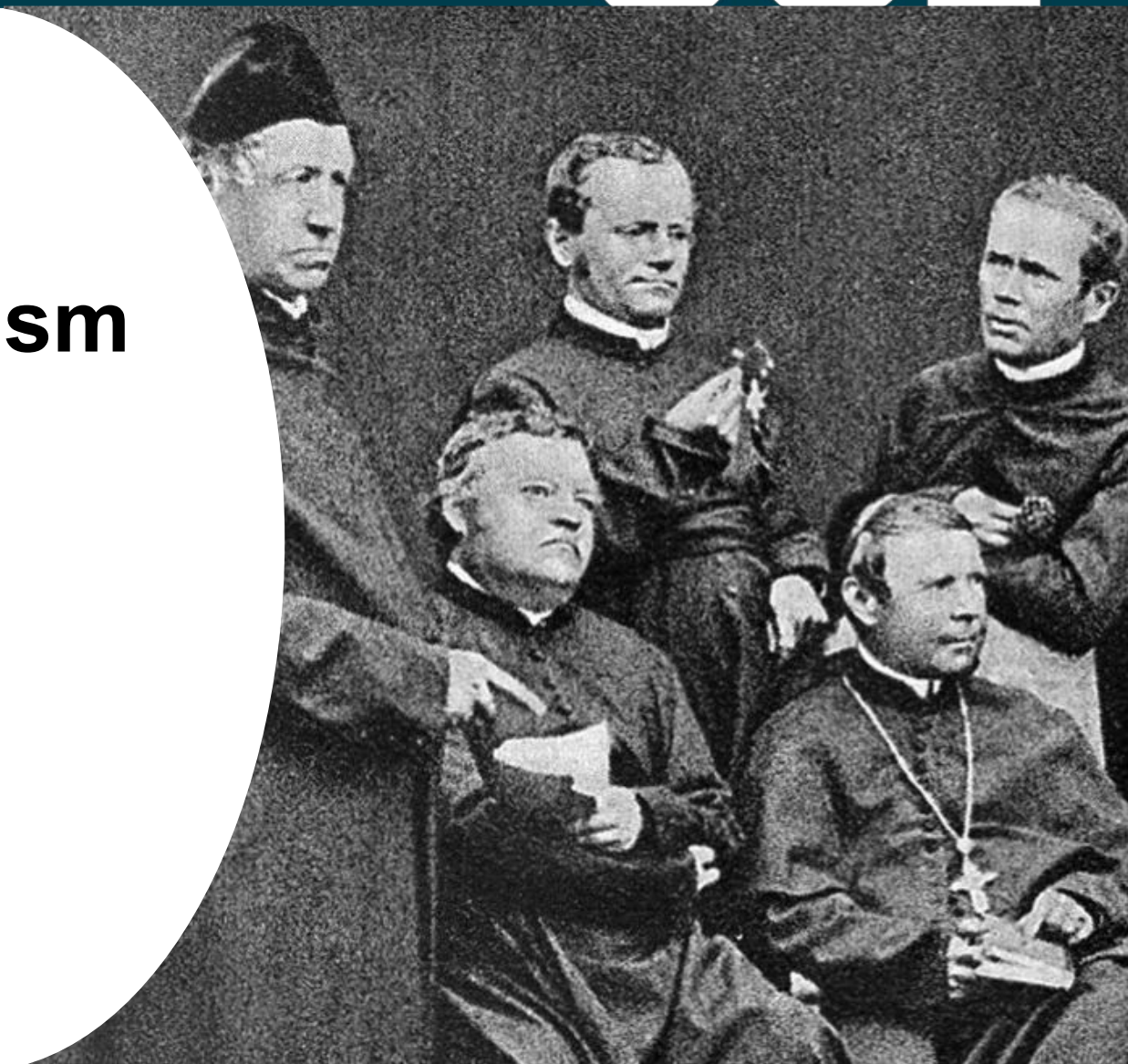
Research Department of
Genetics, Evolution and Environment

UCL

Mendel, Genetic Determinism & Racial Realism



Andy Walton

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Molecular and Cultural Evolution Lab
UCL

My background

- PhD (kindly funded by the Adelphi Genetics Forum) investigating the dominant model underlying population genetics

- Focussing on where its assumptions came from, whether they're still necessary to make and developing new models

- But… my training is in evolutionary genetics

Challenges in Evolutionary Genetics Teaching

- Understanding of evolution amongst the British public is low, even among Biology undergraduates

- Post-COVID many students are accessing learning materials through non-official sources, which frequently contain erroneous or outdated information

- Misconceptions about genetics and evolution boost racial realist or medical misinformation

Contents

- Population genetics in the curriculum today
  - Mendelian Inheritance
  - Genetic variation and Race
  - Inheritance and medicine
- Where these ideas came from
- Good resources & ideas

Mendelian Inheritance

- In 1900 Mendel's work on pea genetics was re-discovered
- Prior to this genes were thought to blend – small and tall parents would have a mid-sized child
- Mendel showed how the continuous traits seen in nature (Darwin) could result from the inheritance of single genes (Weismann) – the *Modern Synthesis*

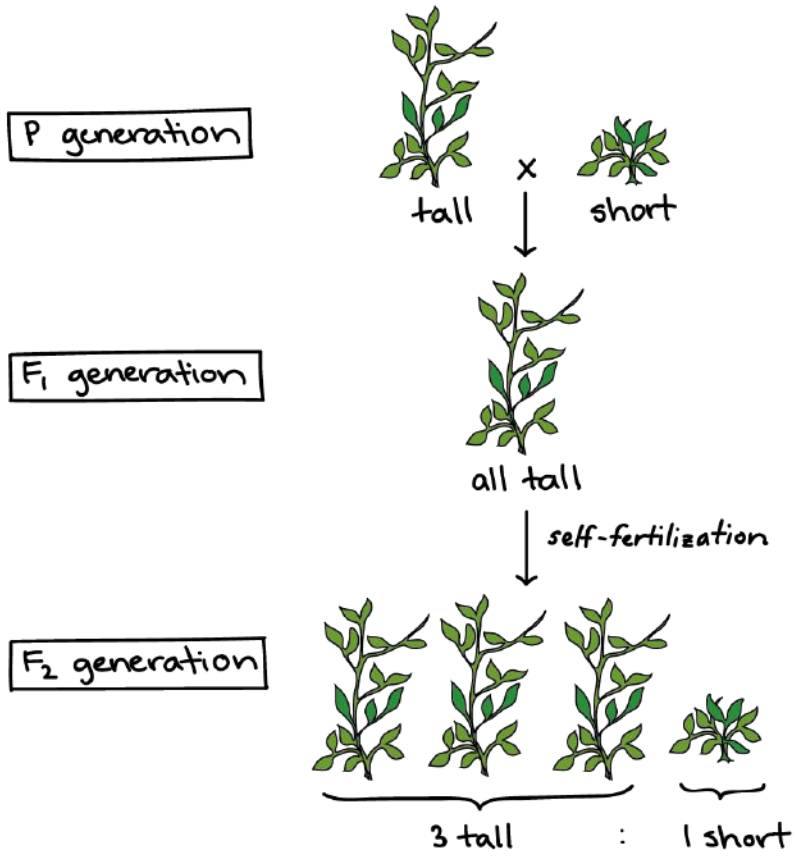


Image: Khan Academy

Mendelian Inheritance in the curriculum

- Across all the major exam boards, how Mendelian Inheritance it taught is pretty consistent
- There is an emphasis on complex traits and gene + environment interaction
- However, textbooks are not the only source of GCSE content

4.6.1.6 Genetic inheritance

Content

Some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans. Each gene may have different forms called alleles.

The alleles present, or genotype, operate at a molecular level to develop characteristics that can be expressed as a phenotype.

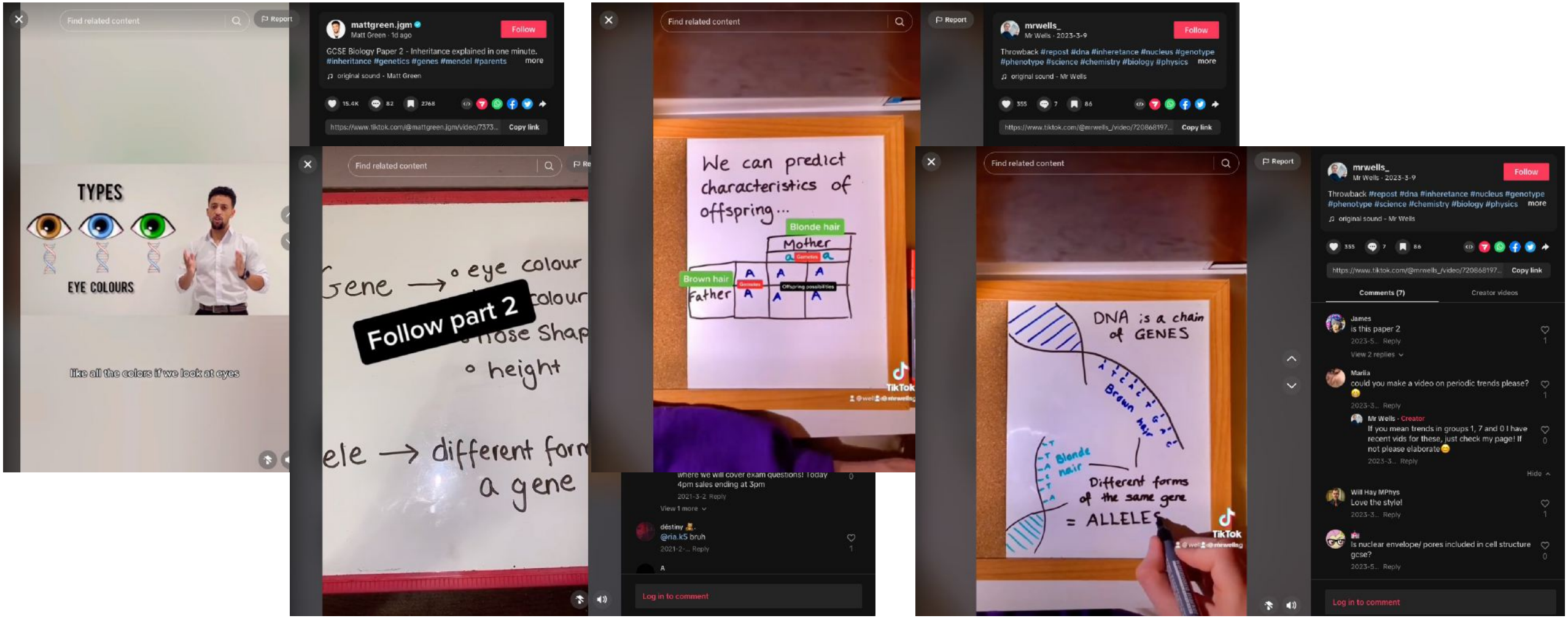
A dominant allele is always expressed, even if only one copy is present. A recessive allele is only expressed if two copies are present (therefore no dominant allele present).

If the two alleles present are the same the organism is homozygous for that trait, but if the alleles are different they are heterozygous.

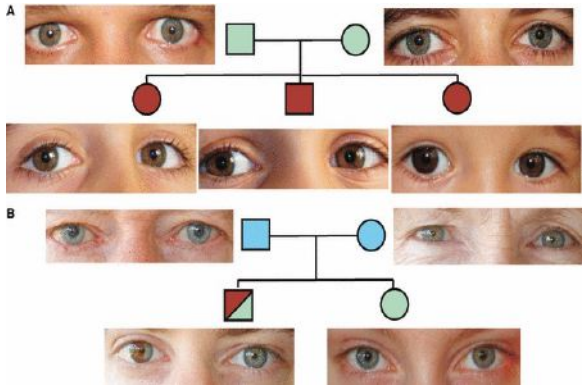
Most characteristics are a result of multiple genes interacting, rather than a single gene.

Source: AQA GCSE Biology (8461) Version 1.0

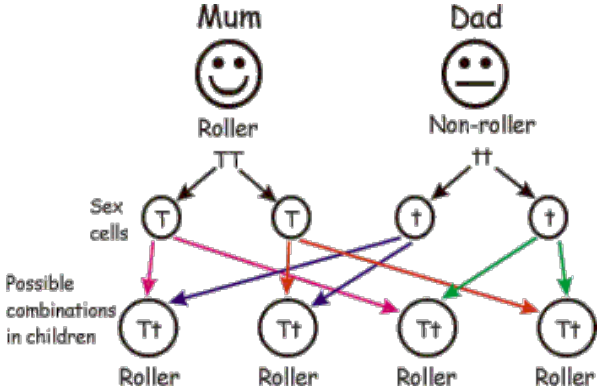
Post COVID Learning



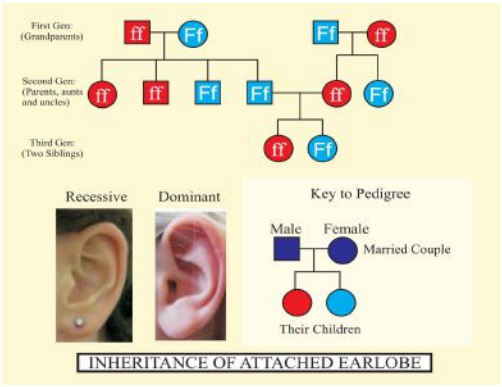
Mendelian Examples



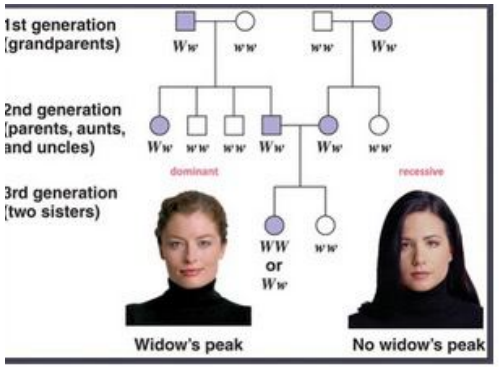
Eye colour



Tongue Rolling

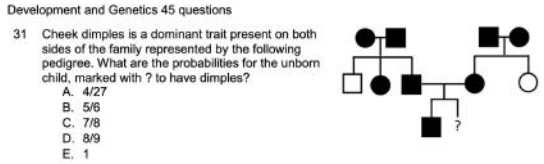


Ear lobes

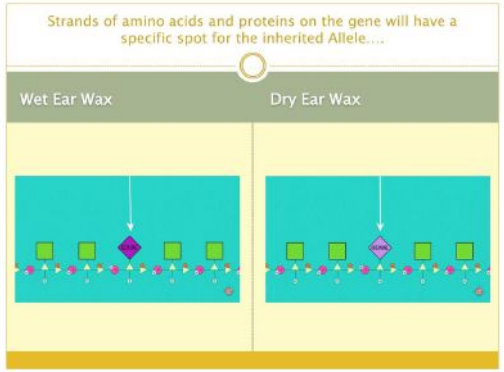


Widow's peak

All of these are a bit more complicated!



Cheek dimples



Ear wax

Mendelian Examples – the problem

- However, almost nothing is monogenic
- Almost every trait is complex, i.e. influenced by the **small effects of many genes + the environment**
- And most phenotypes have extremely complicated mechanisms that are only partly understood
- Likewise, the relationship between phenotype and these genes is complex

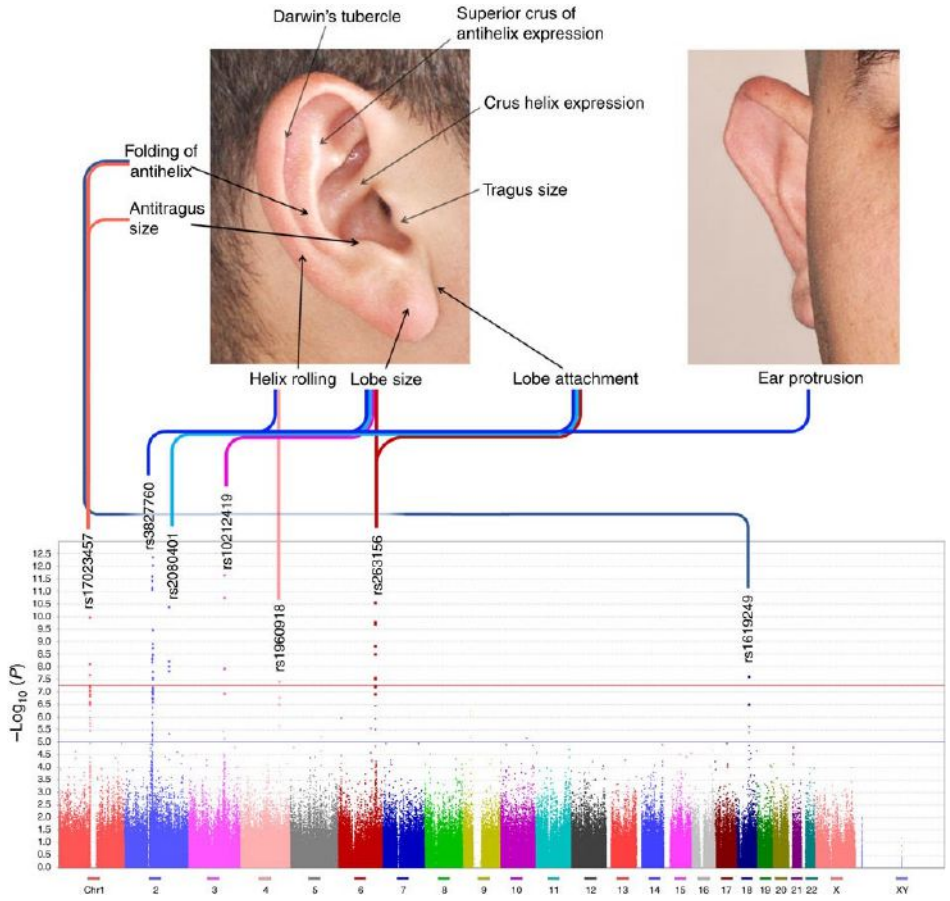


Image: Adhikari et al. (2015), Nature

Why this matters – the ‘gene for’

- Since next generation sequencing there has been a flood of Genome Wide Association Studies (GWAS)
- These are useful for identifying parts of the genome which are associated with a particular trait
- They can also be useful in understanding genetic bases of disease and underlying pathways

Genetic loci associated with heart failure

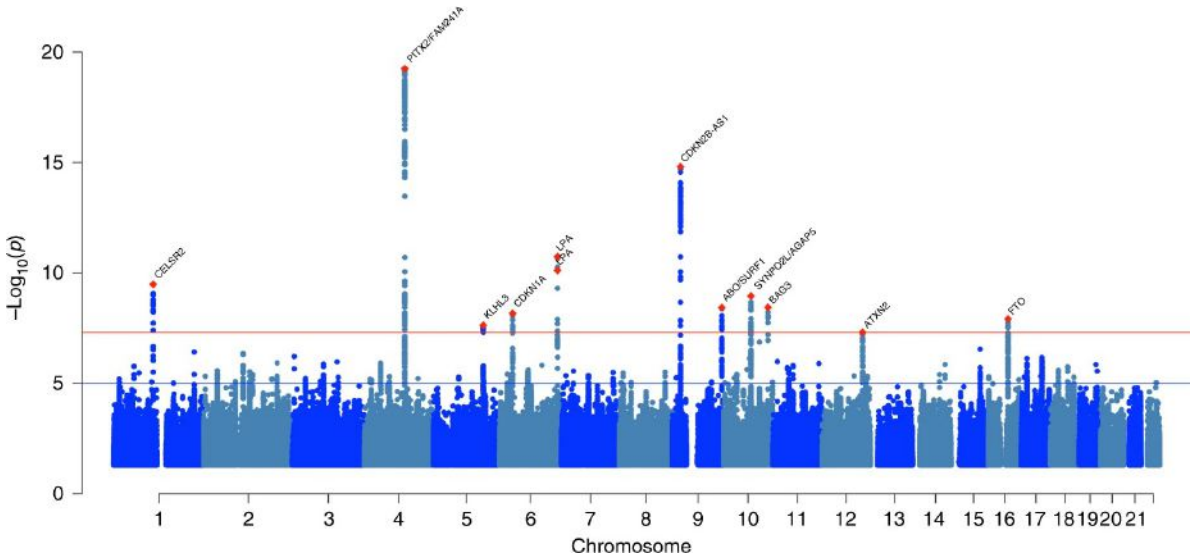


Image: Shah et al. (2020), Nature

Why this matters – the ‘gene for’

- And this leads to media attention:

Why this matters – at home testing

- People are increasingly interested in whether they have the ‘gene for’
- And many companies are quite happy to tell you (for ~ £180)
- This can lead to both mental health concerns but also people putting off checks/treatment

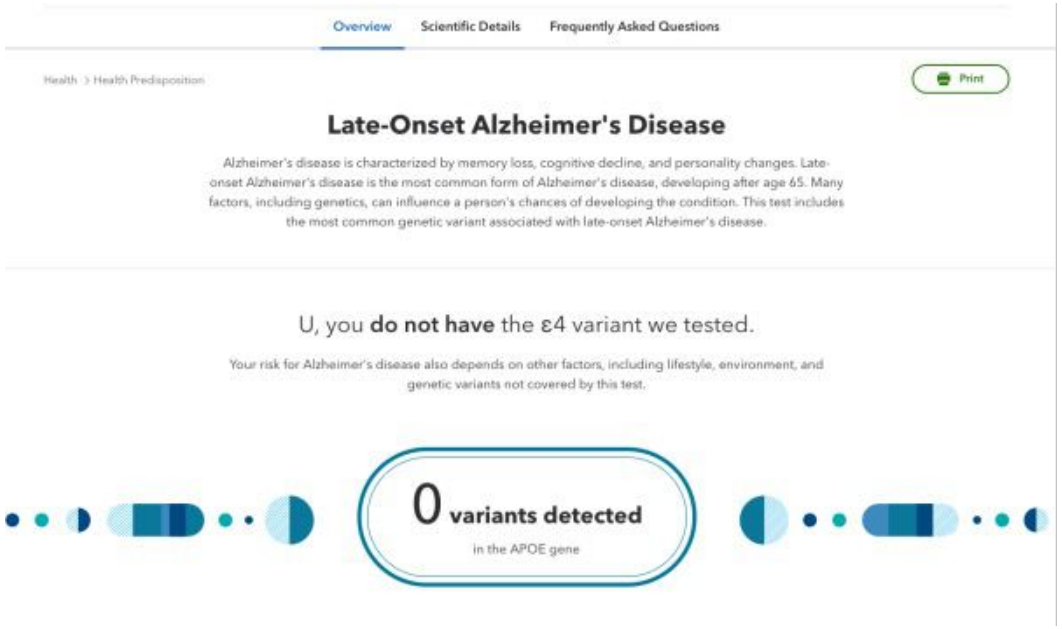


Image: Written Evidence Submitted by 23andMe to Parliament 2020

Why this matters – genetic determinism

- Perhaps more importantly, it re-enforces the idea of genetic determinism
- I.e. that our characteristics and abilities are predominantly genetically determined and thus immutable
- In recent years, miscommunicated genetics has been used to boost the ‘racial realist movement’ and promote scientific racism
- There is evidence in both schools and universities, that emphasis of Mendelian inheritance and monogenic traits promotes essentialist and determinist thinking

Genetics and ‘Racial Realism’

- Over the past few years there had been an increase in the argument that race is a meaningful biological category
- I.e. not only that a person’s race is genetically determined, but that certain characteristics are also determined by their race
- Much of this is based on misunderstandings of heritability and human genetic variation

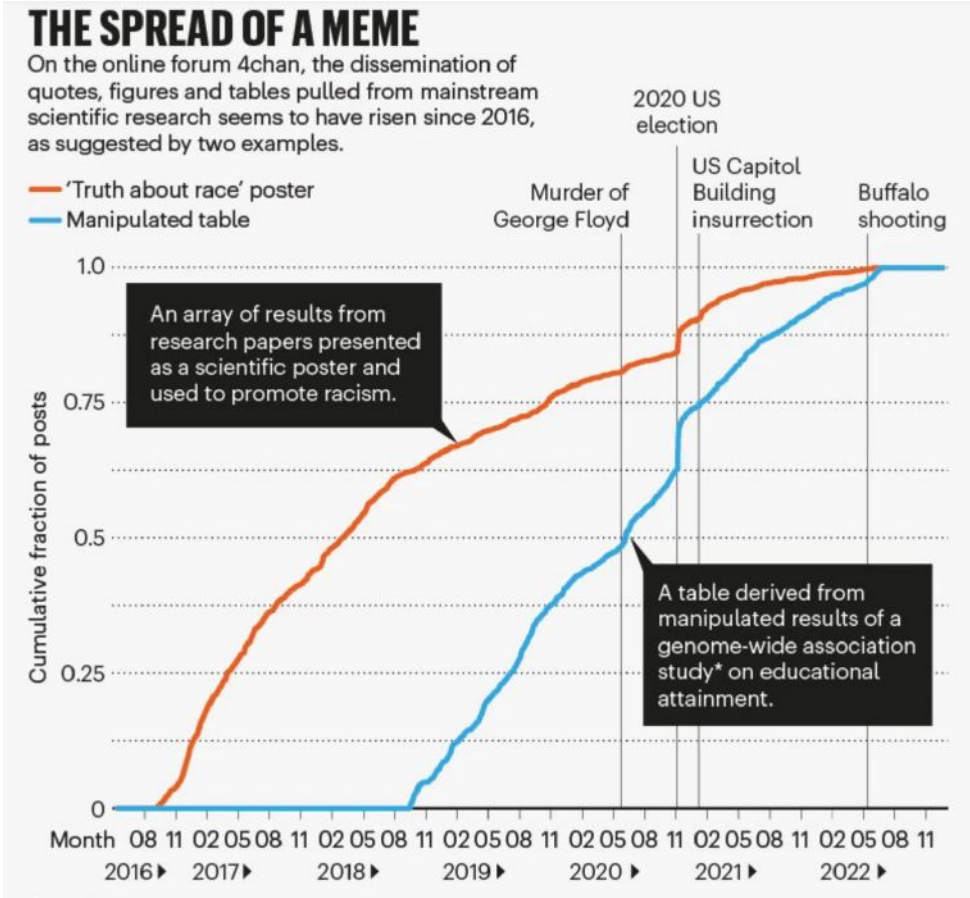
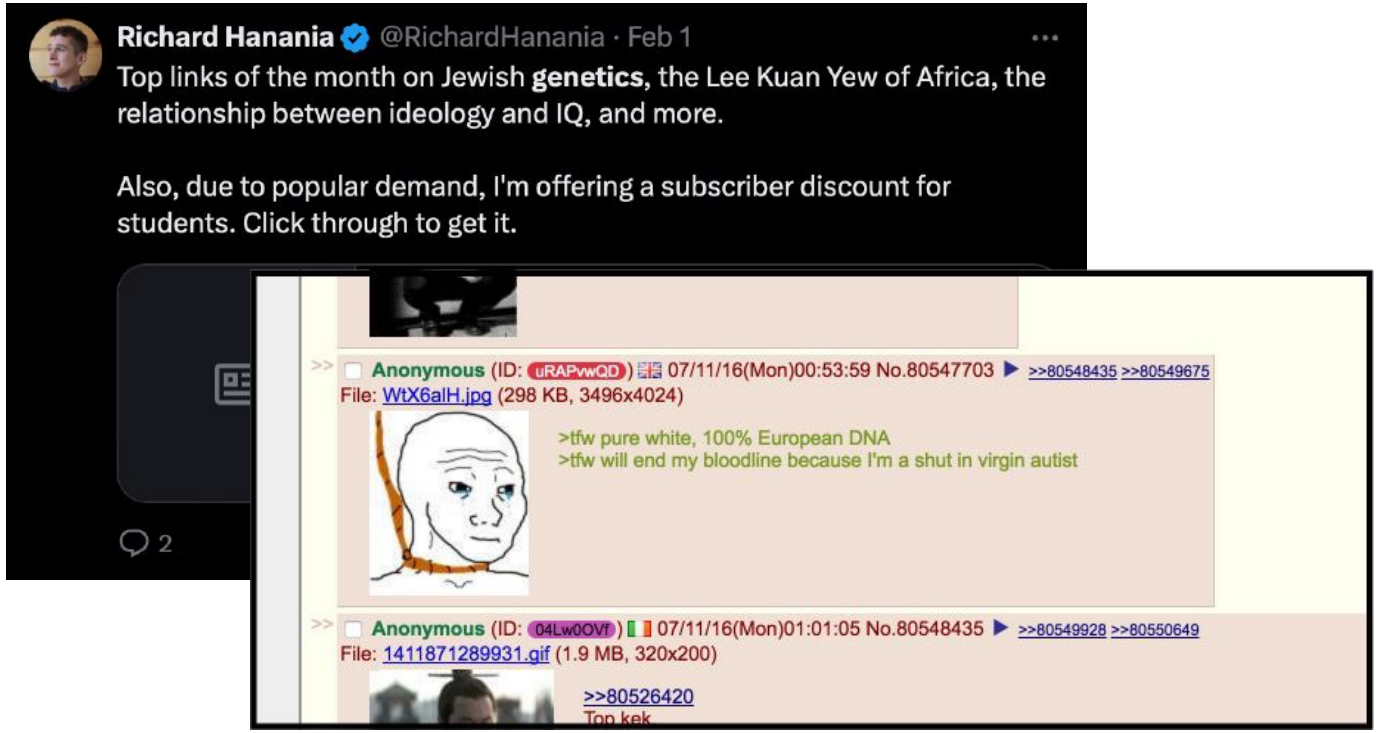


Image: J. J. Lee et al. Nature Genet. (2018)

Genetics and ‘Racial Realism’

- What makes this racist movement unusual is it is popular amongst young people and is frequently promoted through social media:



‘Racial Realism’ – the reality

- Race is not a meaningful biological category
- A few reasons why:

  1) There is more genetic variation within continents than between

  I.e. less than 9% of genetic variation is due to differences between populations with classical racial groupings

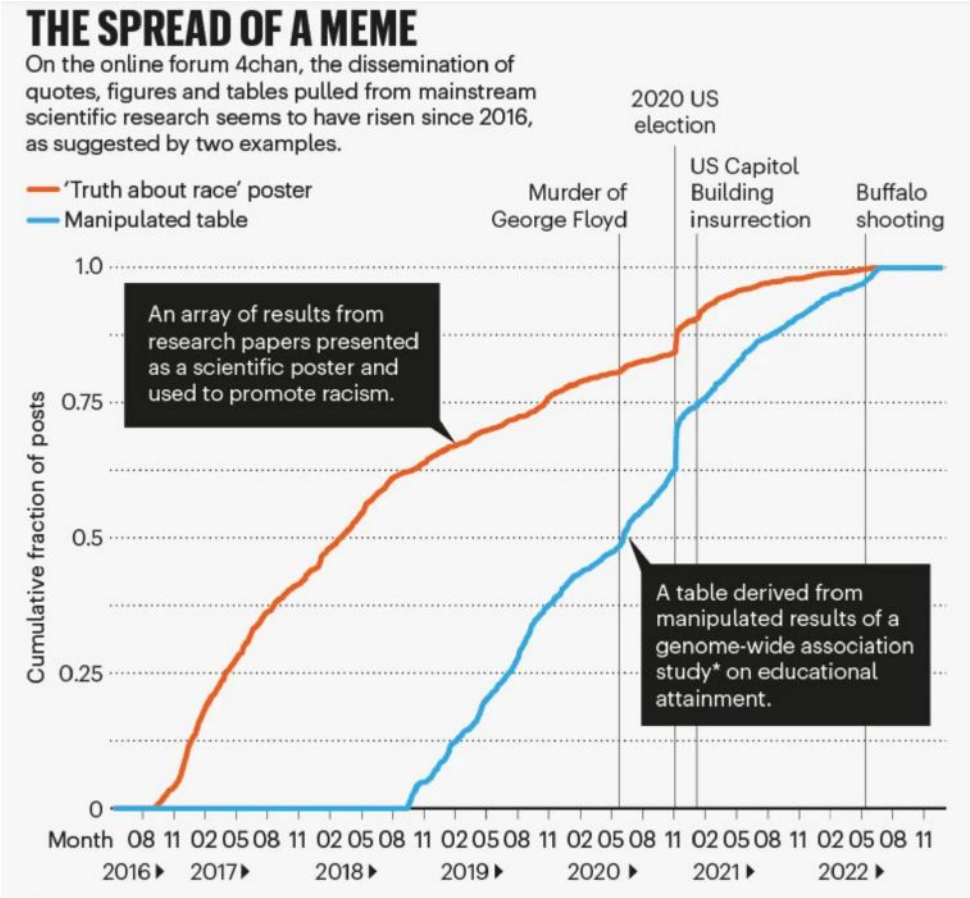


Image: J. J. Lee et al. Nature Genet. (2018)

‘Racial Realism’ – the reality

- This means, that an English person is more genetically similar to a Mongolian person than nearby African populations are to each other:

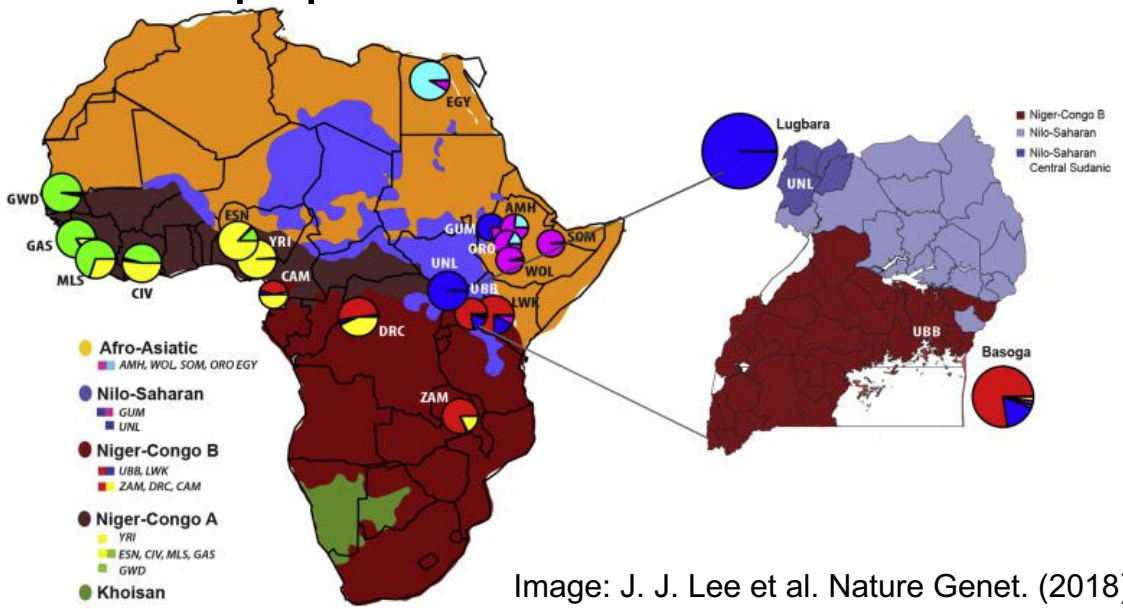
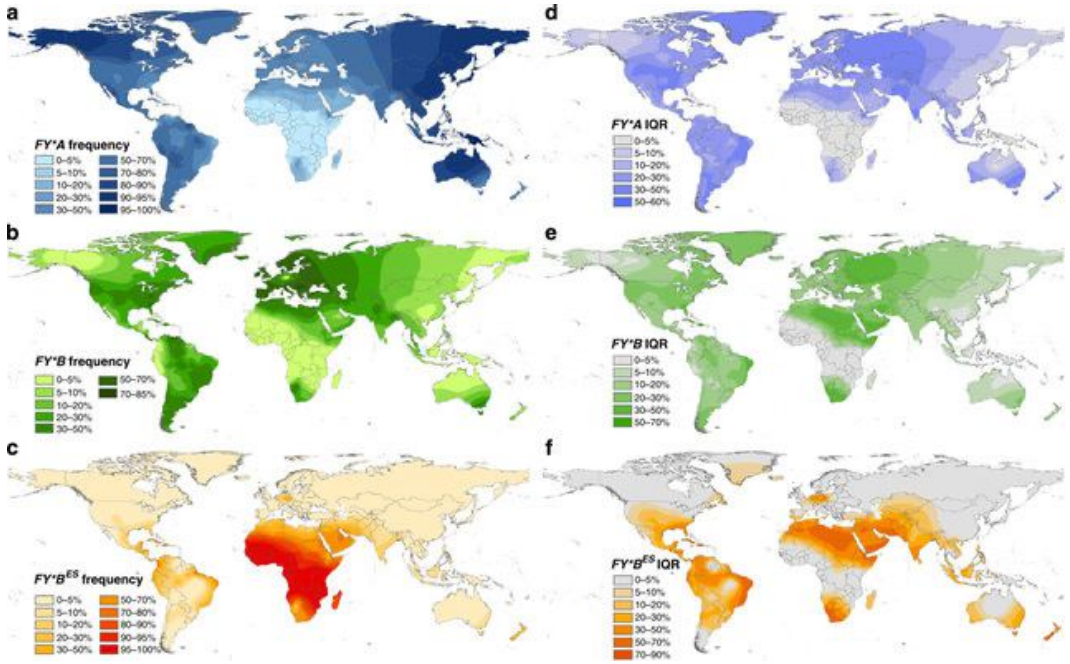


Image: J. J. Lee et al. Nature Genet. (2018)

- This is because all modern humans are descendants from Africa: non-Africans carry only a small subset of total human genetic variation

‘Racial Realism’ – the reality

2) Traditional racial distinctions generally do not line up with geographic distributions of genetic variants:



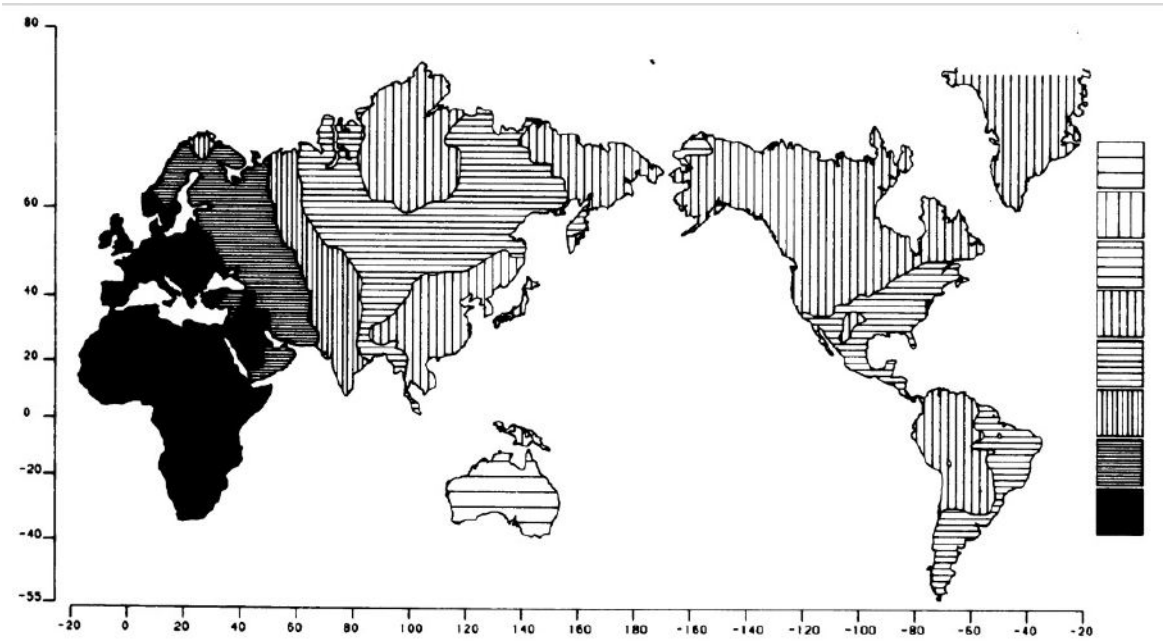
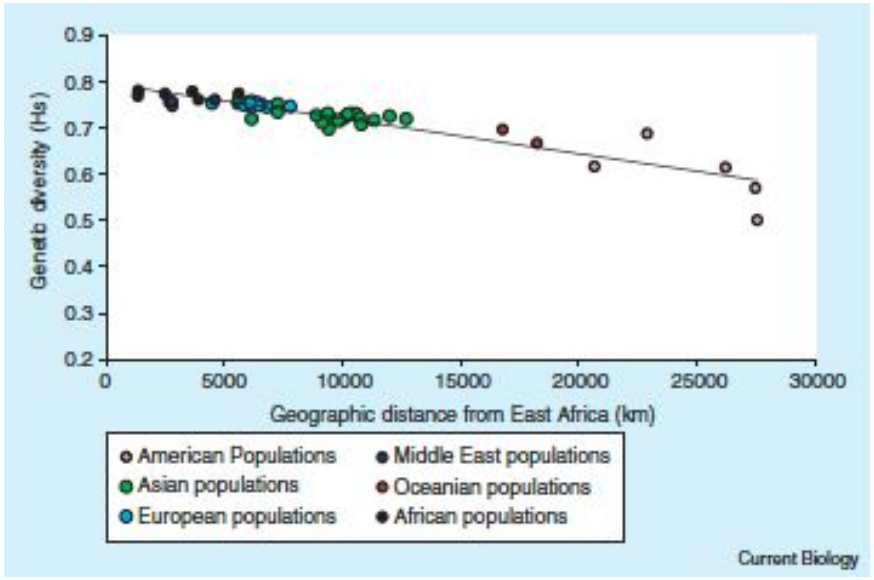
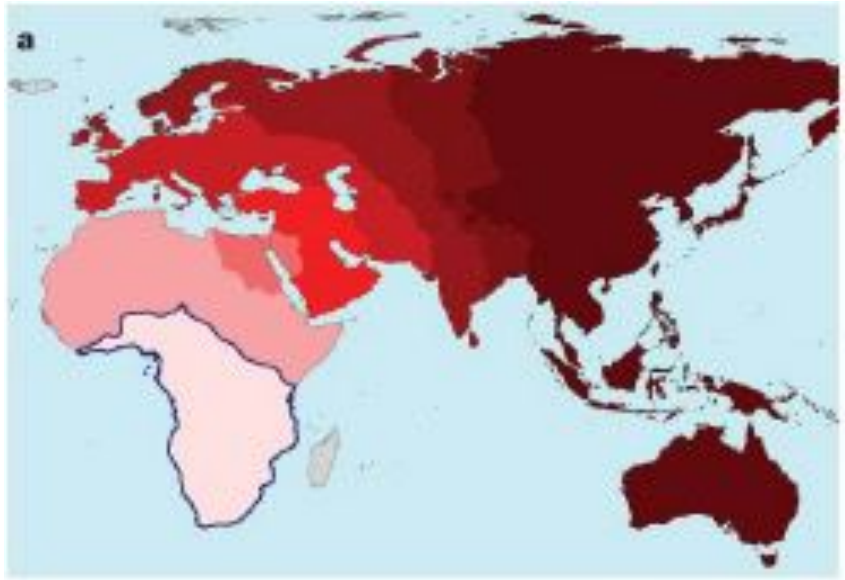


Image: Duffy (2018)

‘Racial Realism’ – the reality

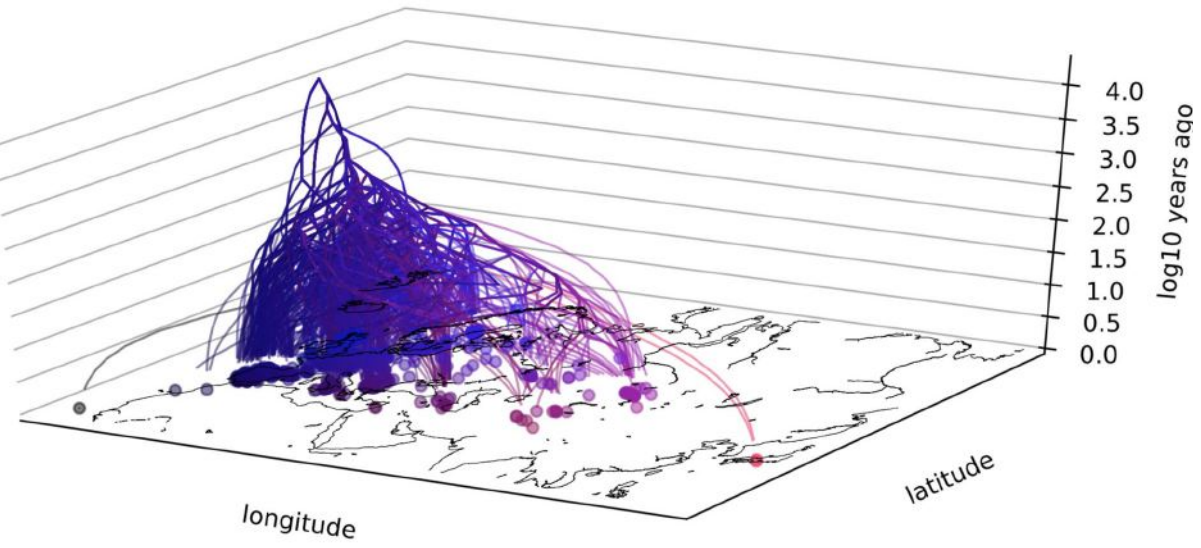
3) Most of the variation that does exist tends to be continuous: racial categorisation tends to be culturally relative

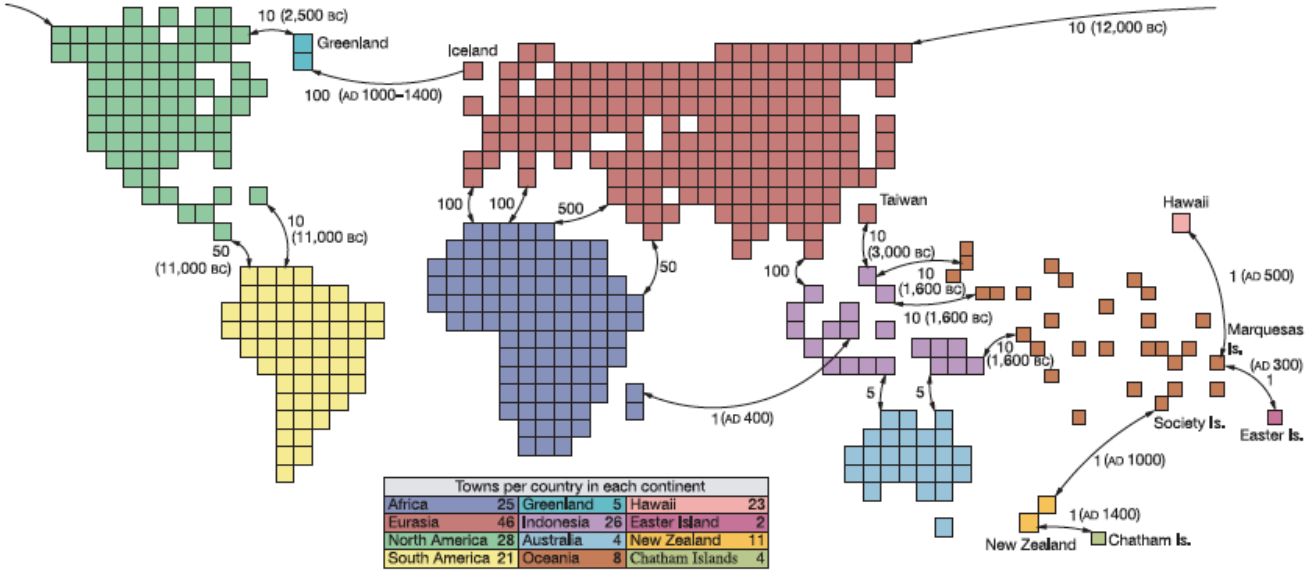




‘Racial Realism’ – the reality

4) All humans share very recent common ancestors: ours is a history of migration and admixture





Genetics and Medicine

- Besides racial realism, misunderstandings about the genetics of race can also have health implications
- Monogenic disorders are often associated with race in school & popular biology content
- This, combined with misunderstandings about the genetic basis of race, has led to widespread misunderstandings about the link between certain medical disorders and race

Genetics and Medicine

- For instance, Sickle Cell:

Sickle Cell Anaemia

This disease affects black people of African origin. It is a recessive gene disease which also has a good side. A person who has one copy of the gene has blood which can fight off the disease malaria, while suffering no defects. If a person inherits two copies of the gene then there are problems. The defective gene affects haemoglobin, the protein in blood which carries oxygen. When oxygen levels in the blood are low the haemoglobin becomes sticky, turning the RBCs from their usual biconcave disc into a crescent moon shape like a sickle. This makes it harder for them to flow through blood vessels leading to blockages which can be very painful.

- Thus, people who do not identify as black are increasingly avoiding Sickle Cell tests
- This has led to numerous preventable deaths worldwide

Sickle cell anaemia is another condition that can be inherited. It is a recessive condition so two HbS alleles are needed for the disease. The dominant allele is HbA . The disease itself is caused by the change in base sequence of the gene that codes for haemoglobin. This causes abnormal haemoglobin and sickle-shaped red blood cells. These can get stuck in blood vessels thus, hindering the delivery of oxygen to tissues. Hence, fatigue, fever and painful joints are symptoms of the disease.

However, being a carrier of the disease can be advantages. If you are heterozygous for the sickle cell allele (genotype HbS HbA), then you are less likely to get malaria as you are resistant to it. This is advantageous in places where the incidence of malaria is high e.g. in Africa. Hence, over time, this has caused an increase in the number sickle cell alleles in the population and also the number of carriers.

Genetics and Medicine

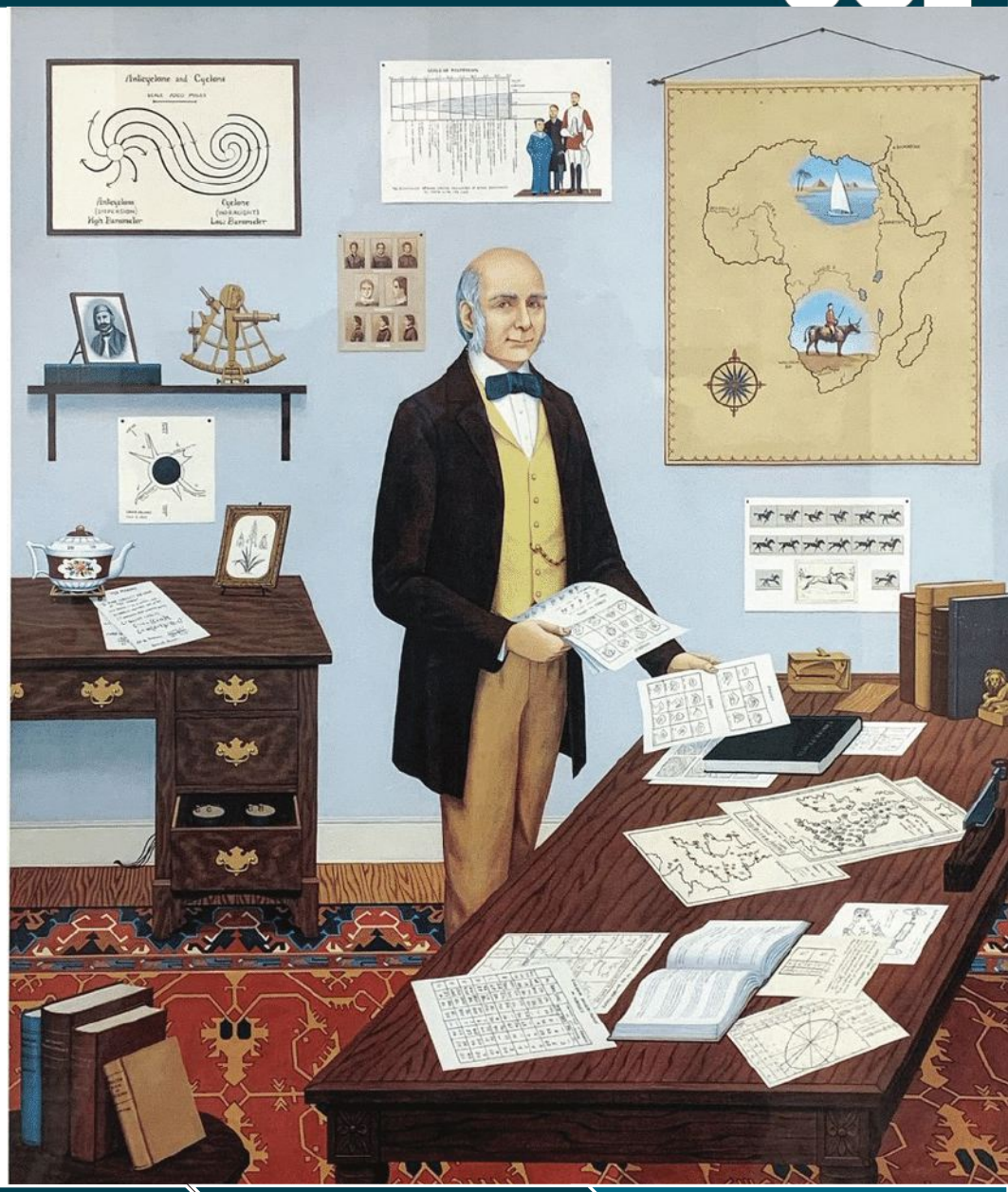
- This is not just a public perception issue – race is still used as a biological concept in medicine
- This has serious implications for patients, particularly those of colour
- Notably in the dishonest marketing of drugs to a particular racial group
- As medicine becomes more genetically informed, increasing public understanding in these areas is critical

A quick sidetrack – where much of this came from…

- Many of the issues we have talked about today are due to the legacy of early geneticists – not the public or teachers
- Many of the founders of the field of population genetics were eugenicists
- Racial realism and race science originated out of eugenics during the birth of population genetics – contributed to in large part by scientists at my own institution
- A little sidetrack into this history…

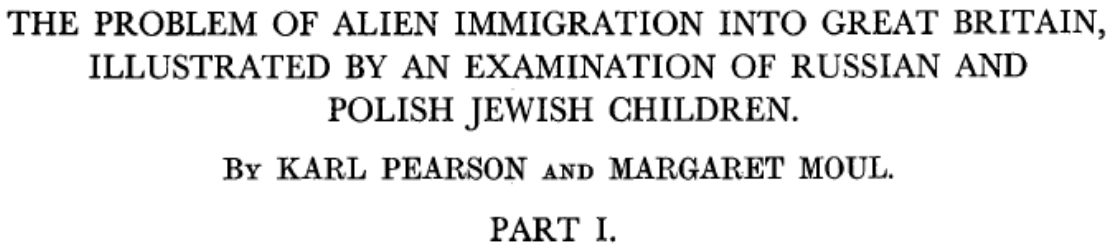
A quick sidetrack – History of Eugenics

- Eugenics was the movement founded in the late 1800s which argued that certain people possess traits that are superior to others
- And that because these are inherited genetically, to improve society certain people should have more or less offspring
- The movement was the intellectual underpinnings of Nazi race policy and its policies continued to harm people (especially in the US) well into the late 20th Century



A quick sidetrack – Eugenics & Genetics

- The assertion that genetics are determinist and that they prove race as a relevant biological category has its roots in the eugenics movement
- Many of the most prominent geneticists of the early 1900s used their research to bolster the movement
- There has been an ongoing effort (in fact since the 50s) to disentangle these racist views from population genetics as a whole



THE PROBLEM OF ALIEN IMMIGRATION INTO GREAT BRITAIN, ILLUSTRATED BY AN EXAMINATION OF RUSSIAN AND POLISH JEWISH CHILDREN.

By KARL PEARSON and MARGARET MOUL.

PART I.

1925 – 1st article published in the UCL-based Annals of Eugenics (Now the Annals of Human Genetics)

Eugenics' legacy in the curriculum

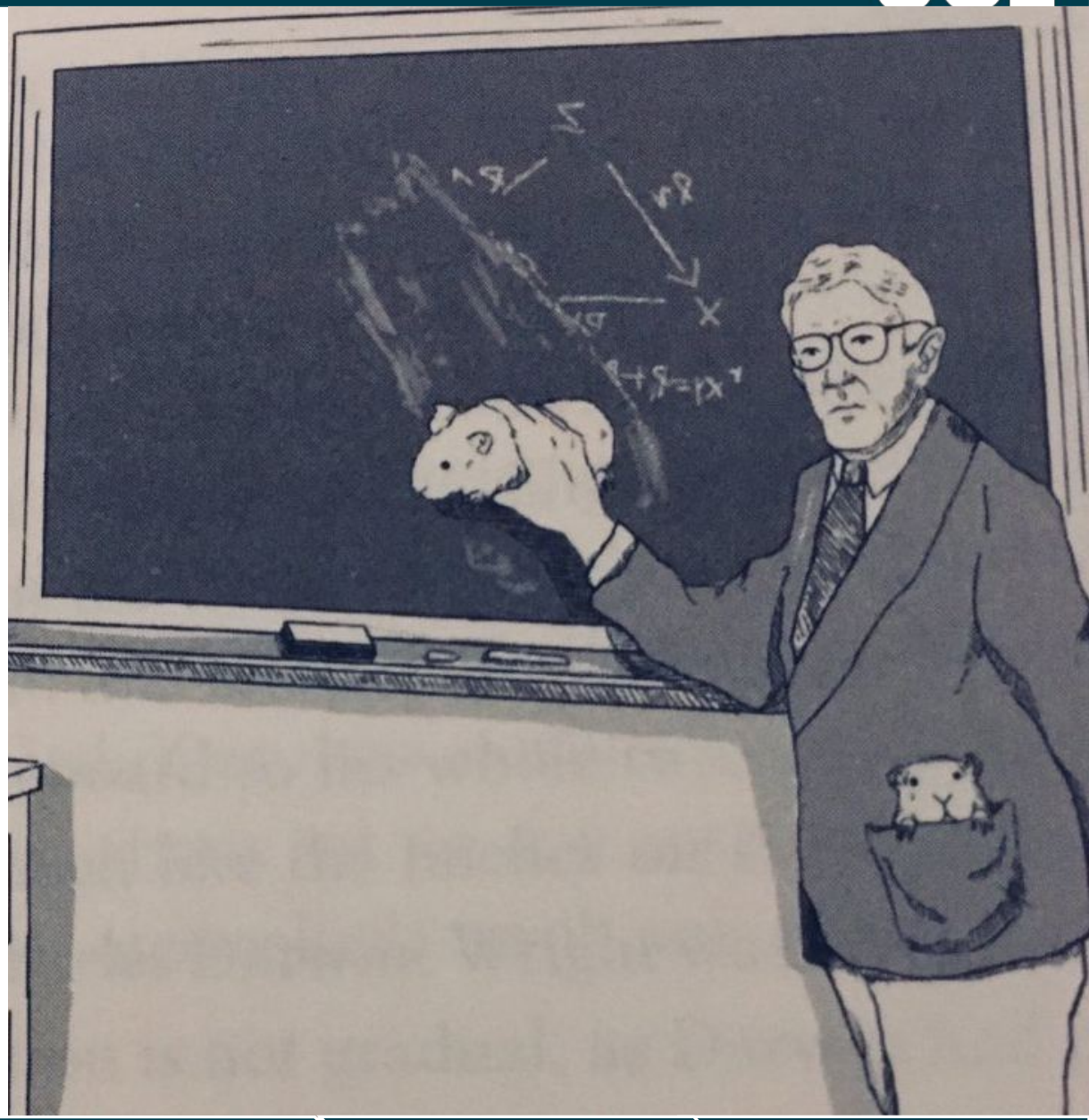
- However, it remains difficult to remove all aspects of this from the curriculum
- The terms 'pure cross' and 'pure breed' persist as "key terms" for many exam boards
- These are based on the Linnean and eugenicist idea that in advance of admixture, breeds or races of people are "pure". In other words, the default in nature is isolated, un-admixed, communities

Put three races together (Caucasian, Mongolian, and the Negroid) you are likely to unite the vices of all three as the virtues. ... ***For the worlds work give me a pure-blooded*** *... ascertain through observation and experiment what each race is best fitted to accomplish. ... If the Negro fails in government, he may become a fine agriculturist or a fine mechanic. ... The right of the state to safeguard the character and integrity of the race or races on which its future depends is, to my mind, as incontestable as the right of the state to safeguard the health and morals of its peoples.*

Henry F. Osborn, (then) President of the American Museum of Natural History, *Eugenics, Genetics, and the Family* (1923)

So, what can we do?

- Time and resources are already limited
- The curriculum is generally good, it's bits round the edges which could be adjusted
- So, some thoughts taken from work on improving genetics teaching both to undergraduates and in other countries
- Again, you are the experts in this – I'd love to hear your thoughts!



1) Emphasise the complexity of the genotype-phenotype relationship

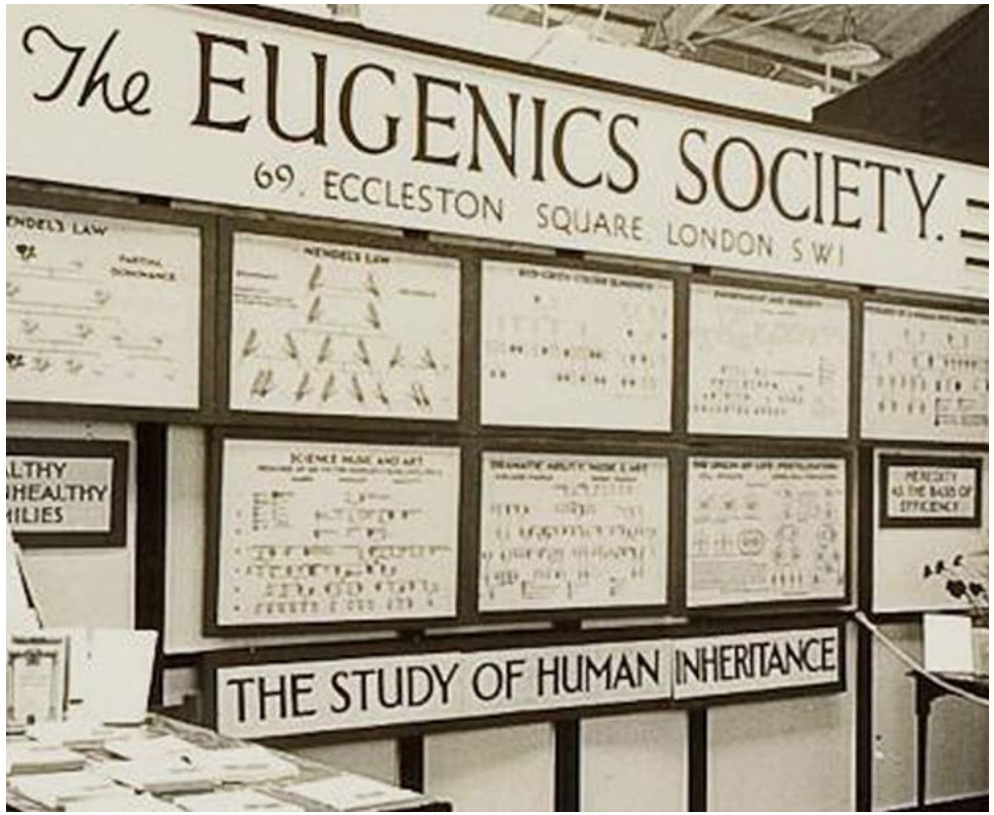
- Mendel's work has had a huge impact on the field of genetics
- What he discovered represents a wonder of nature and have inspired countless students to study genetics
- However, in reality, most traits are the result of small effects of many genes + the environment
- Heritability is a very complex topic, with many confounders making it hard to distinguish this interplay between genes and the environment

2) Our genetics are less of a blueprint – more of an ingredient

- Most students' last exposure to genetics education will be in your classrooms
- Alongside learning the curriculum, it's crucial to give them the genetics literacy to engage with the growing media interest in the field
- Emphasising the complexity of the gene-phenotype relationship and explaining the reality of 'the gene for' stories gives them the tools for this
- They will hopefully be less likely to believe in genetic determinism and the lies of racial realism

3) Don’t shy away from genetics’s dark history

- Many of the issues we have talked about today are the fault of past geneticists – not the public
- Racial realism and race science originated during the birth of population genetics, led by scientists at my own institution
- Don’t be afraid to talk about it – we are



Acknowledgments

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