Human Genetics for Fiction Writers

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Intro

Most applies to all mammals (probably including elves, unicorns and aliens who can interbreed with humans) and a lot to all diploid eukaryotes (flowering plants and probably dinosaurs and dragons).

Writers often make mistakes – *Terminator: The Sarah Conner Chronicles* – Said that Sarah blood type was O and John's AB like his father. Not quiet impossible but very close.

Main uses:

- Biologically related characters with genetic characteristics
- Mystery with genetic evidence
- Use of possibly dubious genetic arguments to make legal or political points including about discrimination
- Genetically distinct groups interbreeding

Not going to talk about mutant or genetically engineered monsters or supers as you're usually not interested in the technicalities, just what they can do and how to kill them.

Definitions

Gene – position in genome where there's sometimes a sequence with a function.

Allele – version of gene (may or may not do something – but at least one allele of a given gene must do something).

Marker – Rare DNA sequence, may not do anything but helps determine relationships.

Modification – related to epigenetics.

Male/Man – XY

Female/Woman - XX

Exceptions to last two but not talking about them.

Justifying discrimination

Some differences between groups are statistical – can lead to much confusion – lies dam lies and statistics!

Sex - Clear genetic, physical and mental differences between the sexes. - Arguments about whether mental differences genetic or environmental.

Race - Genetics shows racial differences to be vague and trivial – does not support racism.

Orientation - Unclear if sexual orientation has genetic basis – may involve epigenetics.

Religion - not genetic but tends correlate with race and geography.

Justifying discrimination

Complications

Isolated groups (e.g. Inhabitants of Tahiti, Samaritans, families with arranged first cousin marriages) tend to have high levels of rare alleles due to inbreeding.

- Statistically different from parent population to start with.

- Evolves away from parent population.

- May result in strange, but usually small, groups within a race or religion.

- Likely to happen with human colonies in space or isolated groups on earth after apocalypse, possibly to a far greater extent.

Justifying discrimination

Complications

Genetic arguments for or against discrimination may get awkward if your discriminated-against group are psychics or aliens etc.

Some groups (e.g. werewolves and vampires) are inherently prone to killing people.

Example – Collapse of human population due to large scale intermarriage and interbreeding with aliens (not a problem with human races).

THINK YOUR ANALOGS THROUGH!

Epigenetics

Definition:

Modifications to DNA or related structures that control gene expression. Modification occurres in response to something and is itself determined by genetics so may not be the same in everybody.

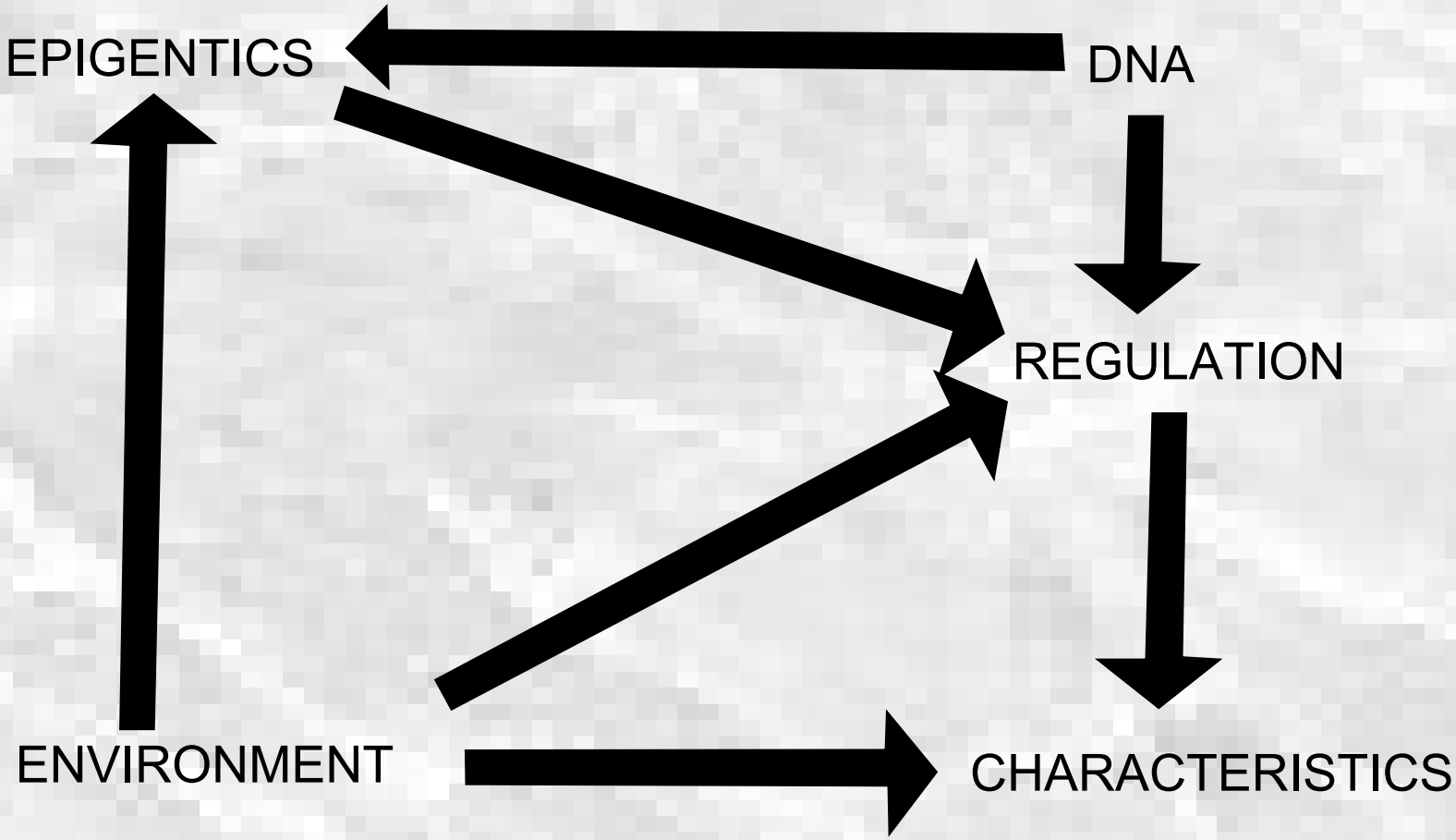
Important in cellular differentiation.

Sometimes affected by environment.

Can be passed on to offspring to an extent (so Lamarckism not complete rubbish after all).

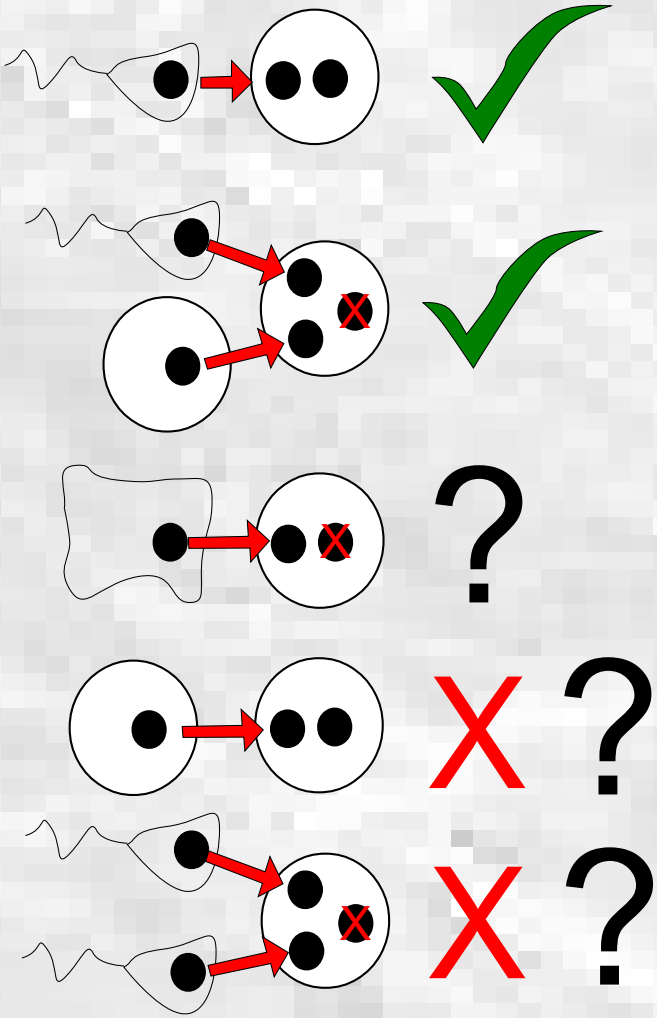
Involved in some diseases, including cancer and psychological problems.

Epigenetics



Humans confuse matters by learning, working things out and telling each other things. Important in genetics of mental factors.

Epigenetics



Prevents egg cells from developing if they contain two egg cell nuclei or sperm cell nuclei. AFAIK only tried in mice.

Thought this is why no virgin births in mammals (only one but that was a miracle).

Will need to get round this to produce children for same sex couples (e.g. One parent Kryptonian).

Epigenetics

Questionable political/legal implications

– “My epigenetics has been messed up, give me lots of money!”

- “Your ancestors did bad things to my ancestors so now my people's epigenetics is messed up – give us lots of money!”

May be used to argue that children must or must not have certain experiences leading to aggressive media censorship and/or aggressive control of child rearing.

Other points

Poorly understood – scope for speculative fiction!

Possible scientific basis for curses, hereditary curses, hereditary memories and reincarnation (only if reincarnated as descendant).

Teleomeres

On the ends of chromosomes, get shorter when cell divides (except for germ line and cancer).

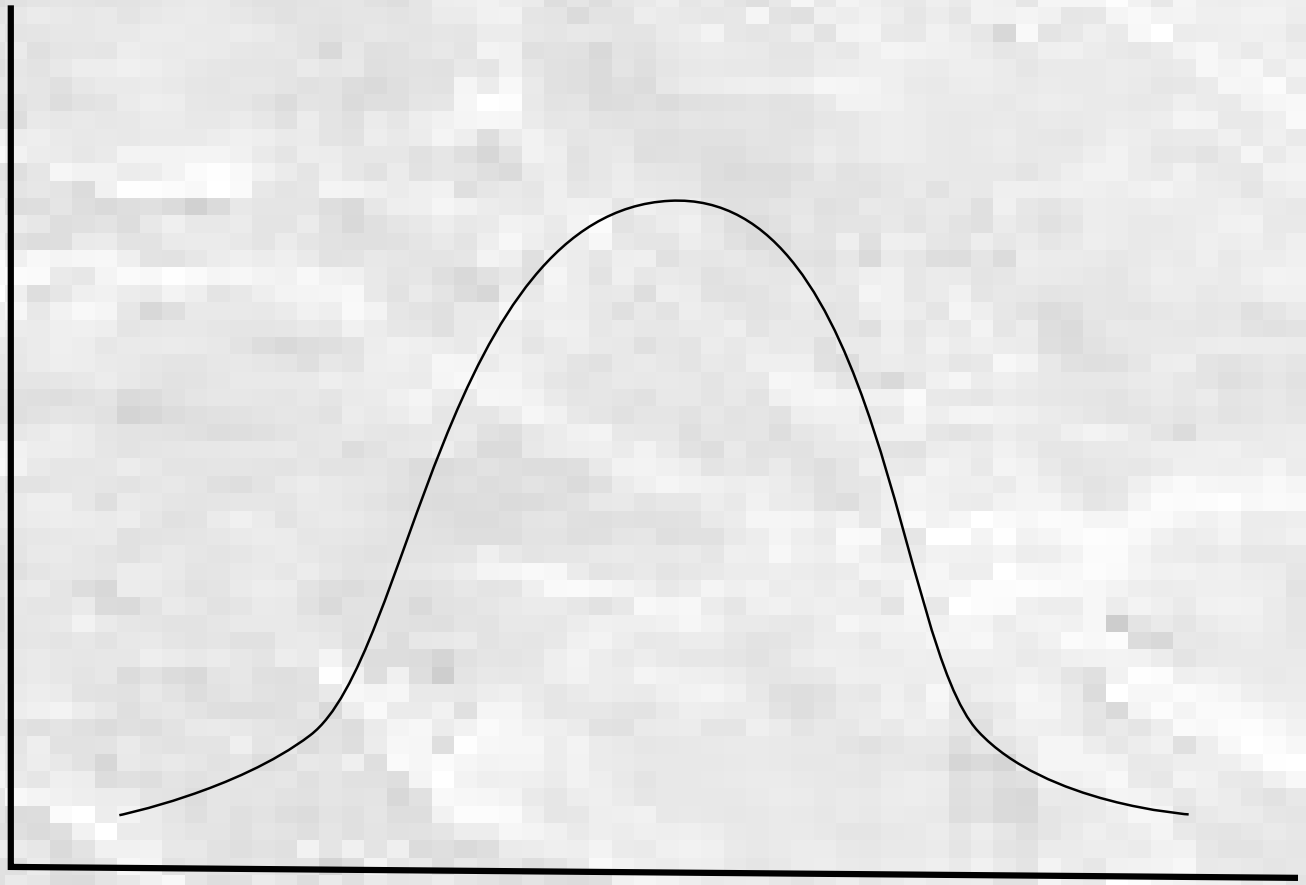
Thought preventing or reversing shortening may extend life but could cause cancer.

Clones from somatic cells start with short teleomeres, possibly shortening the clone's life (plot point in *Gundam Seed*).

Can be used to estimate age.

Unusually long teleomeres may indicate an immortal. Unusually short ones may indicate a clone.

Frequency Distribution Graphs



Strength of characteristic on X axis, number of people who have the characteristic at that strength on Y.

Not at all clear what's going on – complicated genetics, completely environmental, combination of genes and environment.

Frequency Distribution Graphs

The Bell Curve: Intelligence and Class Structure in American Life is a 1994 book by psychologist Richard J. Herrnstein and political scientist Charles Murray - NOT GENETICISTS!

Used IQ bell curve graph to argue for racism.

Strongly criticized for being racist and bad science. Lies, damn lies and statistics.

For questionable genetic arguments, bell curves your friend!

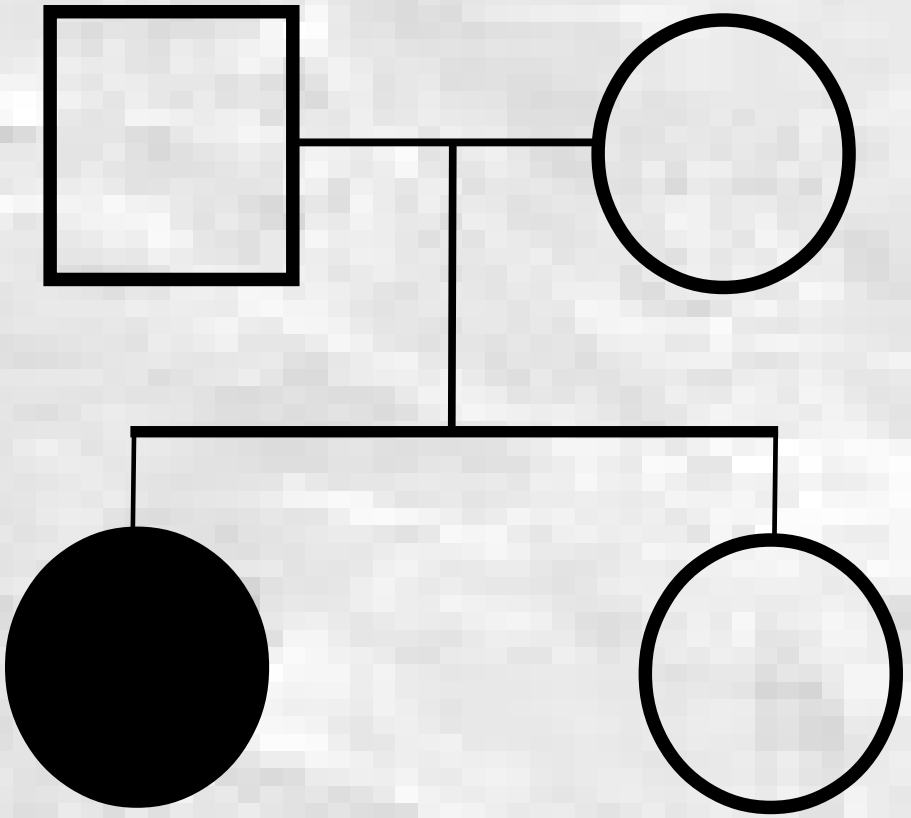
Frequency Distribution Graphs

Discontinuous

Normal people with low score. Psychics or witches with high score.

Probably genetic – single gene with two alleles.

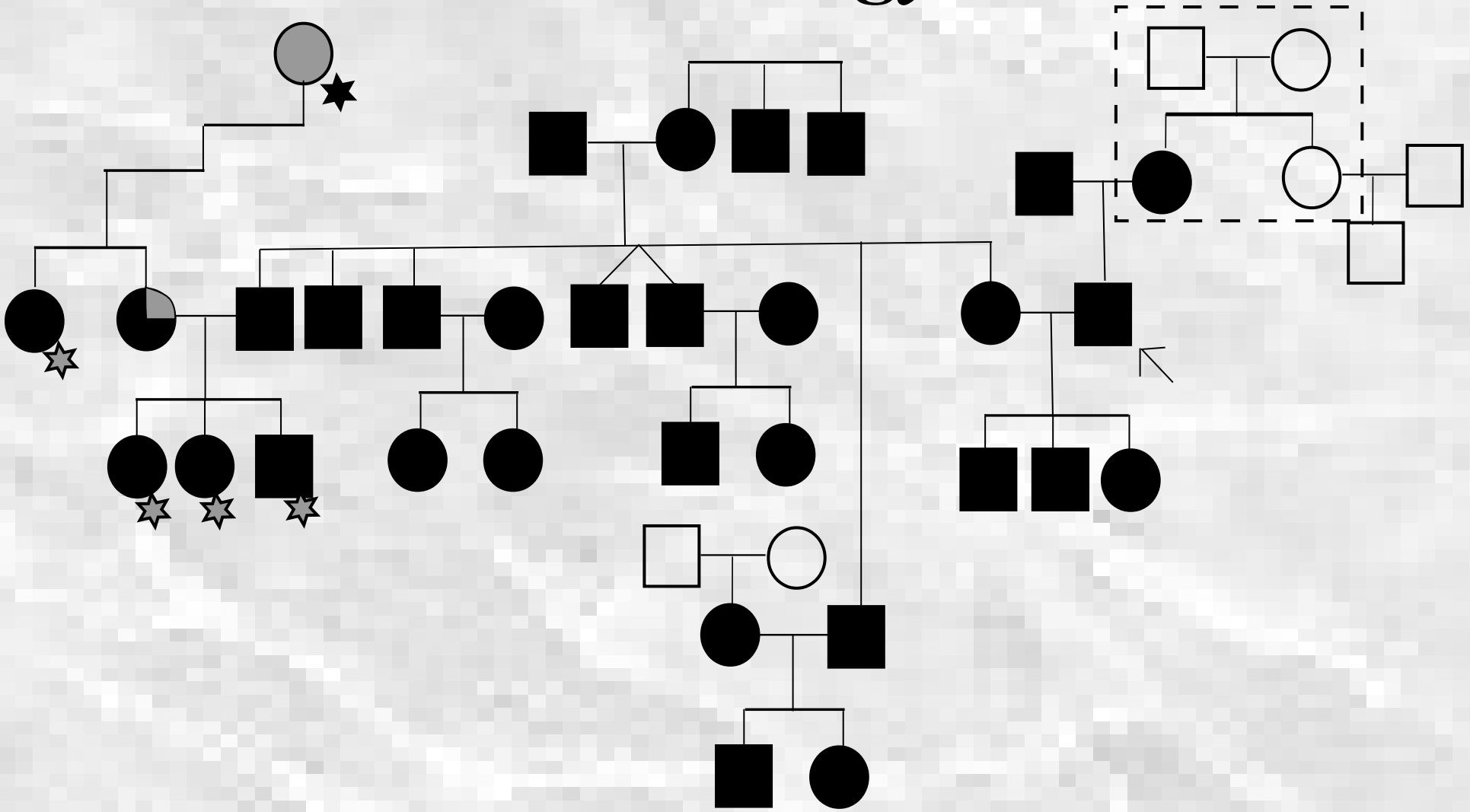
Genealogy



Circles = females, squares = males. White = common phenotype. Black = rare phenotype.

Parents with two daughters, one daughter has the rare phenotype.

Genealogy



Shows more relatives (nuclear family in dotted line).

Grey with black star = second rare phenotype that seems to be related, unknown if also has black phenotype. Black with grey segment = seems to have black phenotype but with aspects of grey phenotype. Black with grey star – seem to have black phenotype but may have aspects of grey. Two black squares from same point on live above is pair of identical twins. Arrow points to proband (person who drew our attention to this family).

Parts of Human Genome

Y Chromosome:

Only in men, passed down male line.

Uses:

Male-line characteristic only found in males.

Tracing ancient male-line ancestry – many men have Y chromosomes indicating descent from Genghis Khan. Many Jewish men have Y chromosomes thought to show descent from Jewish priesthood (hereditary, descended from the prophet Aaron). Nearly all men descended from Y chromosome Adam.

Determining male-line relationships between males.

Parts of Human Genome

Mitochondria:

In everybody, passed on by females to all children, down female line.

Uses:

Female-line characteristic (probably in both sexes).

Tracing ancient female-line ancestry. King Richard III's remains ID'd by mitochondria. All people female line descendants of Mitochondrial Eve.

Determining female-line relationships

More likely to be preserved in ancient or very degraded material.

Parts of Human Genome

Autosomes:

Non-sex chromosomes. Everybody (possibly except Jesus) has two sets of 22.

Tracing general ethnic ancestry.

Determining how closely people are related (more common markers, closer relationship).

Parts of Human Genome

Autosomes:

Crossing over –

Chromosomes of pair exchange parts while making gametes. Alleles of different genes on same chromosome from different parents could be passed on to same child.

Less likely to be crossing over if genes close together – can be used to map where genes are on chromosomes.

Parts of Human Genome

Autosomes:

Supergene –

Group of genes close together on the same chromosome so inherited like a single gene for complicated characteristic.

Use:

Complicated system of different types interbreeding but remaining fairly distinct (e.g. Wessens in *Grimm*, Fey in *Lost Girl*, everybody in *Bojack Horseman*).

Parts of Human Genome

Dominance:

Two copies of each gene – could have two different alleles.

Could have phenotype of one (dominant) while the other (recessive) has no effect. Need two recessive alleles to have the recessive phenotype.

Could have combined effect – partial dominance.

Alleles that do something usually dominant (or partially dominant to each other).

Alleles that don't do anything usually recessive.

Parts of Human Genome

Sarah Connor:

Blood type O, two recessive alleles and must pass one on to each child.

Blood type AB, two different dominant alleles, partially dominant to each other. Can only pass an A or B to each child.

Therefore an O person and an AB person can only have A or B children, not AB! (Except for rare situations).

Parts of Human Genome

Dominant Alleles:

Use:

Characteristic that runs in families in an obvious way (but people with it stand a chance of producing children with the recessive phenotype).

Parts of Human Genome

Recessive Alleles:

Uses:

- Rare characteristic which can be possessed by somebody born to normal parents.
- Characteristic shared by siblings but not necessarily other relatives.
- May have arranged marriages or inbreeding to produce people with “desirable” recessive phenotype.
- Characteristic that appears as a result of inbreeding.
- Recessive phenotypes tend to be bad - why inbreeding tends to be bad. Also leads to loss of fertility. In Bible, Abraham's family incestuous and also had fertility problems.

Parts of Human Genome

Recessive Alleles:

Complications:

- Same or very similar recessive phenotype may be due to alleles of different genes. Children of people with recessive phenotype due to alleles of different genes will produce children with dominant phenotype (plot point in *Tales of Midbar: Secret Priest*).
- Recessive alleles may back-mutate to produce dominant phenotype but not necessarily quiet the same.
- Other genes, environment or epigentics may affect how alleles are expressed.


Tales of Midbar:
SECRET PRIEST
Sue your school
Solve Mysteries
Fight Monsters
RICHARD PEARMAN

Parts of Human Genome

Sarah Connor:

Very rare Bombay phenotype (hh) prevents making A or B antigens even if you have A and/or B alleles.

Somebody with two h alleles may appear as type O (but will have problems receiving blood transfusions). Will be able to produce AB children if they have at least one A and/or B allele – but must still have an A and B gamete combining.

Parts of Human Genome

X Chromosome:

Males have one and females two.

Passed from father to daughter and mothers pass one to each child.

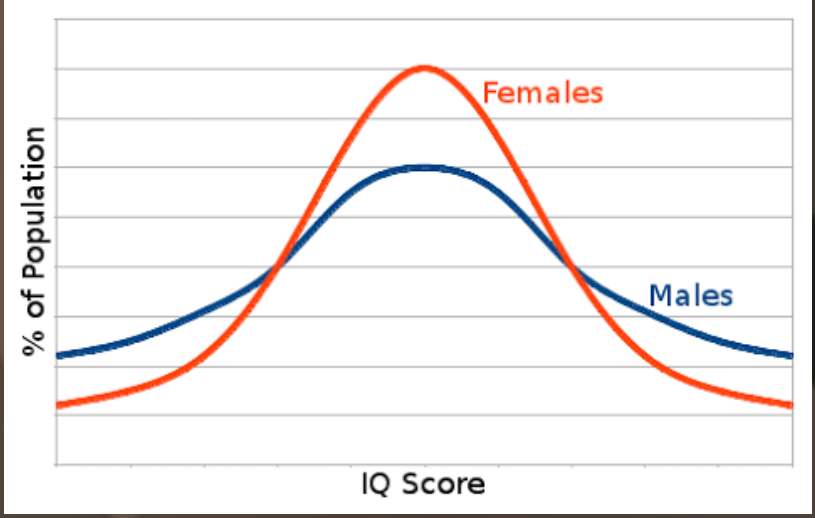
Crossing over only in females (a bit of crossing over between small regions of X and Y chromosomes in males).

Females have two copies of gene and males one (males more likely to have recessive X linked phenotypes).

Thought to have a lot of genes for social skills and intelligence.

Parts of Human Genome

X Chromosome:



Both sexes have an average IQ of 100 but it was rigged like this, on early IQ tests, women scored higher.

Women more likely to be average than men.

Thought to be due to intelligence genes on women's two X chromosomes averaging out while men are more likely to get an extreme combination.

X-linked intelligence genes presumably partially dominant or with about equal numbers of smart dominant and dumb dominant.

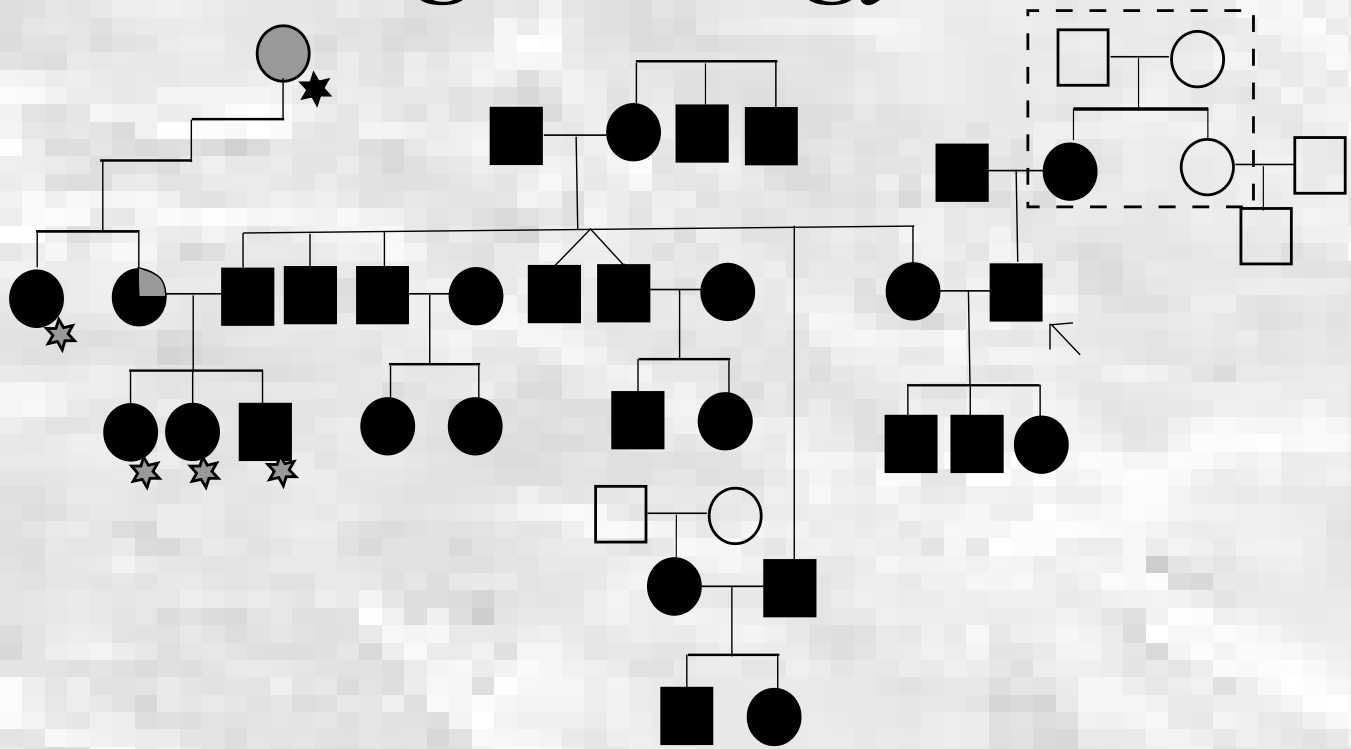
Parts of Human Genome

X Chromosome:

Uses

- Characteristic that's commoner in one sex (probably males).
- Characteristic only present in females – need to be heterozygotes.
- Could be used to trace ancestry but isn't.
- Determining how people are related (e.g. Sister or daughter? - a man's daughter will share his X chromosome but sister will probably share about half of one. A man's X chromosome will be a combination of both his mother's.)
- Determining mental characteristics.
- Estimating how well people are likely to get on with each other – useful for matchmaking?

Determining part of genome from genealogy



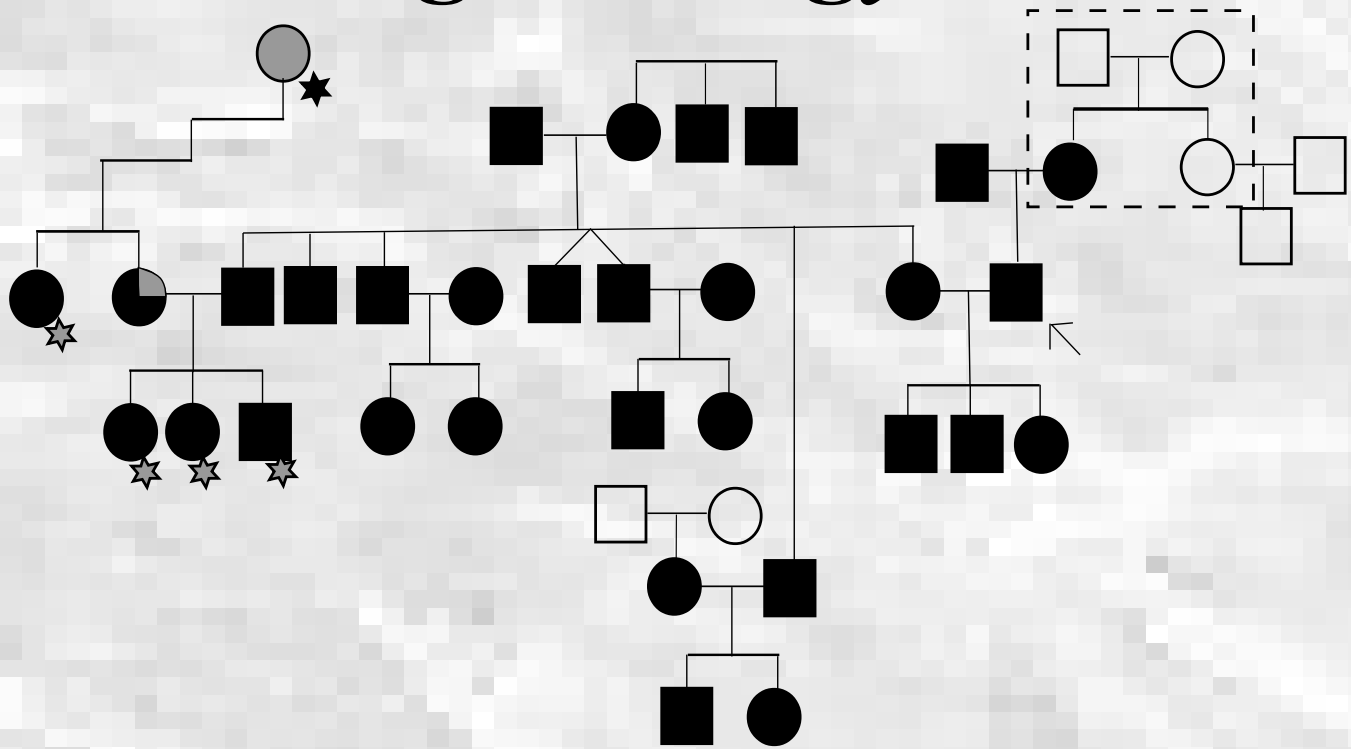
Assume all parentage correct and no mutation.

Affects both sexes. Couples with phenotype produce children with it.

Rare phenotype females born to common phenotype parents is a recessive - Only explanation autosomal allele.

Another recessive phenotype in family - red haired couple with red haired children.

Determining part of genome from genealogy

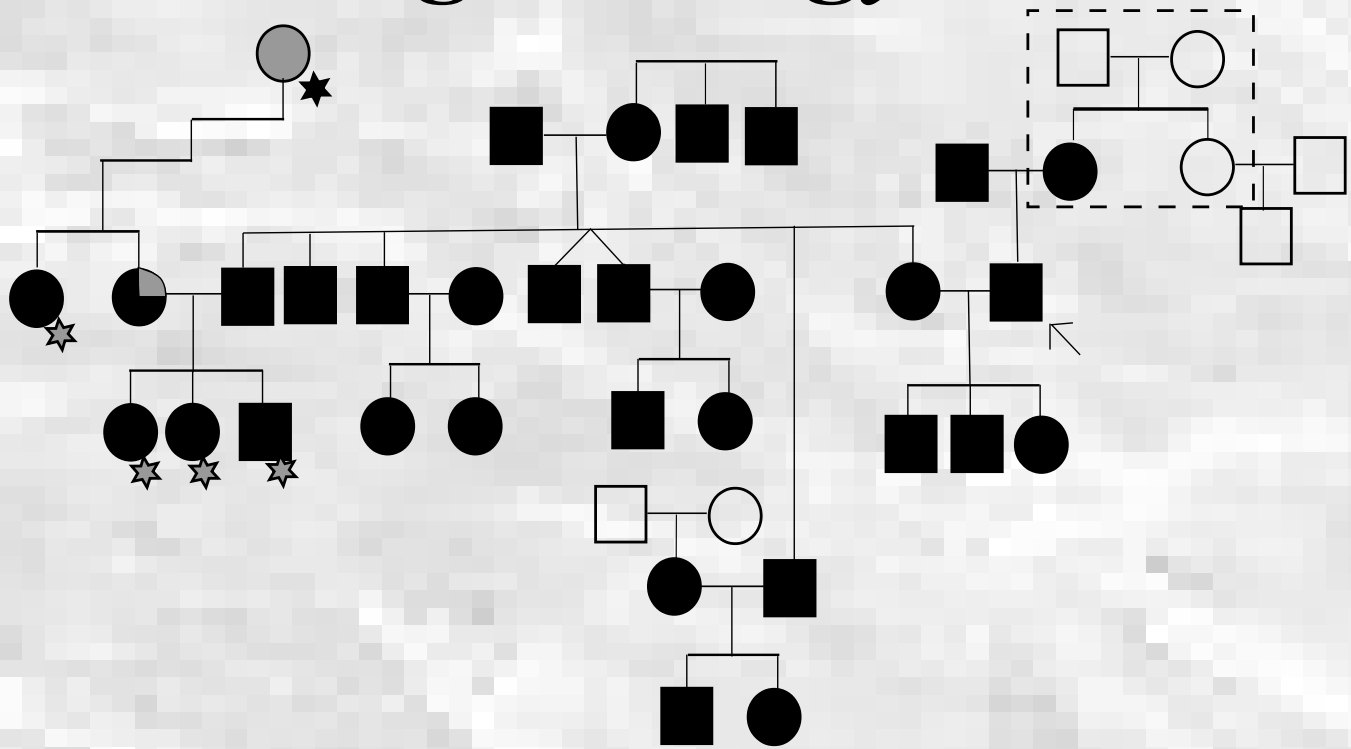


Proband is Harry Potter. Rare characteristic is being a witch or wizard.

Quarter grey woman is Fleur who's wand contains a feather from her grandmother who's a veela.

Not much information on veelas. All seem to be female. Do they normally marry wizards? Complicated characteristic, likely a supergene. Is Fleur a full veela? Are all veelas witches?

Determining part of genome from genealogy



Squibs, slightly different from muggles (cat symbiosis and can see dementors).

Probably due to back-mutation, modifier genes or environment factors.

Not told much about them.

Bloodlines

Presumably starts with somebody people think is special so they track their descendants.

Could continue following long after it becomes genetically meaningless.

To be meaningful:

inbreeding (unwise)

following Y chromosome

following mitochondria

following dominant allele

selective breeding for characteristic (possibly due to recessive allele)
– Biblical prophets and Wizarding families seem to do this.

Hybrids

Between any groups with multiple genetic differences.

First generation (F1) fairly consistent and have hybrid vigor – why nephilim were great heros?

Recombination of genes after first generation. You could get any combination of the characteristics of the parent types or intermediate characteristics if they're partially dominant or controlled by more than one gene.

Hybrid swarm may develop into stable race or species over many generations – consistent with *Shadow Hunters*.

Hybrids

Uses:

Realistic consequences of interbreeding (never seen this done well).

Producing distinctive looking characters.

Producing siblings who look very different, which may confuse people.

For hybrids with elves, aliens etc. Can produce people with strange powers or combinations of powers or strange combinations of powers and appearance.

Hybrids between less closely related species likely to be sterile.

Chimeras

Have two or more genetically different cell lines.

Can, very rarely happen naturally, a woman gets pregnant with fraternal twins but the embryos combine to produce one baby with two genetically different cell lines.

Can also happen artificially, by combining cells from two or more embryos to make one.

If chimeras reproduce, their children will be the genetic children of their gonad's cell line.

Sarah Connor

Type O bone marrow and A, B or AB ovaries but the right sperm still has to fertilize the right egg.