



Wadham Project Workshop:

Genetics

Dr Sally McGrath
Biddenham International School and Sports College
Wadham College, University of Oxford

Session Aims

- Understand the basic principles of genetics
- Use the genetic code to study and comprehend a cancer mutation
- Appreciate the present and future applications of genetics

My Journey

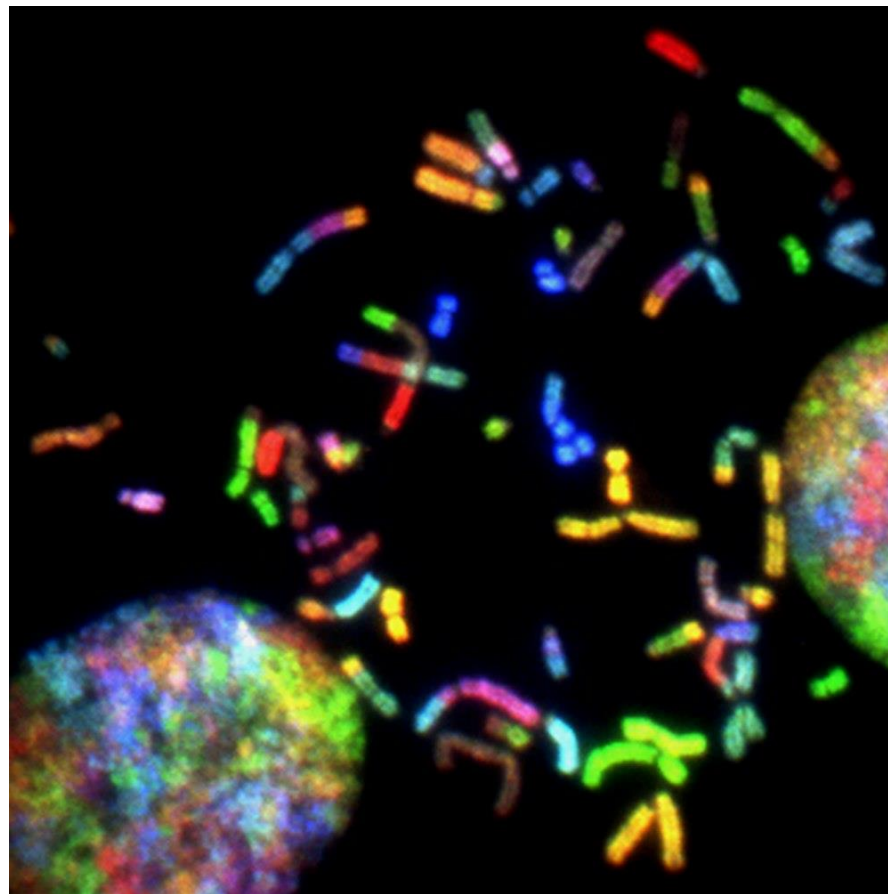




https://unsplash.com/@sangharsh_1

1. What do you know about genetics already? How are characteristics passed on from parent to offspring?

<https://unsplash.com/@nci>

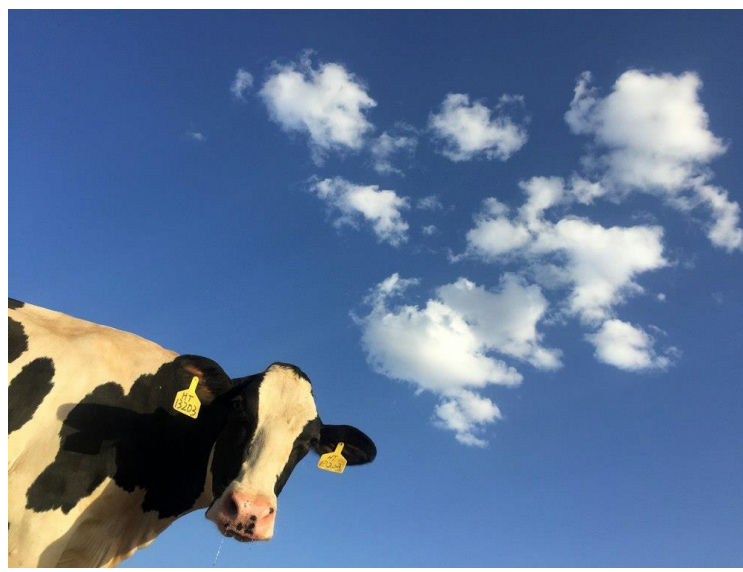


1. What do you know about genetics already? How are characteristics passed on from parent to offspring?



<https://unsplash.com/@tumbao1949>

Chicken



<https://unsplash.com/@ryansong>

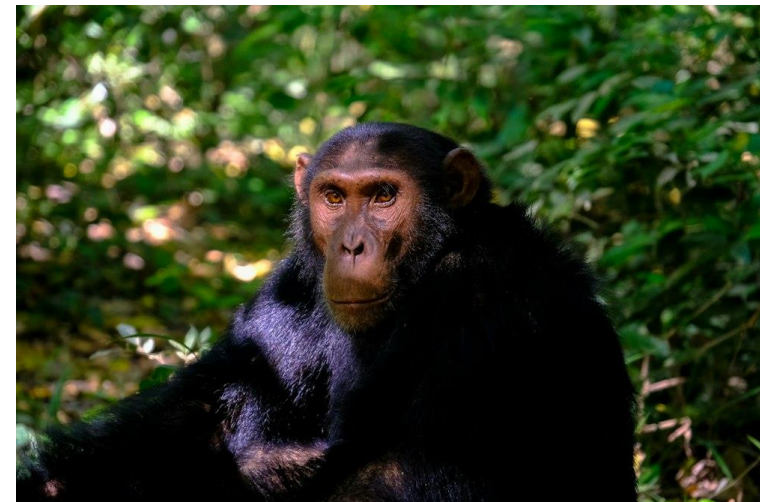
Cow



<https://unsplash.com/@madhatterzone>

Cat

2. What percentage of our genes do you think we share with...



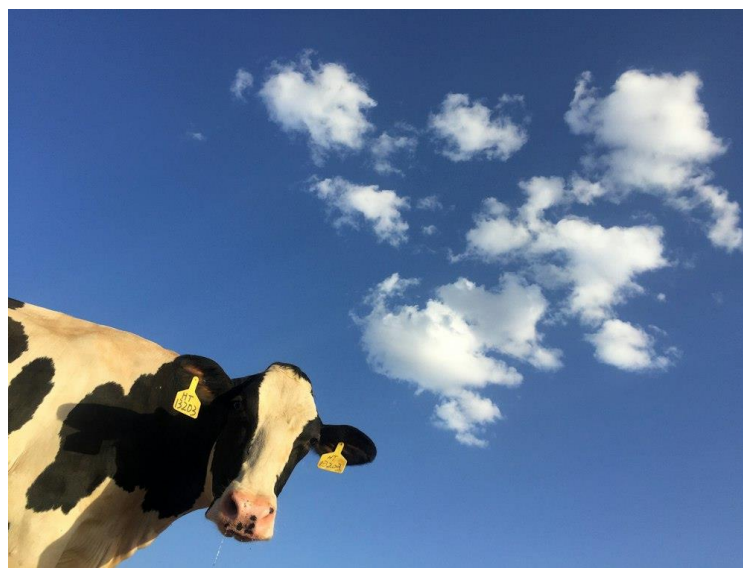
https://unsplash.com/@francesco_ungaro

Chimpanzee



<https://unsplash.com/@tumbao1949>

Chicken 60%



<https://unsplash.com/@ryansong>

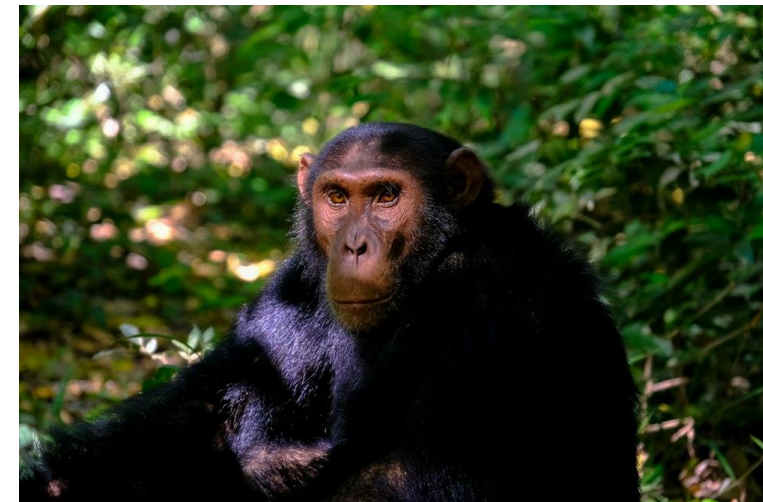
Cow 80%



<https://unsplash.com/@madhatterzone>

Cat 90%

2. What percentage of our genes do you think we share with...



https://unsplash.com/@francesco_ungaro

Chimpanzee 96-98%

3. Why do you think it's useful to study genetics?

To understand biology



<https://unsplash.com/@darkocv>

To develop new medicines

<https://unsplash.com/@usmanyousaf>



To develop agriculture



https://unsplash.com/@no_one_cares

3. Why do you think it's useful to study genetics?

We are going to look at a gene that helps your body prevent cancer: p53!



		second base in codon				
		T	C	A	G	
T	first base in codon	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
		TTA Leu	TCA Ser	TAA stop	TGA stop	A
		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	first base in codon	CTT Leu	CCT Pro	CAT His	CGT Arg	T
		CTC Leu	CCC Pro	CAC His	CGC Arg	C
		CTA Leu	CCA Pro	CAA Gln	CGA Arg	A
		CTG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	first base in codon	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T
		ATC Ile	ACC Thr	AAC Asn	AGC Ser	C
		ATA Ile	ACA Thr	AAA Lys	AGA Arg	A
		ATG Met	ACG Thr	AAG Lys	AGG Arg	G
G	first base in codon	GTT Val	GCT Ala	GAT Asp	GGT Gly	T
		GTC Val	GCC Ala	GAC Asp	GGC Gly	C
		GTA Val	GCA Ala	GAA Glu	GGA Gly	A
		GTG Val	GCG Ala	GAG Glu	GGG Gly	G

But first, you need to know the genetic code...



		second base in codon				
		T	C	A	G	
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		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
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		CTG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	first base in codon	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T
		ATC Ile	ACC Thr	AAC Asn	AGC Ser	C
		ATA Ile	ACA Thr	AAA Lys	AGA Arg	A
		ATG Met	ACG Thr	AAG Lys	AGG Arg	G
G	first base in codon	GTT Val	GCT Ala	GAT Asp	GGT Gly	T
		GTC Val	GCC Ala	GAC Asp	GGC Gly	C
		GTA Val	GCA Ala	GAA Glu	GGA Gly	A
		GTG Val	GCG Ala	GAG Glu	GGG Gly	G

This code tells your cells how to get from the DNA instructions (or 'recipe') to the protein product (or 'cake')!



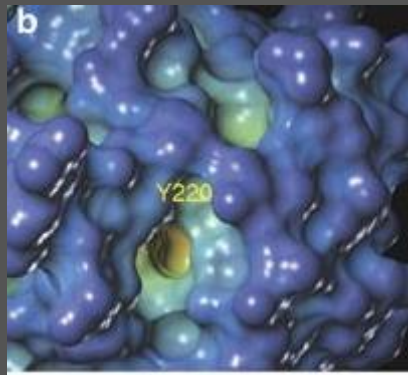
		second base in codon				
		T	C	A	G	
T	first base in codon	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
		TTA Leu	TCA Ser	TAA stop	TGA stop	A
		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	first base in codon	CTT Leu	CCT Pro	CAT His	CGT Arg	T
		CTC Leu	CCC Pro	CAC His	CGC Arg	C
		CTA Leu	CCA Pro	CAA Gln	CGA Arg	A
		CTG Leu	CCG Pro	CAG Gln	CGG Arg	G
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		ATC Ile	ACC Thr	AAC Asn	AGC Ser	C
		ATA Ile	ACA Thr	AAA Lys	AGA Arg	A
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G	first base in codon	GTT Val	GCT Ala	GAT Asp	GGT Gly	T
		GTC Val	GCC Ala	GAC Asp	GGC Gly	C
		GTA Val	GCA Ala	GAA Glu	GGA Gly	A
		GTG Val	GCG Ala	GAG Glu	GGG Gly	G

Here is a section of the normal DNA code for the p53 gene:



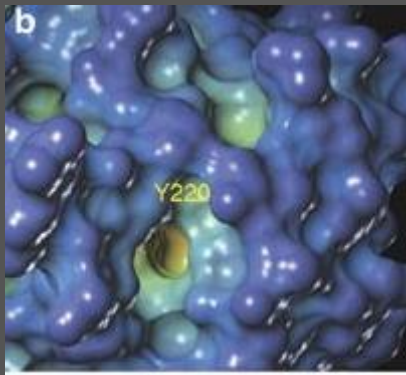
		second base in codon				
		T	C	A	G	
T	first base in codon	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
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		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
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	CTC Leu	CCC Pro	CAC His	CGC Arg	C	
	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A	
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A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T	
	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C	
	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G	
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C	
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A	
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G	

4. Can you work out which three amino acids this sequence will code for?



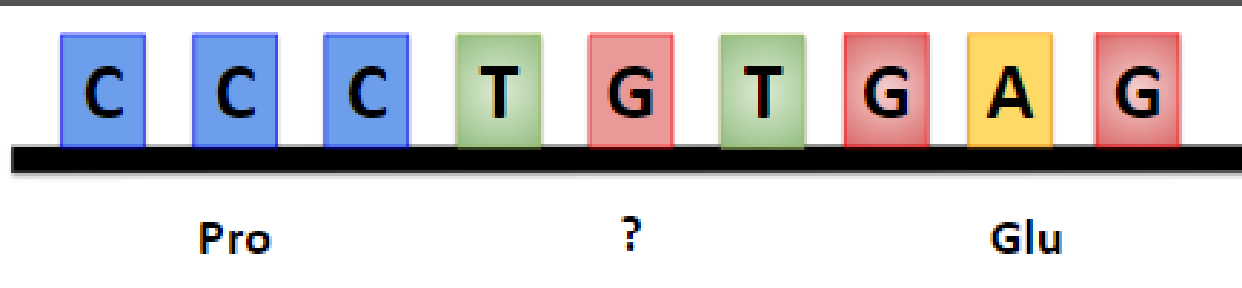
		second base in codon				
		T	C	A	G	
T	first base in codon	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
		TTA Leu	TCA Ser	TAA stop	TGA stop	A
		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	CTT Leu	CCT Pro	CAT His	CGT Arg	T	
	CTC Leu	CCC Pro	CAC His	CGC Arg	C	
	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A	
	CTG Leu	CCG Pro	CAG Gln	CGG Arg	G	
A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T	
	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C	
	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G	
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C	
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A	
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G	

4. Can you work out which three amino acids this sequence will code for?



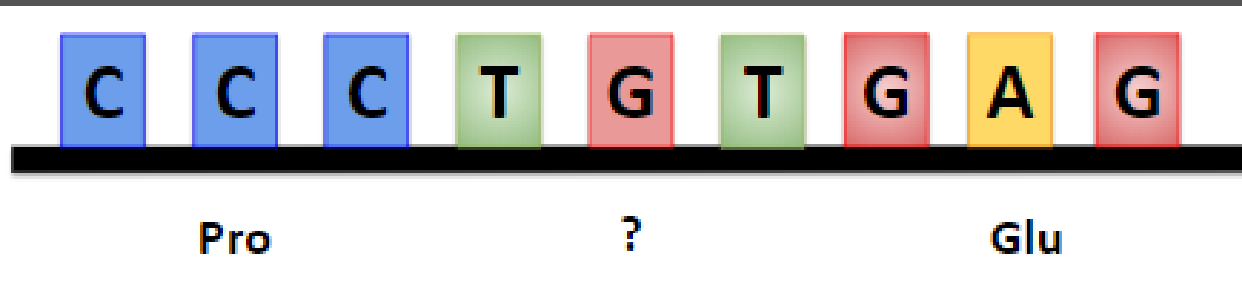
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		TTA Leu	TCA Ser	TAA stop	TGA stop	A
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C	CTT Leu	CCT Pro	CAT His	CGT Arg	T	
	CTC Leu	CCC Pro	CAC His	CGC Arg	C	
	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A	
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A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T	
	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C	
	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G	
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C	
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A	
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G	

In 50% of cancers, p53 is mutated. One of the mutations is shown below:



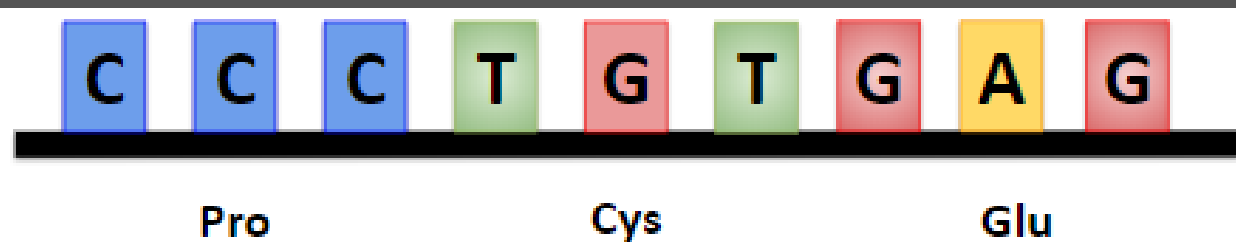
		second base in codon				
		T	C	A	G	
T	first base in codon	TTT Phe	TCT Ser	TAT Tyr	TGT Cys	T
		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
		TTA Leu	TCA Ser	TAA stop	TGA stop	A
		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	CTT Leu	CCT Pro	CAT His	CGT Arg	T	
	CTC Leu	CCC Pro	CAC His	CGC Arg	C	
	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A	
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A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T	
	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C	
	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G	
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C	
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A	
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G	

5. What will be the effect of this mutation on the amino acid sequence?



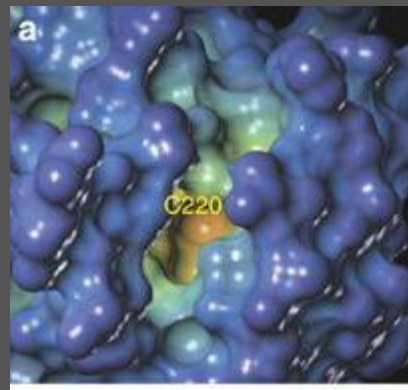
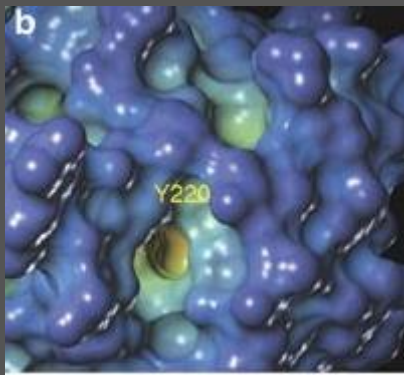
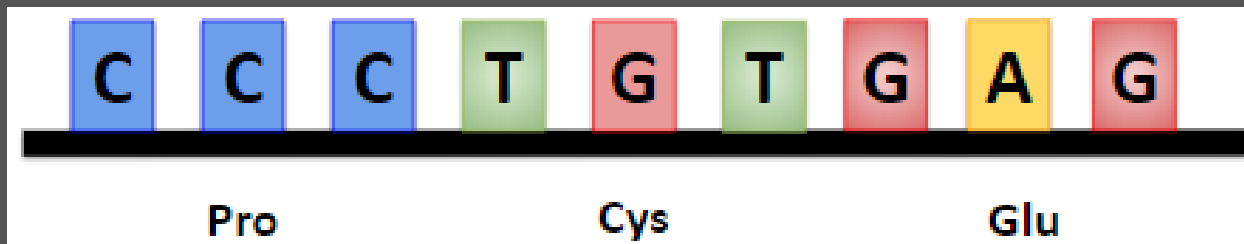
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		TTC Phe	TCC Ser	TAC Tyr	TGC Cys	C
		TTA Leu	TCA Ser	TAA stop	TGA stop	A
		TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	CTT Leu	CCT Pro	CAT His	CGT Arg	T	
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G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
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	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	ATG Met	ACG Thr	AAG Lys	AGG Arg	G	
G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T	
	GTC Val	GCC Ala	GAC Asp	GGC Gly	C	
	GTA Val	GCA Ala	GAA Glu	GGA Gly	A	
	GTG Val	GCG Ala	GAG Glu	GGG Gly	G	

6. What will be the effect of this mutation on the protein?

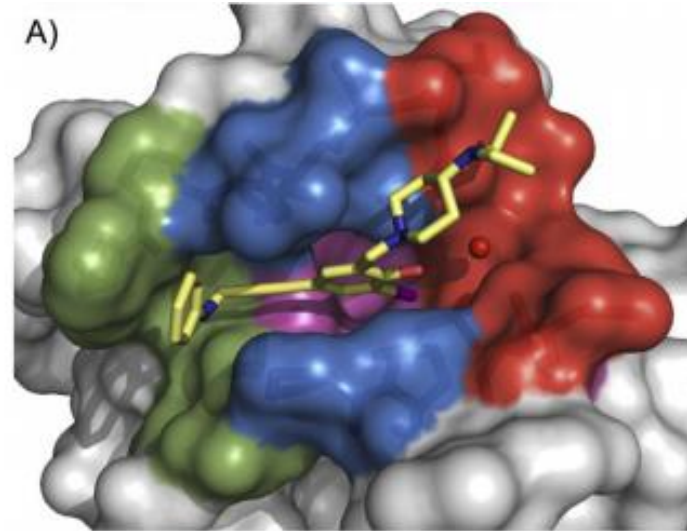
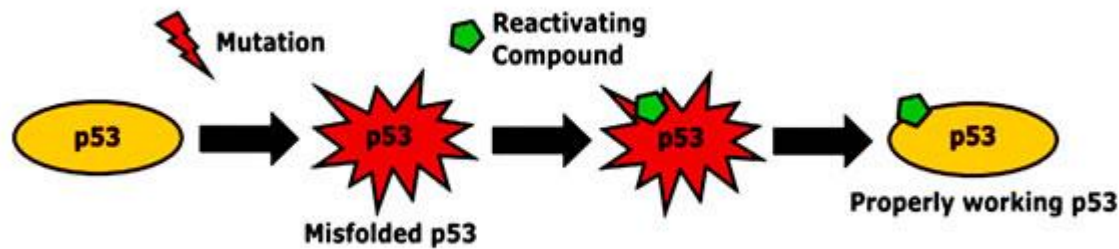


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		T	C	A	G	
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	T	TTG Leu	TCG Ser	TAG stop	TGG Trp	G
C	C	CTT Leu	CCT Pro	CAT His	CGT Arg	T
	C	CTC Leu	CCC Pro	CAC His	CGC Arg	C
	C	CTA Leu	CCA Pro	CAA Gln	CGA Arg	A
	C	CTG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	A	ATT Ile	ACT Thr	AAT Asn	AGT Ser	T
	A	ATC Ile	ACC Thr	AAC Asn	AGC Ser	C
	A	ATA Ile	ACA Thr	AAA Lys	AGA Arg	A
	A	ATG Met	ACG Thr	AAG Lys	AGG Arg	G
G	G	GTT Val	GCT Ala	GAT Asp	GGT Gly	T
	G	GTC Val	GCC Ala	GAC Asp	GGC Gly	C
	G	GTA Val	GCA Ala	GAA Glu	GGA Gly	A
	G	GTG Val	GCG Ala	GAG Glu	GGG Gly	G

Scientists can combat cancers and other diseases by giving drugs that target mutated proteins like this.

What can we do?

The drug molecules can ‘inhibit’ (block) a target protein, or in this case stabilise it so it works again:



What can we do?

7. What do you think are the applications of genetics in the future?

What next?

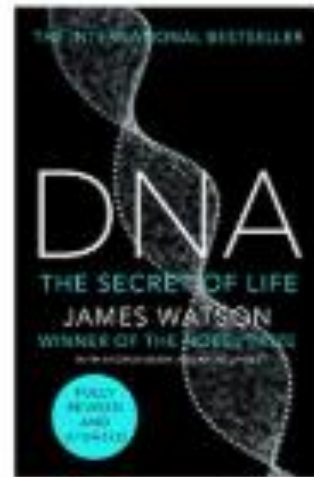
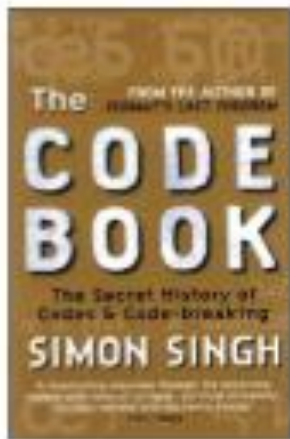
- Designer babies
- Human cloning
- Exact genetic repairs?

What next?

Suggested Reading

The Code Book

Simon Singh

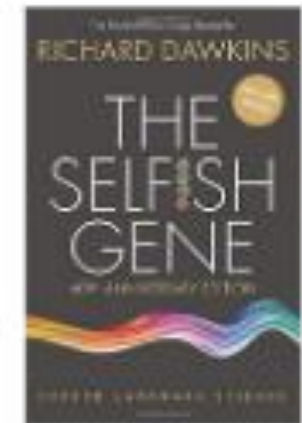
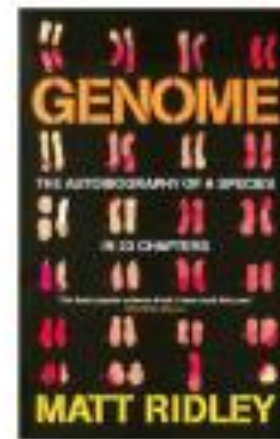


DNA: The Secret of Life

James Watson

Genome

Matt Ridley

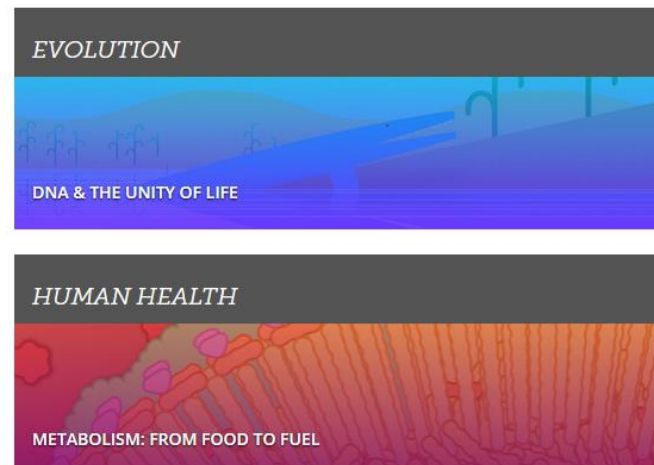
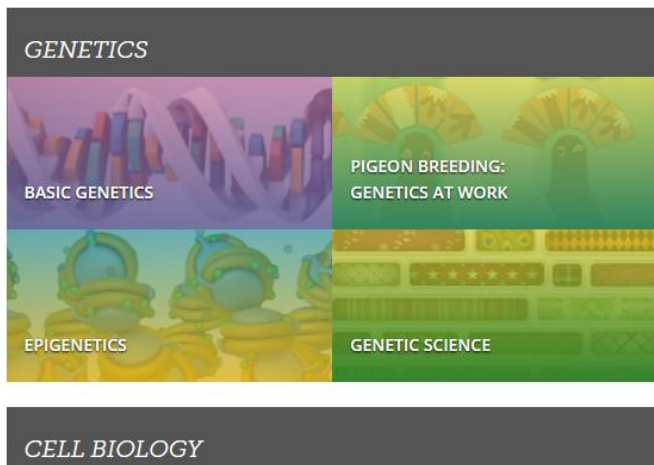


The Selfish Gene

Richard Dawkins

Suggested Websites

<https://learn.genetics.utah.edu/>



Suggested Websites

<https://www.yourgenome.org/>

The screenshot shows the homepage of yourgenome.org. At the top left is the logo "yourgenome" in white on a dark green background. To its right is the tagline: "Discover more about DNA[?], genes[?] and genomes[?], and the implications for our health and society." Below this is a navigation bar with five categories: "In the Cell", "Methods & Technology", "Targeting Disease", "Society & Behaviour", and "Animals & Plants". The main content area features three featured articles:

- What is a stem cell?** (FACTS): A stem cell is a cell with the unique ability to develop into specialised cell types in the body. In the future they may be used to replace ...
- DNA replication** (VIDEO): This 3D animation shows you how DNA is copied in a cell. It shows how both strands of the DNA helix are unzipped and copied to produce two ...
- What is a genome?** (FACTS): A genome is an organism's complete set of genetic instructions. Each genome contains all of the information needed to build that organism ...

Suggested Websites

<https://www.amnh.org/explore/ology>

“OLogy” means “the study of” Choose an OLogy!

 Anthropology People and cultures in the past and today	 Genetics How genes are passed down generations
 Archaeology People and artifacts from ancient time	 Marine Biology Life in the ocean
 Astronomy The Universe and everything in it	 Microbiology Bacteria, viruses, and other microorganisms
 Biodiversity The rich variety of life on Earth	 PaleontOLOGY Dinosaurs and other things that lived long ago
 Brain The organ inside our skulls	 Physics Matter and its motion through space and time
 Climate Change Long-term changes in global temperature	 Water The liquid that makes life on Earth possible
 Earth The dynamic planet that we call home	 Zoology All animals from insects to mammals

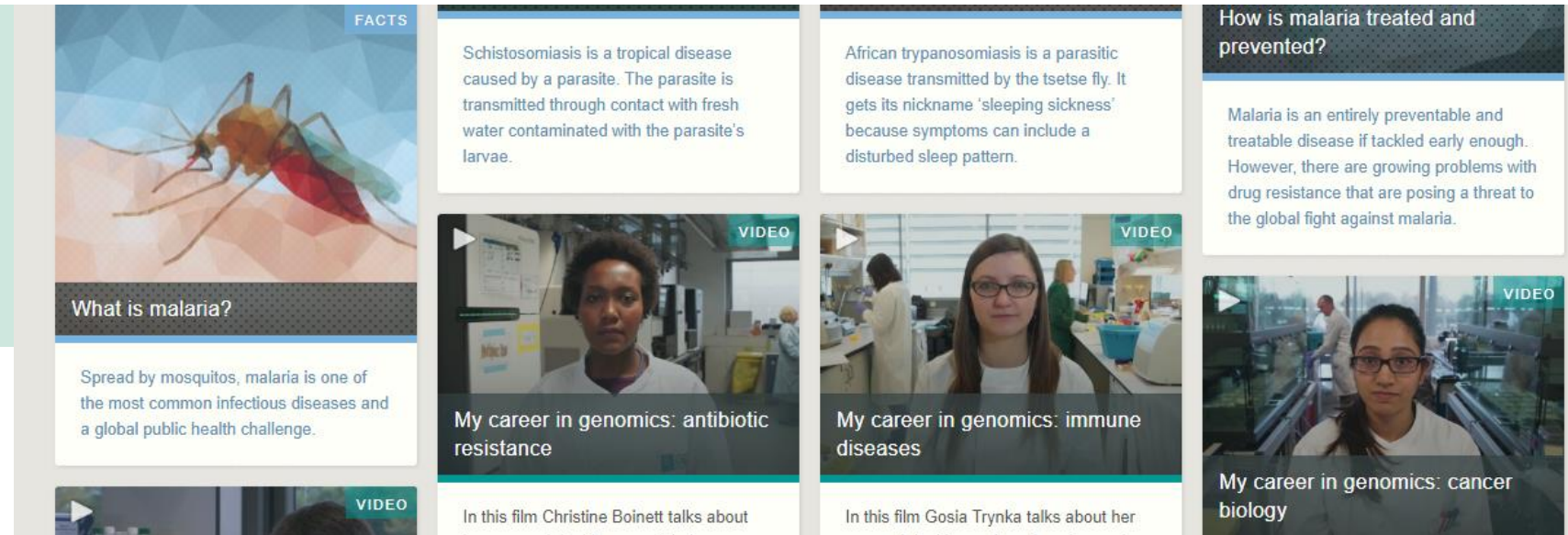
Follow Up Tasks

Visit this website:

<https://www.yourgenome.org/topic/targeting-disease>

Pick a disease area that is of interest to you and read the article and/or watch the video.

Summarise the information in one paragraph and send to sally.mcgrath@mybiddenham.com



FACTS

Schistosomiasis is a tropical disease caused by a parasite. The parasite is transmitted through contact with fresh water contaminated with the parasite's larvae.

African trypanosomiasis is a parasitic disease transmitted by the tsetse fly. It gets its nickname 'sleeping sickness' because symptoms can include a disturbed sleep pattern.

How is malaria treated and prevented?

Malaria is an entirely preventable and treatable disease if tackled early enough. However, there are growing problems with drug resistance that are posing a threat to the global fight against malaria.

What is malaria?

Spread by mosquitos, malaria is one of the most common infectious diseases and a global public health challenge.

VIDEO

My career in genomics: antibiotic resistance

In this film Christine Boinett talks about

VIDEO

My career in genomics: immune diseases

In this film Gosia Trynka talks about her

VIDEO

My career in genomics: cancer biology