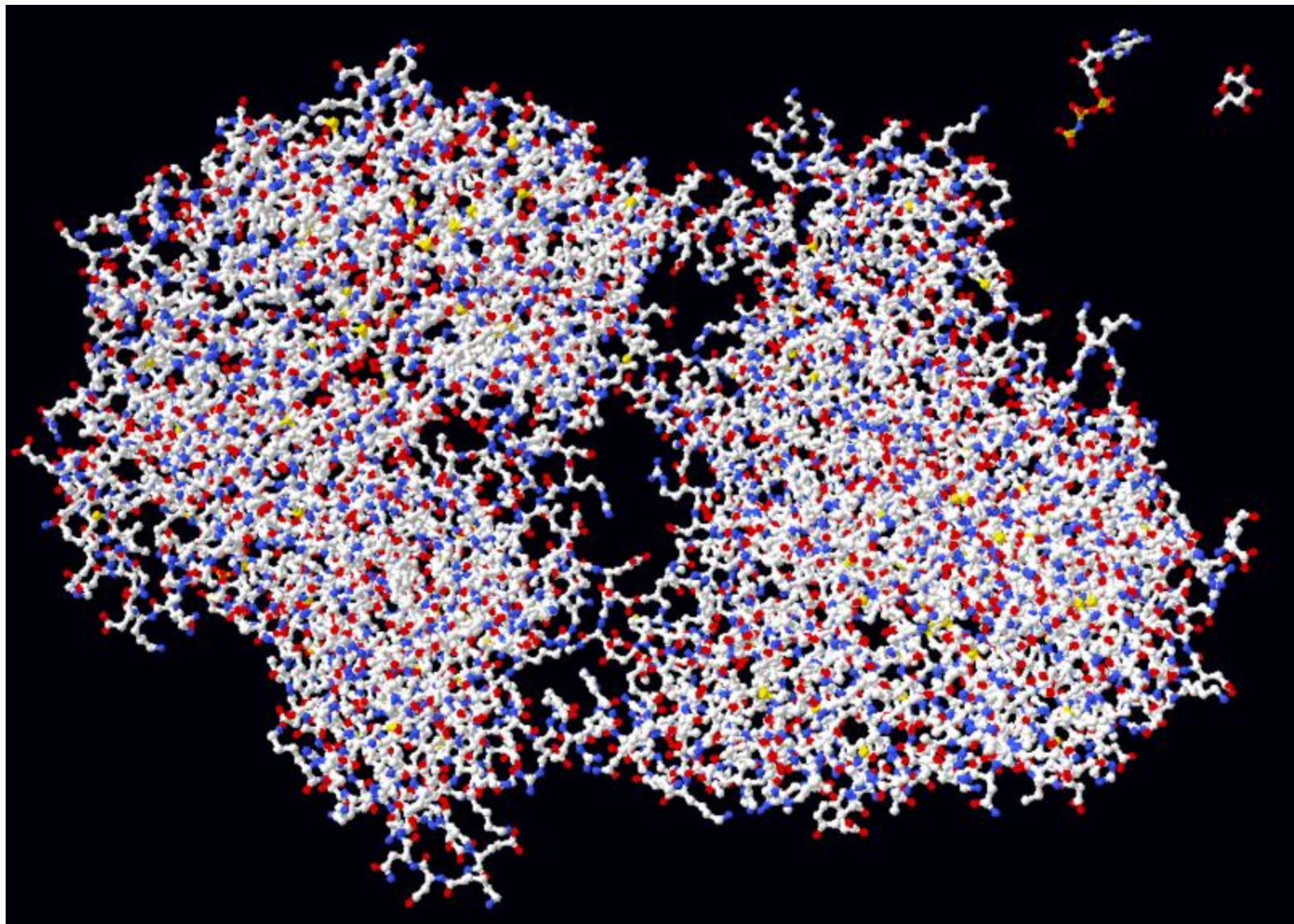


Valyl  
[Val]

# Protein Structures

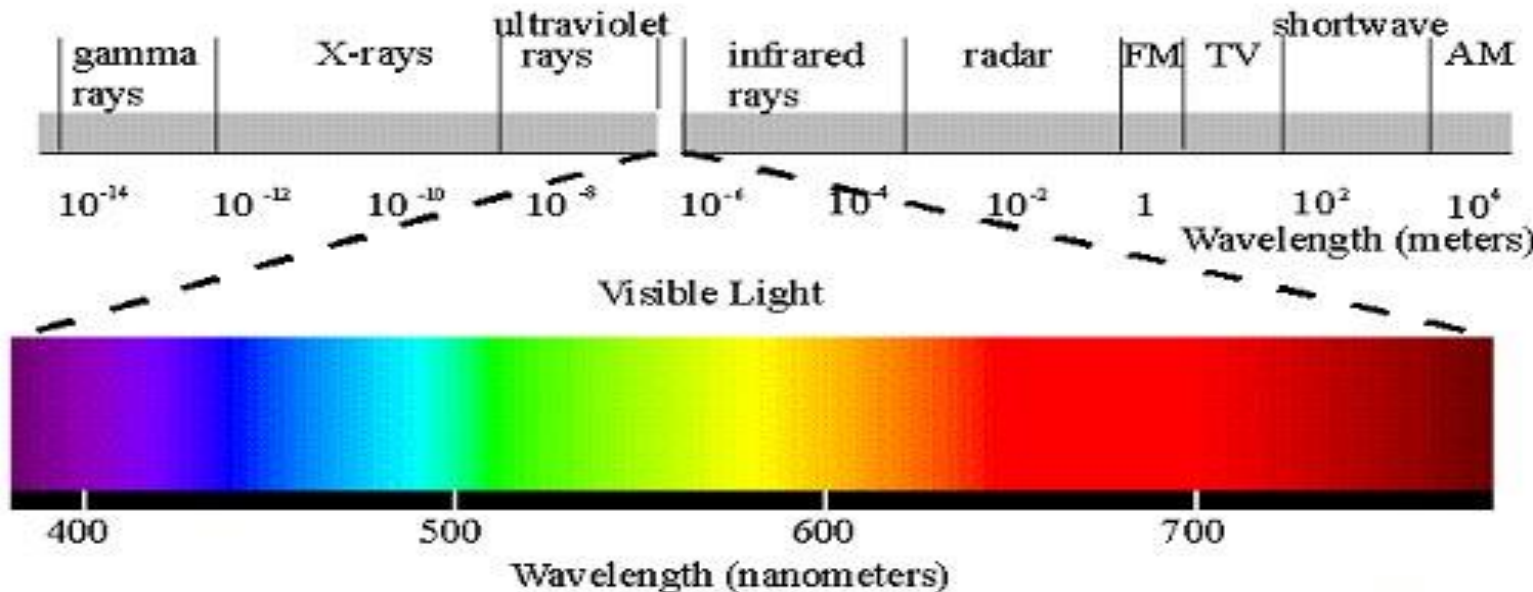
- Amino acids form long chains called polypeptides or proteins
- As the chains get longer they start to form secondary structures like sheets and helices
- Large proteins fold even further to form unique tertiary structures
- The largest proteins form enzymes made up of several tertiary units these are called quaternary structures





# Fluorescence

- *Fluorescent substances glow when light is shone on to them*
- *Electrons are excited to a higher energy level then drop back down releasing the energy as a photon*
- *The colour emitted must be lower in energy then than that which is absorbed*



# Fluorescent Proteins

- Green fluorescent protein was discovered in 1998 winning its discoverers the Nobel prize in biochemistry
- When exposed to blue light it fluoresces bright green
- The gene that expresses it has been successfully used in bacteria and in mammals



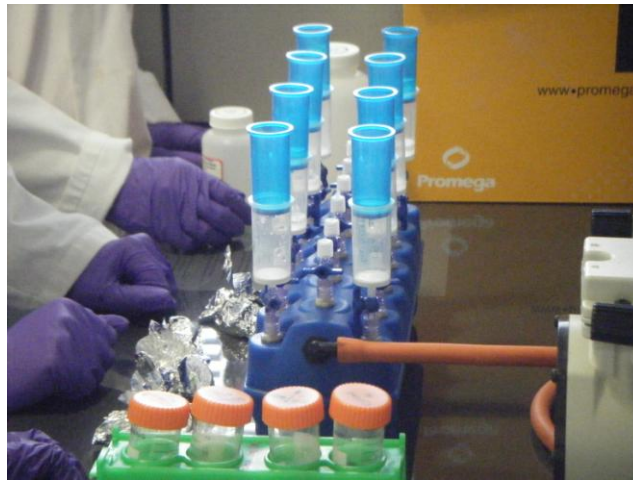
# Lab safety

- Always wear your labcoat and goggles when in the lab
- When handling agar plates always wear gloves
- Wash your hands before leaving the lab
- No eating or drinking in the lab



# How its done in the lab

- **Small scale colonies of bacteria are grown on agar plates**
- **DNA can be transferred between these until the desired result is obtained**
- **Complex multi step processes are required**



# How it's done in industry

- Once the desired product is obtained in the lab it is scaled up for mass production
- Large incubators are used to keep the bacteria at ideal temperature
- Production is either done continuously or in batches



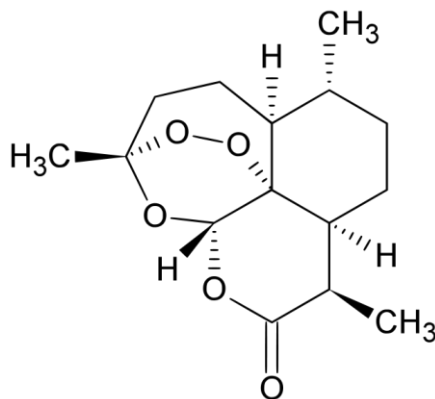
# Applications

- The iGEM competition allows students from around the world to compete to come up with innovative bacterial machines
- Synthetic biology has already found use in drug creation



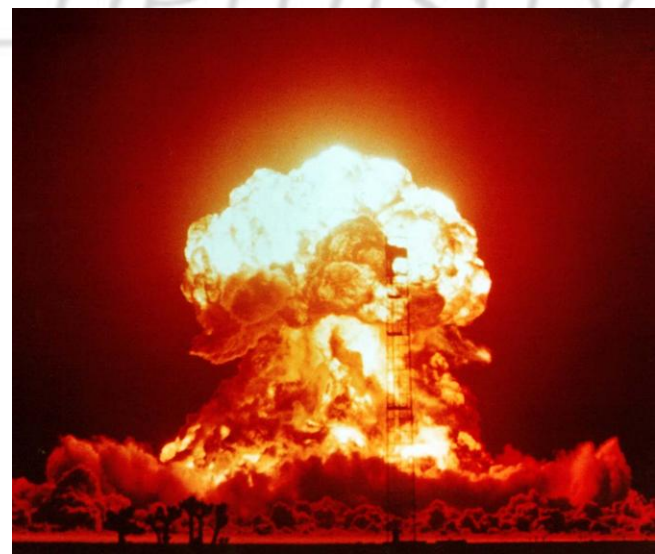
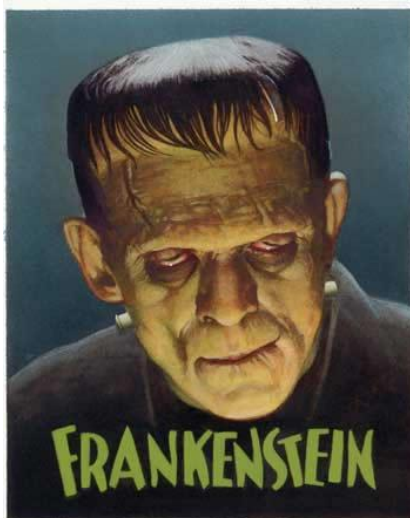
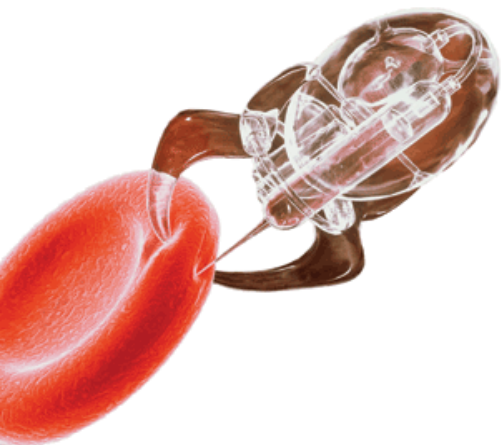
# Bio synthesis of Artemisinin

- Malaria is a deadly disease that affects some of the poorest countries in the world
- A child dies of malaria every 30 seconds (WHO)
- Artemisinin is an effective anti malarial drug but is too expensive to manufacture conventionally
- Using a biosynthetic route the cost has been drastically reduced



# Ethics

- Are we doing enough to control it?
- Are we doing too much?
- What if it escapes?
- What if it kills thousands of people?
- What if it saves thousands of people?
- Are we messing with something we don't understand?



# What kind of charge does dDNA contain?

✓ 1. Negative

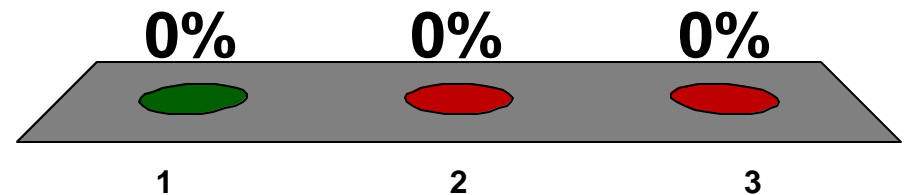
2. Positive

3. No overall charge



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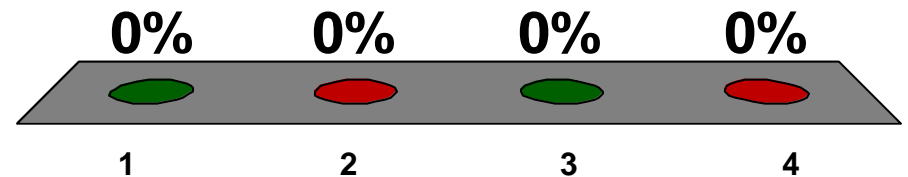
Chemistry



# Which of the following are prokaryotic cells?

- ✓ 1. E. coli
- 2. Skin cells
- ✓ 3. Yeast
- 4. Plant cells

Hint: A prokaryotic cell is a simple single-celled organism such as a bacteria



# Which forms of DNA are found in bacteria?

1. Nucleic DNA

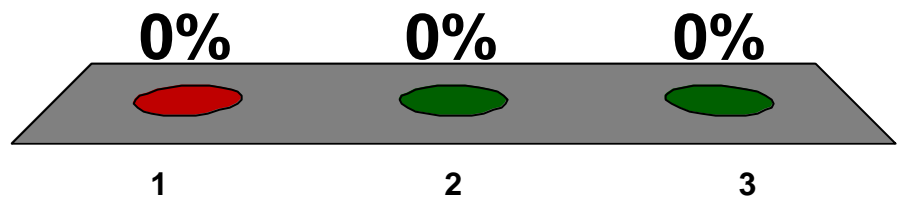
✓ 2. Supercoiled loop

✓ 3. Plasmid



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# Which organelle do bacteria use for propulsion?

1. Ribosome

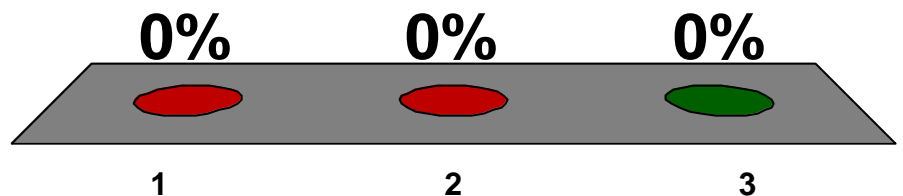
2. Plasmid

✓ 3. Flagellum



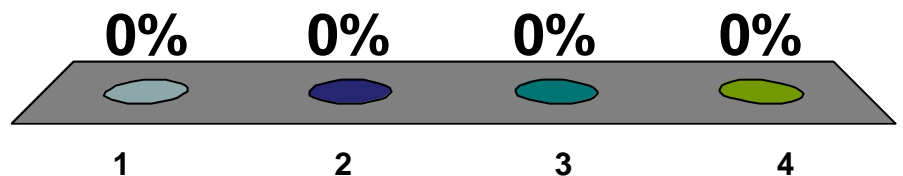
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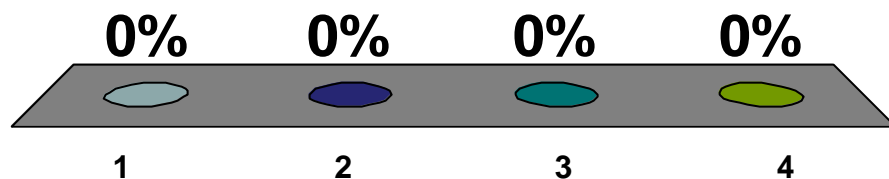
# Do you think synthetic biology has the solutions to the worlds problems?

1. Defiantly
2. Maybe but more research is needed
3. Maybe as part of a bigger solution
4. No it's a waste of time



# Who is best placed to solve the worlds problems?

1. Scientists
2. Politicians
3. The media
4. The public



# Which of these is an amino acid?

1.

2.

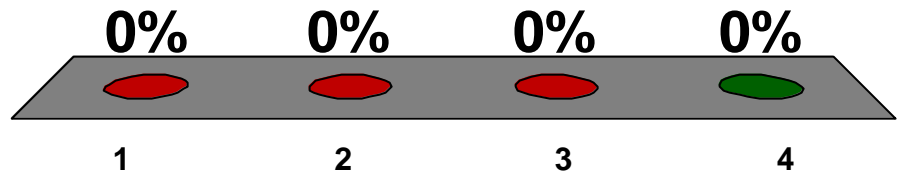
3.

4.



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# Which of these disciplines is not relevant to synthetic biology?

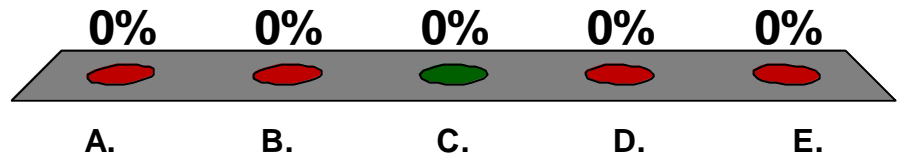
A. Chemistry

B. Biology

✓ C. History

D. Engineering

E. Medicine



# Which of these is not a nucleotide?

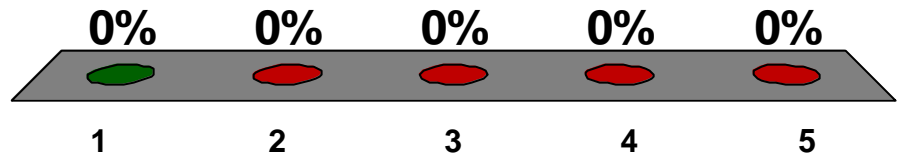
✓ 1. Branamine

2. Adenine

3. Guanine

4. Thymine

5. Cytosine



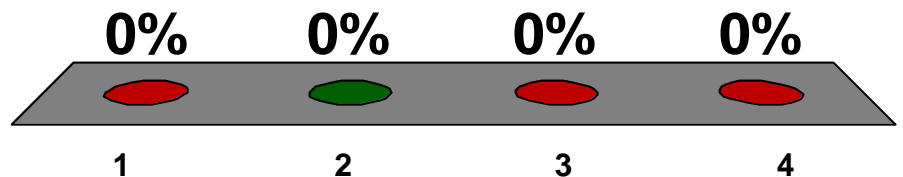
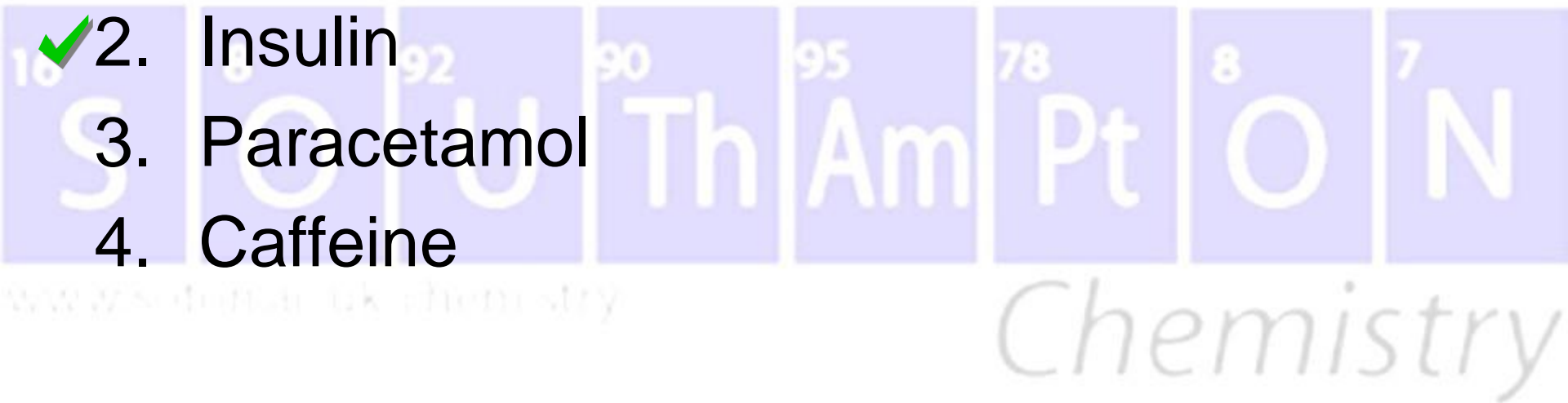
# Which of these chemicals/ drugs is already produced by micro organisms?

1. Crude Oil

✓ 2. Insulin

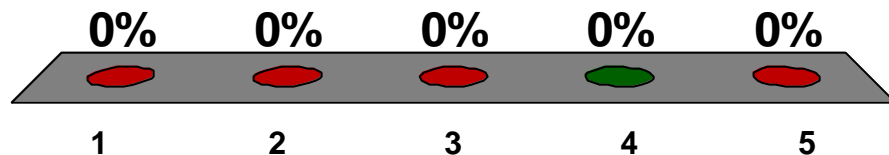
3. Paracetamol

4. Caffeine



# How many bacteria are there on an average kitchen towel?

1. 4 thousand
2. 200 thousand
3. 8 million
- ✓ 4. 64 million
5. 12



# Which of these substances contain sodium?

1. Sugar

2. Alcohol

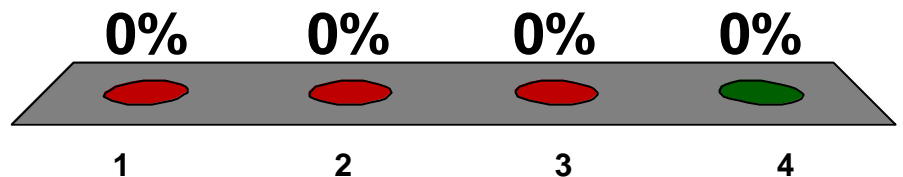
3. Glass

✓ 4. Table salt



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# Is salt an organic molecule?

1. Yes

✓ 2. No

An organic molecule is made up of carbon, hydrogen and Nitrogen. Salt only contains Chlorine and sodium

# How many nucleotides make up a codon?

1. 1

2. 2

3. 3

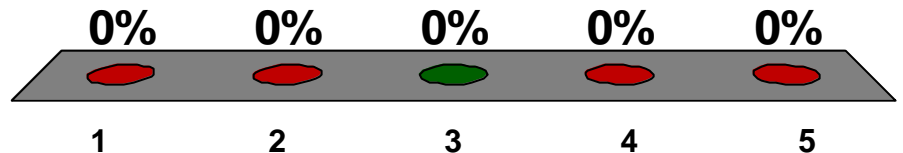
4. 4

5. 5



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*Chemistry*



# Team Scores



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