Each DNA molecule is packed into a [redacted].

1

[redacted] *contain instructions for making* [redacted].

2

The two strands of DNA twist to form a [redacted].

3

When replicating, the [redacted] *between the DNA strands break, and* [redacted] *come to bind with the exposed ones on the separated strands to form new strands.*

4

Proteins act alone or in [redacted] *to perform many cellular functions.*

5

The four DNA bases are...

6

A [redacted] *backbone provides structure for the DNA.*

7

[redacted] *bonds hold the two strands of DNA together.*

8

Genes contain instructions for making proteins.

2

Each DNA molecule is packed into a chromosome.

1

When replicating, the hydrogen bonds between the DNA strands break, and new bases come to bind with the exposed ones on the separated strands to form new strands.

4

The two strands of DNA twist to form a double helix.

3

Adenine, Thymine, Guanine, Cytosine

6

Proteins act alone or in complexes to perform many cellular functions.

5

Hydrogen bonds hold the two strands of DNA together.

8

A sugar-phosphate backbone provides structure for the DNA.

7

binds to , *binds to* .

9

Before a cell divides, its DNA is duplicated using .

10

What is the Karyotype?

11

What is an autosome?

12

In addition to the autosomes, what other chromosomes are there?

13

is the process where a sperm producing cell or an egg producing cell makes a new cell with 23 chromosomes.

14

is when an exact replica of the genome is made (46 chromosomes).

15

is when only one chromosome from each pair is passed on to the new (sperm/egg).

16

Before a cell divides, its DNA is duplicated using semi-conservative replication.

10

Adenine binds to Thymine, Cytosine binds to Guanine.

9

One of the 22 pairs of normal chromosomes in humans.

12

The 23 pairs of chromosomes in the cell.

11

Meiosis is the process where a sperm producing cell or an egg producing cell makes a new cell with 23 chromosomes.

14

One pair of sex chromosomes.

13

Meiosis is when only one chromosome from each pair is passed on to the new gamete (sperm/egg).

16

Mitosis is when an exact replica of the genome is made (46 chromosomes).

15

DNA [redacted] *RNA* [redacted] *protein*

17

When a gene is [redacted]*, it forms many* [redacted] *molecules.*

18

[redacted] *molecules get* [redacted] *into proteins.*

19

Define an allele

20

Define polymorphism (in the context of DNA)

21

[redacted] *is when a person has two copies of one allele on a gene locus.*

22

[redacted] *is when a person has two different alleles on a gene locus.*

23

A gene is [redacted] *if the* [redacted] *protein that it produces can be compensated for by the correct protein produced by* [redacted]*.*

24

When a gene is transcribed, it forms many RNA molecules.

18

$DNA \xrightarrow{transcription} RNA \xrightarrow{translation} protein$

17

Any of several forms of a gene, usually arising through mutation. Alleles are responsible for hereditary variation.

20

RNA molecules get translated into proteins.

19

Homozygous is when a person has two copies of one allele on a gene locus.

22

The existence of several alleles for one gene locus. Individuals have one or two alleles per locus.

21

A gene is recessive if the mutated protein that it produces can be compensated for by the correct protein produced by an alternative allele.

24

Heterozygous is when a person has two different alleles on a gene locus.

23

If a mutated gene produces proteins that fulfil a new function, then it may be [redacted]*, since the original function will be fulfilled by* [redacted].

25

Genes can be [redacted]*,* [redacted] *or* [redacted].

26

Define genotype.

27

Define phenotype

28

The phenotype is controlled by [redacted] *derived from* [redacted]*, and the* [redacted].

29

What bloodgroup is made from two co-dominant alleles?

30

Blood groups:

	I^A	I^B	i
I^A	[redacted]	[redacted]	[redacted]
I^B	[redacted]	[redacted]	[redacted]
i	[redacted]	[redacted]	[redacted]

31

Allele frequency is linked to [redacted] *to its* [redacted] *in a given* [redacted].

32

Genes can be recessive, dominant or co-dominant.

26

If a mutated gene produces proteins that fulfil a new function, then it may be co-dominant, since the original function will be fulfilled by the other allele.

25

The physical appearance of an individual, including its observable or measurable traits.

28

The genetic make-up of an individual, which includes the genes or alleles present in it.

27

AB

30

The phenotype is controlled by proteins derived from genes, and the environment.

29

Allele frequency is linked to the fitness it provides to its carriers in a given environment.

32

Blood groups:

	I^A	I^B	i
I^A	A	AB	A
I^B	AB	B	B
i	A	B	O

31

Define genetic fitness

33

If an allele provides [redacted] *, it is likely to* [redacted] *and become* [redacted] *in a given population.*

34

Mutations have allowed us to [redacted] *our diet. This includes a mutation that lets us produce* [redacted] *during adulthood (to drink milk) and another one that reduces the function of a* [redacted] *allowing us to eat broccoli and sprouts! This is an example of* [redacted] *.*

35

Carriers of [redacted] *alleles are* [redacted] *and get protection from malaria.*

36

Carriers of [redacted] *alleles die if they are* [redacted] *since their haemoglobin does not function well.*

37

People [redacted] *for a mutation affecting* [redacted] *are asymptomatic and immune to HIV. Probably because this gave protection against* [redacted] *and* [redacted] *in the past. This mutation is less effective against pathogens from* [redacted] *.*

38

Environment interaction can influence the genotype. [redacted] *and* [redacted] *are sensitive to temperature, and change colour at different temperatures. This is caused by temperature sensitive* [redacted] *.*

39

The environment affects the phenotype; a [redacted] *can make a human twin grow to be smaller, and flowers have* [redacted] *based on the soil* [redacted] *.*

40

If an allele provides an advantage, it is likely to persist and become more prominent in a given population.

34

The reproductive success of a genotype, measured as the number of offspring produced by and individual that survive to a reproductive age relative to the average age for the population.

33

Carriers of sickle cell anaemia alleles are asymptomatic and get protection from malaria.

36

Mutations have allowed us to diversify our diet. This includes a mutation that lets us produce lactase during adulthood (to drink milk) and another one that reduces the function of a bitter substance taste receptor allowing us to eat broccoli and sprouts! This is an example of natural selection.

35

People homozygous for a mutation affecting CCR5 are asymptomatic and immune to HIV. Probably because this gave protection against the plague and smallpox in the past. This mutation is less effective against pathogens from developing countries.

38

Carriers of sickle cell anaemia alleles die if they are homozygous since their haemoglobin does not function well.

37

The environment affects the phenotype; a worse diet can make a human twin grow to be smaller, and flowers have different colours based on the soil pH.

40

Environment interaction can influence the genotype. Himalayan rabbits and arctic foxes are sensitive to temperature, and change colour at different temperatures. This is caused by temperature sensitive tyrosine.

39

Most [redacted] *are due to several genes and the environment (e.g.* [redacted]*,* [redacted]*,* [redacted]*).*

41

A greater similarity between [redacted] *for a particular* [redacted] *compared to* [redacted] *provides evidence that* [redacted] *factors play a role.*

42

[redacted] *twins share all their genes and their home environment.* [redacted] *twins share* [redacted] *their genes and a home environment.*

43

Define a mutation

44

The size of mutations ranges from [redacted] *(*[redacted] *- SNP) to* [redacted] *(*[redacted]*)*

45

SNP mutations are [redacted]*, chromosome rearrangements are* [redacted]

46

Define a hereditary mutation.

47

Define an acquired (somatic) mutation.

48

A greater similarity between identical twins for a particular trait compared to fraternal twins provides evidence that genetic factors play a role.

42

Most phenotypes are due to several genes and the environment (e.g. skin colour, height, weight).

41

*A **permanent** alteration in the DNA sequence passed on into daughter cells (and sometimes gametes).*

44

Identical twins share all their genes and their home environment. Fraternal twins share half their genes and a home environment.

43

SNP mutations are micro-mutations, chromosome rearrangements are macro-mutations

46

The size of mutations ranges from a single base pair (single nucleotide polymorphism - SNP) to large segments of a chromosome (chromosome rearrangement)

45

When a mutation occurs at some point in a person's life, and is present only in the cell that it occurred and it's daughter cells (through mitosis).

48

A mutation inherited from a parent gamete and present throughout a person's life and in every cell in their body. This can be passed on to progeny through meiosis.

47

Environmental factors that cause mutations include...

49

Intrinsic factors causing mutations include...

50

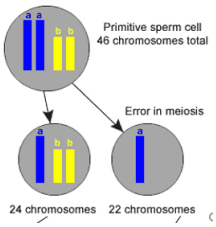
Macro mutations occur during _____ *or in* _____

51

Mutations during meiosis include...

52

What will these mutations result in when the gamete is combined with another?



53

Single chromosome macro-mutations include...

54

Examples of diseases caused by macro-mutations include _____, _____ *and* _____.

55

What are the three types of substitution micro-mutations and what are they caused by?

56

Errors during DNA replication (before mitosis) and repair. Errors during meiosis (e.g. an error in chromosome separation).

50

Mutagens; chemicals, radiation etc that causes breaks between DNA bases. Biological factors such as viruses that can integrate into the genome and cause disturbances in the DNA.

49

Trisomy (when a sperm has an extra chromosome) or monosomy (when a sperm has one too few chromosomes).

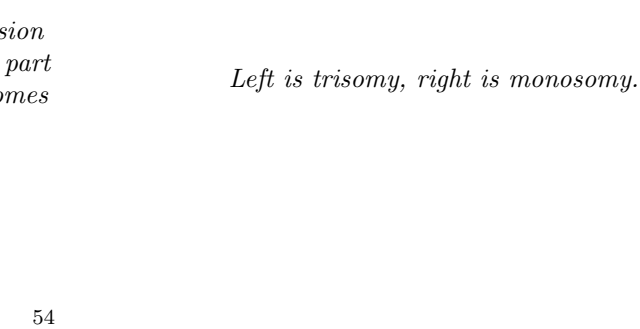
52

Macro mutations occur during meiosis or in late stage cancers

51

Within one chromosome; deletion, duplication and inversion of regions of the chromosome. Within two chromosomes, part of one can go into another (insertion), parts of chromosomes can swap places (translocation).

54



Left is trisomy, right is monosomy.

53

Caused by single base substitutions (SNP), and they are silent, nonsense (STOP) and mis-sense.

56

Examples of diseases caused by macro-mutations include down syndrome, klinefelter syndrome and Cri du chat.

55

How does a nonsense mutation occur?

57

What is a silent mutation?

58

What is a mis-sense mutation?

59

[redacted] can cause great disturbances to a protein through [redacted] unless the number of bases [redacted], so there is no [redacted]

60

There are [redacted] bad (but [redacted]) alleles for cystic fibrosis. The normal gene [redacted]. Patient must be [redacted] for one bad allele, or [redacted] for two.

61

[redacted] are when a person has many repeats of a base pair triplet. [redacted] dictates the likelihood of a person getting certain diseases (more is worse for the patient).

62

Sometimes a SNP in a region far away from a gene can cause problems. In the case of lactose intolerance, a pair 13910 bases before the relevant gene is substituted (from T to C), meaning a protein cannot bind. This is recessive, since just a bit of lactase does the job.

63

The Human Genome project took [redacted] to sequence [redacted] base pairs. DNA from [redacted] individuals of [redacted] was taken.

64

When the protein coded for by a triplet is not changed by an SNP.

58

When a SNP (single base substitution) converts a triplet from coding a protein to coding a STOP signal.

57

Insertions and deletions can cause great disturbances to a protein through frameshift mutations unless the number of bases is divisible by three, so there is no frameshift

60

When a SNP mutation changes the protein coded for by a triplet.

59

Trinucleotide repeated expansions are when a person has many repeats of a base pair triplet. The number of repeats dictates the likelihood of a person getting certain diseases (more is worse for the patient).

62

There are 900 bad (but recessive) alleles for cystic fibrosis. The normal gene produces enough protein to compensate. Patient must be homozygous for one bad allele, or heterozygous for two.

61

The Human Genome project took 13 years to sequence 3 billion base pairs. DNA from 5 anonymous individuals of varying ethnicity was taken.

64

Sometimes a SNP in a region far away from a gene can cause problems. In the case of lactose intolerance, a pair 13910 bases before the relevant gene is substituted (from T to C), meaning a protein cannot bind. This is recessive, since just a bit of lactase does the job.

63

It was discovered that humans only have [redacted] *genes, but it was thought that humans should have around* [redacted]*. This was because flies have* [redacted] *and humans are more complicated!*

65

Humans share [redacted] *of their genes with flies, and only* [redacted] *of the human DNA codes for genes.*

66

Why can humans get by with so few genes?

67

Cells have the [redacted]*, but do not express the* [redacted]*. Where these* [redacted] *are expressed determines the type of cell formed.*

68

Humans genomes differ by about [redacted]*, which is about* [redacted] *base pairs which are mostly* [redacted]

69

The frequency of SNP's is one in every [redacted] *base pairs. Most are* [redacted] *and have* [redacted]*.*

70

SNP's outside of genes are useful because...

71

GWAS stands for...

72

Humans share sixty percent of their genes with flies, and only two percent of the human DNA codes for genes.

66

It was discovered that humans only have 20,500 genes, but it was thought that humans should have around 100,000. This was because flies have 13,000 and humans are more complicated!

65

Cells have the same genome, but do not express the same genes and isoforms. Where these proteins are expressed determines the type of cell formed.

68

Alternative splicing; the same gene can produce different proteins when it is shaped differently (isoforms). This means that we can make 100k proteins with 23k genes.

67

The frequency of SNP's is one in every 300 base pairs. Most are outside genes and have no effect on the phenotype.

70

Humans genomes differ by about 0.01 percent, which is about 3 million base pairs which are mostly SNP's

69

Genome wide association studies

72

They act as landmarks for us as scientists!

71

Most diseases result from [redacted], *patients with* [redacted] *have been found to be more at risk of developing some diseases.*

73

GWAS aim to identify the common SNP's associated with [redacted] *by testing at least* [redacted] *of SNP's in large population samples.*

74

Where are the samples for GWAS taken from

75

When particular landmark SNP's are seen in greater diseased patients compared to controls, we say that the SNP's are [redacted] *with the disease.*

76

If a patient has SNP's associated with a disease, what does it mean?

77

Some people will be affected more by [redacted] *if they have SNP's associated to a disease in their genome (e.g. are far more likely to get a disease if they smoke).*

78

What is pharmacogenomics?

79

In 2005, [redacted] *SNP's were known to be associated with diseases, in 2008, it was* [redacted] *and now it's over* [redacted].

80

GWAS aim to identify the common SNP's associated with complex diseases and traits by testing at least hundreds of thousands of SNP's in large population samples.

74

Most diseases result from polygenic and environmental interactions, patients with particular groups of landmark SNP's have been found to be more at risk of developing some diseases.

73

When particular landmark SNP's are seen in greater diseased patients compared to controls, we say that the SNP's are associated with the disease.

76

Both patients who have the disease and people who do not (the control).

75

Some people will be affected more by their environment if they have SNP's associated to a disease in their genome (e.g. are far more likely to get a disease if they smoke).

78

The patient as a higher risk of the disease (very rarely, there could be a 100 percent association).

77

In 2005, less than 50 SNP's were known to be associated with diseases, in 2008, it was over 500 and now it's over 14,000.

80

How do patients genomes affect their response to a treatment?

79

What was the aim of the 1000 genomes project?

81

On average, each person carries [redacted] *loss of function variants in annotated genes, and* [redacted] *previously implicated in inherited disorders.*

82

How many new disease causing mutations were identified in the 1000 genomes project?

83

In [redacted] *the 100,000 genomes project was started by* [redacted]*. It was split between helping* [redacted] *and* [redacted]*.*

84

The 100,000 genomes project sampled [redacted] *people including* [redacted] *serious illness patients.* [redacted] *cancer patient genomes (one cancer and one normal per patient), and* [redacted] *rare disease genomes (three per patient;* [redacted]*)*

85

[redacted] *and* [redacted] *both let you get your genome sequenced.* [redacted] *does not offer much advice or counselling, but* [redacted] *does, and is therefore more expensive.*

86

Immlumina tests healthy adults interested in learning about their risk for [redacted]*, assessing their* [redacted] *status and understanding their response to certain* [redacted]*.*

87

How many different types of cell are there in humans?

88

To establish the most detailed catalogue of human genetic variations.

81

On average, each person carries 250-300 loss of function variants in annotated genes, and 50-100 previously implicated in inherited disorders.

82

671

83

In 2014 the 100,000 genomes project was started by the NHS. It was split between helping cancer patients and patients with rare diseases.

84

The 100,000 genomes project sampled 75,000 people including 40,000 serious illness patients. 50,000 cancer patient genomes (one cancer and one normal per patient), and 50,000 rare disease genomes (three per patient; one patient genome and two blood relatives))

85

23andMe and Illumina both let you get your genome sequenced. 23andMe does not offer much advice or counselling, but illumina does, and is therefore more expensive.

86

Immlumina tests healthy adults interested in learning about their risk for a set of adult-onset conditions, assessing their carrier status and understanding their response to certain drugs.

87

220 cell types.

88

What is the first cell created by the fusion of the egg and sperm?

89

What are the initial cells formed from the zygote called?

90

After there are more than 8 blastomeres, what is there?

91

What is the trophoblast?

92

Where does the embryo form from?

93

When the [redacted] *is dividing, the cells become smaller since they are partitioning the* [redacted] *cytoplasm via mitosis.*

94

What lets the embryo attach to the wall of the uterus?

95

[redacted] *is driven by the* [redacted]*. The* [redacted] *expands and changes shape and location, but is still* [redacted]*.*

96

Blastomeres

90

The zygote.

89

The embryo after it was a blastocyst (5 days). Separate from the inner cell mass

92

A blastocyst a ball of cells.

91

When the inner cell mass is dividing, the cells become smaller since they are partitioning the zygote cytoplasm via mitosis.

94

The inner cell mass, not the trophoblast.

93

uterine implantation is driven by the trophoblast. The Inner cell mass expands and changes shape and location, but is still only one type of cell.

96

The trophoblast

95

Once attached to the uterus wall, the inner cell mass sets the [redacted]*. The* [redacted] *is the* [redacted] *axis.) The body is symmetrical along this.*

97

After setting the axis, [redacted] *takes place. This is where cells migrate, along the bottom, endoderm form,* [redacted] *in the middle* [redacted] *at the top.* [redacted] *will be the skin and nerves,* [redacted] *forms* [redacted] *and the* [redacted] *forms the* [redacted]

98

What is a highly coordinated cell movement?

99

What structures become the vertebrae?

100

What do somites eventually form into?

101

Growing organs is called...

102

By saying organogenesis is progressive, we mean

103

What is used as a reference for growing specialised cells in an embryo?

104

After setting the axis, gastrulation takes place. This is where cells migrate, along the bottom, endoderm form, mesoderm in the middle and ectoderm at the top. ectoderm will be the skin and nerves, mesoderm forms muscles, blood, skeleton, heart etc and the endoderm forms the digestive system, lungs etc

98

Once attached to the uterus wall, the inner cell mass sets the axis of the body. The primitive streak is the anterior posterior (head to tail) axis.) The body is symmetrical along this.

97

Somites; they emit signals telling what organs to form where.

100

Gastrulation

99

Organogenesis

102

Muscles, vertebral column and dermis of the skin. They are landmarks for organ formation during development.

101

The head to tail framework.

104

That the organs grow in stages, e.g. there is a little growth for the arm first, then it gets longer, then it gets digits etc.

103

What is a differentiated cell?

105

The gurdon experiment was done on...

106

The gurdon experiment involves...

107

Cells developmental potential (potency) changes how as it gets more specialised?

108

What is involved in a grafting experiment?

109

The fate of a cell [redacted] *before differentiation. They can sometimes* [redacted] *a new situation, up to* [redacted].

110

Source	***Potential***	***Type of cell***	***Can develop into***
Zygote	[redacted]	*-*	*Whole organism.*
[redacted]	[redacted] *and self-renewing*	*Embryonic stem cell*	*Any cell type*
Adult	*Multipotent,* [redacted]	*multipotent* [redacted]	*Some cell types*
Organ	*Limited potential and renewal*	[redacted]	*Choice of between* [redacted] *types*
-	*Limited division*	*committed progentor*	*1 type, locked fate.*
-	*No division*	*Differentiated*	*No division.*

111

Once a cell is differentiated...

112

Frogs

106

One where the shape, structure and function is well defined.

105

It decreases.

108

Taking egg cells, removing the nuclei and inserting nuclei from either a small embryo or a developed intestine cell. The former usually develop into tadpoles, but the latter mostly stop developing before the tadpole stage.

107

The fate of a cell can be locked before differentiation. They can sometimes not adapt to a new situation, up to 4 generations before.

110

Cells from an early gastrula (early embryo) that would form an eye are taken and transplanted into an host embryo (oldest), as well as ones from an neurala (older embryo than gastrula). The ones from the younger embryo develop into anything depending where they are implanted, the ones from the older embryo develop into eyes.

109

It has a clear cut identity and expresses specific proteins for morphology and function.

112

Source	***Potential***	***Type of cell***	***Can develop into***
Zygote	*Totipotent*	-	*Whole organism.*
Blasocyst	*Pluripotent and self-renewing*	*Embryonic stem cell*	*Any cell type*
Adult	*Multipotent, self-renewing*	*multipotent stem cells*	*Some cell types*
Organ	*Limited potential and renewal*	*Progenitor*	*Choice of between 2-6 types*
-	*Limited division*	*committed progentor*	*1 type, locked fate.*
-	*No division*	*Differentiated*	*No division.*

111

Cells have the same genes, but it's how they express their genes that makes them different.

113

At any given time, each cell expresses around [redacted] *of it's genes*

114

About [redacted] *of the* [redacted] *active genes are developmental genes.*

115

Developmental genes control:

116

One small difference in gene expression can [redacted].

117

Proteins inside the egg are [redacted].

118

After two [redacted] *of the zygote (egg to two cells, to four), the* [redacted] *are in the cytoplasm. After division two, the cells have different maternal proteins after division, so they have different gene expressions and more differences occur after each cell division onwards.*

119

Describe the cell lineage of insulin producing beta cells.

120

At any given time, each cell expresses around 20 percent of it's genes

114

Cells have the same genes, but it's how they express their genes that makes them different.

113

Proteins that regulate genes expression (turn genes on and off), proteins involved in cell communication or signalling (tell other cells what genes to turn on and off).

116

About ten percent of the 20 percent active genes are developmental genes.

115

Proteins inside the egg are not uniformly distributed.

118

One small difference in gene expression can create a cascade of changes downstream.

117

Fertilised egg (zygote) → inner cell mass → endoderm → pancreas → endocrine → beta cell

120

After two cleavage divisions of the zygote (egg to two cells, to four), the same maternal proteins are in the cytoplasm. After division two, the cells have different maternal proteins after division, so they have different gene expressions and more differences occur after each cell division onwards.

119

A differentiated cell can give rise to a new organism (), which means genes are as a cell specialises.

121

are proteins that bind to the DNA and . They change how the DNA is shaped so that different parts can be accessed.

122

The embryo starts with a zygote (.
It becomes a with a and
()
Before full differentiation, cells
and are
At the gene level, cells become different by
The initial differences come from the being unevenly distributed in the . As form from , they end up not having the same .

123

stem cells can become any cell.

124

have the minimum level of specialisation, have the maximum level of specialisation.

125

cells are not stem cells, but cells are.

126

cell stage is the limit for totipotency in humans.

127

Stem cells in the ICM are .

128

Epigenetics are proteins that bind to the DNA and retrieve totipotency. They change how the DNA is shaped so that different parts can be accessed.

122

A differentiated cell can give rise to a new organism (totipotent), which means genes are not lost as a cell specialises.

121

Totipotent stem cells can become any cell.

124

The embryo starts with a zygote (totipotent.
It becomes a blastocyst with a trophoblast and ICM (plurpiotent)
Before full differentiation, cells become locked in their fate and are determined
At the gene level, cells become different by expressing different developmental genes
The initial differences come from the maternal developmental proteins being unevenly distributed in the egg cytoplasm. As blastomeres form from cleavage divisions, they end up not having the same developmental proteins.

123

Committed progenitor cells are not stem cells, but progenitor cells are.

126

totipotent stem cells have the minimum level of specialisation, differentiated cells have the maximum level of specialisation.

125

Stem cells in the ICM are pluripotent.

128

8 cell stage is the limit for totipotency in humans.

127

Adult stem cells are [redacted].

129

Adult stem cells are found in...

130

Embryonic stem cells are [redacted] *and* [redacted].

131

In order to control ESL's in vitro, we can [redacted] *culture medium, or* [redacted].

132

Adult stem cells are [redacted] *to grow in the lab than* [redacted] *but do show* [redacted].

133

Describe the plasticity of ASC's

134

What are the most apparently plastic cells?

135

Why are UC-MSC's better than BM-MSC's?

136

Brain, Skin, Bone Marrow, Skeletal muscle, Intestines (any cell that needs regrowth).

130

Adult stem cells are multipotent.

129

In order to control ESL's in vitro, we can change the chemical composition of the culture medium, or insert specific genes into cells.

132

Embryonic stem cells are immortal and pluripotent.

131

Most adult stem cells can trans-differentiate in the lab, but this is a low efficiency process.

134

Adult stem cells are harder to grow in the lab than ESC's but do show some plasticity.

133

- *Less immunogenic*
- *longer telomeres*
- *less DNA damage*
- *non-invasive to harvest*
- *same plasticity as BM-MSC's.*

136

Mesenchymal stem cells (mesoderm), which can transform into liver cells (endoderm) and brain cells (ectoderm)

135

How many proteins are usually considered for immuno-compatibility?

137

What is GVHD?

138

Why are neonatal (UC cells) less immunogenic?

139

Neonatal cells have longer [redacted] *(which* [redacted]*), since they get shorter* [redacted] *since they do not get replicated, and neonatal cells have not divided many times.*

140

In ESC's what enzyme is expressed that stops a telomeres from getting shorter?

141

When is telomerase turned off?

142

What enzyme do most cancer cells produce and why?

143

What is a bank of ESC lines?

144

Graft Vs Host Disease, where the immune cells in the transplant attack the host.

138

5

137

Neonatal cells have longer telomeres (which indicate the age of the cell), since they get shorter at each cell division since they do not get replicated, and neonatal cells have not divided many times.

140

Embryos and foetuses have to evade the mother's immune system, so there are less surface markers on cells. Also, newly born babies have no/little immune system so there is less chance of GVHD.

139

Before the baby is born

142

Telomerase

141

A bank of embryonic stem cells, where each 'line' of cells is derived from a single embryo.

144

Telomerase so that the cells are immortal and divide indefinitely.

143

What are the three sources of human stem cells?

145

How could we make a stem cell with only some skin cells?

146

What are the currently approved stem cell based therapies?

147

How does a bone marrow transplant to cure leukaemia work?

148

Give an example of tissue engineering

149

What is ex-vivo and in-situ cartilage engineering

150

List advantages of MSC's

151

MSC's might be good for [redacted] *e.g. with HMC's since they help other stem cells to graft*

152

Make it into an induced pluripotent stem cell in the lab.

146

Embryonic SC's, Neonatal SC's, adult SC's (bone marrow, fat tissue (liposuction), skin).

145

1. Get a matching donor 2. Replicate stem cells ex vitro 3. Destroy bone marrow in patient using irradiation and chemotherapy 4. transplant stem cells into patient.

148

Skin grafts, Hematopoietic SC transplant from adult bone marrow or neonatal cells.

147

Growing new cartilage outside the body and in the body respectively (using MSC's to stimulate growth).

150

Remove cells from lungs, hips and nose, remove a donor trachea (from cadaver) and remove all cells, grow cells around trachea and transplant in patient.

149

MSC's might be good for cotransplants e.g. with HMC's since they help other stem cells to graft

152

- *Easy to isolate*
  Plastic (not literally!) in the lab
  Can be -frozen and thawed
  Possess potent immuno-suppression and -anti-inflammation effe
  Capable of homing (going to site of -injury)
  Stimulate regeneration

151

Clinical trials take [redacted], and [redacted] therapies are in phase 3 for stem cell treatments. Foreign clinics advertise MSC treatments, but none have published data from clinical trials.

153

Most trials for stem cell therapies are carried out with MSC's ([redacted]), HSC's count for [redacted]. ESC's are around [redacted] and are being tested with [redacted] since they are [redacted].

154

SC's can be used for [redacted], [redacted] and [redacted].

155

For repairing and replacing cells, what type of cell should we use?

156

What is an induced pluripotent stem cell?

157

How to do Parkinson's in a dish?

158

The traditional approach to medicine is [redacted].

159

The traditional approach to medicine does not take into account [redacted], which is successful for some, but not all patients.

160

Most trials for stem cell therapies are carried out with MSC's (70 percent), HSC's count for 20 percent. ESC's are around 2 percent and are being tested with eyes since they are immuno-privileged.

154

Clinical trials take a long time, and less than 10 therapies are in phase 3 for stem cell treatments. Foreign clinics advertise MSC treatments, but none have published data from clinical trials.

153

The patients own cells (autologous transplants). This requires adult stem cells that are reasonably plastic though, and its hard to isolate ASC's in the lab. Otherwise, use donor SC's with low immunogenicity.

156

SC's can be used for replacing cells (e.g. transplants), repairing cells (e.g. genetically modify SC's outside the body and re-implant) and protecting via MSC immunosupression.

155

- *Collect skin cells*
  Re-program them into stem cells
  Grow -brain cells from them (induce brain cell -differentiation)
  Stress out the brain cells with -toxins
  Observe Parkinson's-like features

158

When you reprogram a normal (e.g. skin) cell by inserting genes (via viruses or otherwise). Only 3-4 gene insertions required.

157

The traditional approach to medicine does not take into account individual differences between patients, which is successful for some, but not all patients.

160

The traditional approach to medicine is one size fits all.

159

What is stratified medicine?

161

Personalised medicine (aka) takes into account individual differences such as , and .

162

Examples of historical personalised medicine include...

163

When the human genome project started, drugs had pharmacogenetic information. After it ended, drugs had this information and ten years later, there drugs. Now the , , and are examined.

164

Genetic changes of interest include , , and . These all change how much of the proteins coded for by an affected gene is produced.

165

What are the advantages of personalised medicine (6 things)?

166

What genes increase your risk of breast and ovarian cancer and how much by?

167

There are over predictive tests looking at genes. They can of treating patients.

168

Personalised medicine (aka precision medicine) takes into account individual differences such as genes, environment and lifestyle.

162

Targeting different types of specific diseases made up of lots of different genes e.g. maturity onset diabetes

161

When the human genome project started, 4 drugs had pharmacogenetic information. After it ended, 46 drugs had this information and ten years later, there 104 drugs. Now the genome, proteome, metabolome and epigenome are examined.

164

Inheritance of alkaptunoria, blood transfusions using blood capability testing, genetic basis of selective toxicity of an antimalarial drug.

163

- *Shift reaction to prevention*
- *Predict susceptibility of developing a disease*
- *Improve dosing of drugs (increase efficiency, reduce side effects)*
- *Reduce cost, time and attrition rate in drug development*
- *Decrease adverse affects of drugs, increase diagnostic and detection power for disease*

166

Genetic changes of interest include SNP's, base insertions, copy-number variations and variable number tandem repeats. These all change how much of the proteins coded for by an affected gene is produced.

165

There are over 15000 predictive tests looking at 2800 genes. They can save the cost of treating patients.

168

BRAC1, BRAC2; 85 percent higher lifetime chance of breast cancer and 60 percent chance of ovarian cancer.

167

Even if a predictive test for a gene doesn't have an associated drug to lower risk, you can [redacted]. *Sergey Brin does this for Alzheimer's!*

169

It's easy to take biopsy of cancer tumours (because they're by definition, not needed), so they can have their genome sequenced to see what genes the cancers have.

170

There are drugs (Ivacaftor) that target the [redacted] *of diseases rather than just treating symptoms.*

171

What does metastatic cancer mean?

172

Enzymes metabolise drugs, and [redacted] *metabolise over* [redacted] *percent of drugs. There are* [redacted] *in genes that code for these enzymes. Some people metabolise fast (and are at risk of* [redacted]*), or even ultra-fast metabolisers (meaning the drugs* [redacted]*).*

173

After a stent has been put into [redacted]*, the body recognises it as foreign and blood will clot around it. A drug is given to stop clotting, but one enzyme (*[redacted]*) converts the drug from inactive to active. Variations in this enzyme mean not as much is converted, meaning the blood can clot possibly causing a heart attack or stroke.*

174

What are some problems with personalised medicine?

175

What are the ethical problems with personalised medicine (5 things)?

176

It's easy to take biopsy of cancer tumours (because they're by definition, not needed), so they can have their genome sequenced to see what genes the cancers have.

170

Even if a predictive test for a gene doesn't have an associated drug to lower risk, you can change environmental factors (e.g. eat better, stop smoking etc). Sergey Brin does this for Alzheimer's!

169

When the cancer has moved from the original site to other areas of the body.

172

There are drugs (Ivacaftor) that target the gene underlying cause of diseases rather than just treating symptoms.

171

After a stent has been put into an artery, the body recognises it as foreign and blood will clot around it. A drug is given to stop clotting, but one enzyme (CYP 2C19) converts the drug from inactive to active. Variations in this enzyme mean not as much is converted, meaning the blood can clot possibly causing a heart attack or stroke.

174

Enzymes metabolise drugs, and one family of enzymes metabolise over 90 percent of drugs. There are thousands of mutations in genes that code for these enzymes. Some people metabolise fast (and are at risk of overdose toxicity), or even ultra-fast metabolisers (meaning the drugs are broken down before they have an effect).

173

Who sees the data? How will it be stored? How will it be used? Could it be used against us? What legal protection do we have?

176

Ethics, multiple gene variations per disease, quantity of data

175

mutations can be involve with genes. Drugs need to target driver mutations in order to be effective.

177

Define biomarker

178

Why are biomarkers helpful?

179

can be used to build up a signature, telling us how multiple etc contribute towards a disease

180

and are used to identify genes involved in diseases.

181

Given a patient, we can use , and (detecting antigens on the surface of cells) to determine their biomarkers. These can be gotten from , , , etc. Anywhere where we in the body.

182

How do DNA chips work?

183

What is the name for a test that goes with a drug?

184

A naturally occurring molecule, gene or characteristic by which a particular pathological or physiological process, disease etc can be identified.

178

Driver and passenger mutations can be involve with genes. Drugs need to target driver mutations in order to be effective.

177

multiple biomarkers can be used to build up a signature, telling us how multiple genes/proteins etc contribute towards a disease

180

Because they help with prediction, diagnosis, progression, regression, or the outcome of treatment of a disease.

179

Given a patient, we can use DNA sequencing, microarrays and immunohistochemistry (detecting antigens on the surface of cells) to determine their biomarkers. These can be gotten from normal or diseased tissue, blood, saliva, sweat etc. Anywhere where we can find protein or DNA in the body.

182

GWAS and microarrays are used to identify genes involved in diseases.

181

A companion diagnostic (CDx).

184

First, sample DNA is taken, then it is amplified using PCR. It is then placed on a DNA chip with many probes, where it will bind to probes that it is complementary to. The chip is washed to remove the non-bound DNA, then scanned, where the bound probes will be visible.

183

Oncotype Dx identifies [redacted] *genes associated with* [redacted] *and* [redacted] *housekeeping genes (used as a control). These are used to give a score of 1-100 giving the likely reoccurrence of* [redacted] *within the next* [redacted] *years. It also predicts the response to* [redacted]*. This costs* [redacted]*.*

185

[redacted] *determines how aggressive a* [redacted] *tumor is (i.e. whether there is a high or low risk of* [redacted]*). It measures the mRNA of* [redacted] *genes. A biopsy is taken and determined to make sure that* [redacted] *or more cells are cancerous, then the tissue is used for a* [redacted]*.*

186

What is ecosystem services?

187

Give examples of ecosystem services.

188

Biological resources include...

189

What are the social benefits to biodiversity?

190

Define biodiversity

191

What are the three main levels of biodiversity.

192

MammaPrint determines how aggressive a breast cancer tumor is (i.e. whether there is a high or low risk of metastasis). It measures the mRNA of 1900 genes. A biopsy is taken and determined to make sure that thirty percent or more cells are cancerous, then the tissue is used for a microarray.

186

Oncotype Dx identifies 16 genes associated with breast cancer and 5 housekeeping genes (used as a control). These are used to give a score of 1-100 giving the likely reoccurrence of the tumor within the next ten years. It also predicts the response to chemotherapy. This costs $4175.

185

Protection of water resources, controbution to climate stability, maintinance of ecosystems, pollution breakdown and absorbtion, nutrient storage and recycling, soil formation etc...

188

Involves putting a value on a service that protects biodiversity. E.g. instead of building a dam, work out how much preseving a forest can help water retention (protecting water resources).

187

Research, recreation and tourism, culture.

190

Food, medinal resources and pharmaceutical drugs (e.g. stuff in rainforests), wood, ornamental plants, breeding stocks, gene diversity.

189

Genetic diversity, species diversity, ecosystem diversity.

192

The variety of life at all levels; gene level, population level, species level, ecosystem level. Also, the interactions between these living things.

191

Define genetic diversity

193

What does a low genetic diversity mean?

194

A small population is prone to positive feedback loops that draw it down an [redacted].

195

Define genetic drift

196

Extinction vortex: small population means interbreeding and genetic drift, so there is a loss of genetic diversity, meaning that there is a reduction in individual fitness and population adaptability so there is lower reproduction and a higher mortality.

197

What (is the biggest thing that) makes species susceptible to extinction?

198

Cheetah has a [redacted] *because it had a* [redacted] *near the last ice age (*[redacted]*) and they had an isolated populations in North Africa and Asia are* [redacted].

199

Greater Prarie Chicken were fragmented by [redacted]*, and then found to exhibit a decreased fertility. In order to try to save the colonies, genetic variation was imported by* [redacted]*, and the declining populations rebounded, confirming that* [redacted] *was causing the* [redacted].

200

The key factor driving the extinction vortex is the loss of genetic variation since variation is necessary for evolutionary responses to environmental change.

194

The combination of different genes found within a population of a single species, and the pattern of variation found within different populations of the same species.

193

When a population has little genetic variation, any disease that all individuals are suseptible to could kill the whole population.

196

A small population is prone to positive feedback loops that draw it down an extinction vortex.

195

Small population size; i.e. rare species are most at risk.

198

Extinction vortex: small population means interbreeding and genetic drift, so there is a loss of genetic diversity, meaning that there is a reduction in individual fitness and population adaptability so there is lower reproduction and a higher mortality.

197

Greater Prarie Chicken were fragmented by agriculture, and then found to exhibit a decreased fertility. In order to try to save the colonies, genetic variation was imported by taking birds from larger populations, and the declining populations rebounded, confirming that low genetic variation was causing the extinction vortex.

200

Cheetah has a low genetic variation because it had a genetic bottleneck near the last ice age (only a few individuals survived) and they had an isolated populations in North Africa and Asia are still genetically similar.

199

Define species diversity

201

Define species richness

202

Define species evenness

203

Define ecosystem diversity

204

An ecosystem can [redacted] *such as a whole forest or a* [redacted] *such as a pond.*

205

Give four causes of biodiversity loss

206

Most threatened species are imperiled [redacted].

207

Give the three types of (endangered) species

208

The number of different species in a particular area.

202

The variety and abundance of different types of organisms which inhabit an area.

201

Encompasses the variety of habitats that occur in a ragion, or the mosaic of patches found within a landscape

204

The relative abundance with which each species is represented in an area (e.g. lots more grey than red squirels).

203

Habitat loss, intriduced species, overexploitation, pollution.

206

An ecosystem can cover a large area such as a whole forest or a small area such as a pond.

205

Rare, dominant and keystone

208

Most threatened species are imperiled for more than one reason.

207

What is a rare species?

209

What is a dominant species?

210

What is a keystone species?

211

Conserving biodiversity aims to look for [redacted] *by mapping biodiversity by region (richness, levels of threat) and by country. These areas are ranked and preserved.*

212

Hotspots have three aspects; [redacted]*,* [redacted] *and* [redacted]*. These rarely overlap.*

213

There are [redacted] *hotspots in the world containing* [redacted] *of the worlds threatened vertebrates and only cover* [redacted] *of the earth's surface.*

214

Costa Rica has [redacted] *percent of global biodiversity, but only* [redacted] *percent of the land surface of earth. It has the highest* [redacted] *per kilometer squared in the world, and* [redacted] *of the country is conserved.*

215

The Isthmohyla rivularis frog was thought to be eztinct in [redacted] *for* [redacted] *years before a* [redacted] *was spotted in* [redacted]*.*

216

A species that supports many other species. Saving these often helps many others.

210

A species that has a small population.

209

Conserving biodiversity aims to look for hotspots by mapping biodiversity by region (richness, levels of threat) and by country. These areas are ranked and preserved.

212

A keystone species is a species whos very presence contributes to a diversity of life and whos extinction would lead to the extinction of many otheres. They help support the whole ecosystem.

211

There are 34 hotspots in the world containing seventy five percent of the worlds threatened vertebrates and only cover two point three percent of the earth's surface.

214

Hotspots have three aspects; richness, threatened species and endemic (unique to a location) species. These rarely overlap.

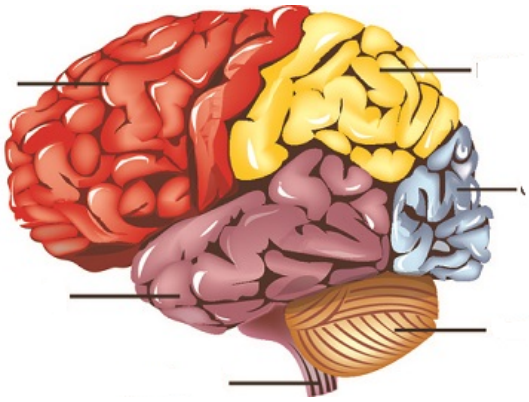
213

The Isthmohyla rivularis frog was thought to be eztinct in Costa Rica for 20 years before a female was spotted in 2008.

216

Costa Rica has 4 percent of global biodiversity, but only 0.01 percent of the land surface of earth. It has the highest species richness per kilometer squared in the world, and half of the country is conserved.

215



217

What are the lobes in the brain?

218

What are the parts of the brain?

219

An obvious feature of the hemisphere of the brain is the . *The ridges are called* *and the valleys are called* .

220

The frontal lobe has the *and the* . *The latter seperates the frontal lobe from the rest of the brain. The* *is located in the* .

221

The frontal lobe is responsible for , *and* .

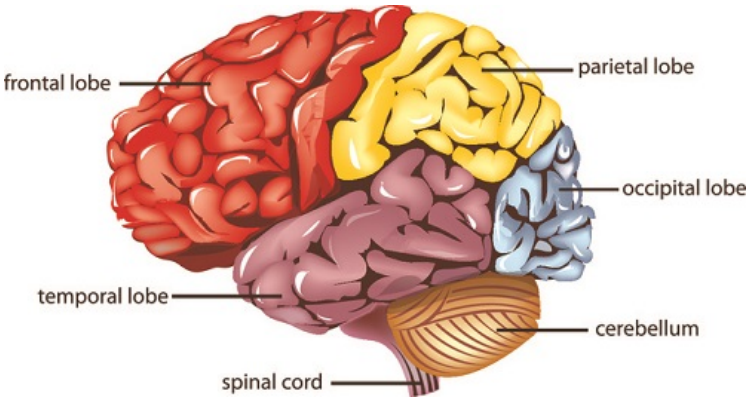
222

What is a lesion?

223

The parietal lobe is located , *and is responsible for* *and* .

224



217

Frontal, parietal, temporal, occipital

218

Cerebellum, brainstem, frontal lobe, parietal lobe, temporal lobe, occipital lobe.

219

An obvious feature of the hemisphere of the brain is the highly convoluted surface. The ridges are called gyri and the valleys are called sulci/fissures.

220

The frontal lobe has the primary motor cortex and the central sulcus. The latter seperates the frontal lobe from the rest of the brain. The primary motor cortex is located in the pre-central gyrus.

221

The frontal lobe is responsible for movement, personality and planning.

222

When the function of an organ is impaired

223

The parietal lobe is located behind the pre-central cortex, and is responsible for awareness of surroundings and stereognosis.

224

The temporal lobe is responsible for [redacted], [redacted] *and* [redacted].

225

The occipital lobe is responsible for [redacted].

226

The cerebellum [redacted].

227

The brainstem has [redacted] *are here. This dictates things like* [redacted] *and* [redacted].

228

What are the two different types of the somatic nervous system.

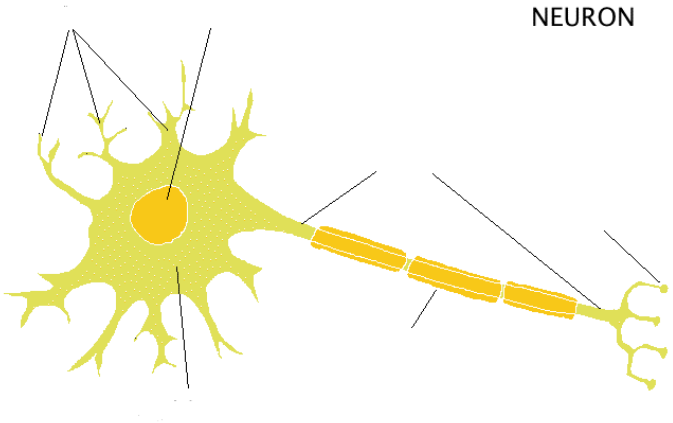
229

What makes up the Centeral Nervous System (CNS))

230

What makes up the Peripheral Nervous System (PNS)

231



The occipital lobe is responsible for processing visual signals.

226

The temporal lobe is responsible for hearing, language and naming.

225

The brainstem has cardiovascular and respiratory centers are here. This dictates things like heart beat speed and blood pressure.

228

The cerebellum coordinates movement and posture.

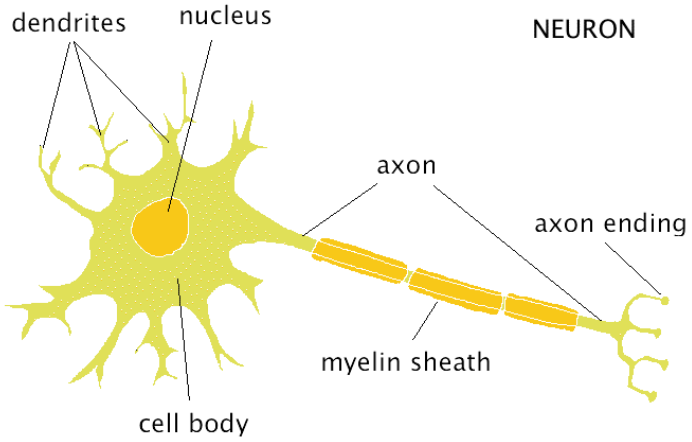
227

The brain, brain stem and spinal chord

230

Central nervous system (CNS; brain, brain stem and spinal chord) and peripheral nervous system (includes the cranial and spinal nerves).

229



232

The brain, brain stem, spinal chord and cranial + spinal nerves

231

Myelin acts as an [redacted] *and* [redacted].

233

Axons that have a myelin sheath are called [redacted].

234

The gaps bewteen myelin sheathes are called [redacted]

235

Affeent neurones go [redacted] *a receptor and efferent neurones is* [redacted] *a receptor.*

Name	*Number of connections*	*Class*
[redacted]	*1*	*Structural*
Interneurone	[redacted]	[redacted]
[redacted]	*2*	[redacted]
Multipolar	[redacted]	[redacted]

236

Sense	*Name*
Pressure	[redacted]
Temperature	
Light	
Smell/taste	
Pain/heat/tissue damage	

237

TODO

238

Neuroglia are [redacted] *for the neurons.*

239

The plasma membrane is a [redacted] *membrane that allows some things to move through and not others. Structures such as* [redacted] *are on the membrane.*

240

Axons that have a myelin sheath are called Myelinated axons.

234

Myelin acts as an insulator and speeds up transmission along the axon.

233

Affeent neurones go from a receptor and efferent neurones is to a receptor.

Name	*Number of connections*	*Class*
Unipolar	*1*	*Structural*
Interneurone	*1*	*Functional*
Bipolar	*2*	*Structural*
Multipolar	*n*	*Structural*

236

The gaps bewteen myelin sheathes are called Nodes of Ranvier

235

TODO

238

Sense	*Name*
Pressure	*Mechanoreceptor*
Temperature	*thermoreceptor*
Light	*Photoreceptor*
Smell/taste	*Chemoreceptor*
Pain/heat/tissue damage	*Nociceptor*

237

The plasma membrane is a selectively permeable membrane that allows some things to move through and not others. Structures such as sodium and potassium channels are on the membrane.

240

Neuroglia are supporting cells for the neurons.

239

What is the resting membrane potential of a cell?

241

At rest, [redacted] *in a neurone.* [redacted] *are closed, others are open.*

242

When a cell is stimulated, the [redacted] *channels open, and* [redacted]*. This makes the cell cytoplasm* [redacted]*.*

243

Define depolarisation

244

TODO

245

TODO

246

TODO

247

TODO

248

-70mv

241

At rest, all of the sodium channels are closed in a neurone. Some potassium channels are closed, others are open.

242

When a cell is stimulated, the sodium channels open, and the potassium channels close. This makes the cell cytoplasm less negative.

243

The inside of the cell has gone from -ve to +ve.

244

TODO

245

TODO

246

TODO

247

TODO

248

TODO

249

TODO

250

TODO

251

Are viruses life?

252

Flu and ebola are [redacted] *strand group* [redacted] *viruses*

253

Why is influenza so prevalent?

254

How many types of flu viruses are there? Which is the main human one?

255

What is the structure of the influenza virus?

256

TODO

249

TODO

250

No, since they have to be inside another cell to replicate.

251

TODO

252

Flu and ebola are negative strand group 5 viruses

253

Since it has so many hosts that it can infect (i.e. different species)

254

Three; A, B and C. A is the one that is the main human pathogen.

255

See slide...

256

Where does influenza infect in the mammal?

257

TODO

258

[redacted] *are messenging molecules for the immune system that are released by cells infected with a virus.*

259

Why is invluenza so prone to variation?

260

How often are there flu epedemics?

261

There are [redacted] *subtypes of H-influenza and* [redacted] *subtypes of N-influenza.*

262

How often are there influenza pandemics?

263

Why are young healthy people vulnrable to flu?

264

TODO

258

The respiritory tract. The lower down, the worse the symptoms.

257

Since the RNA of viruses lacks proof reading, so that the H and N antigens change ("antigenic drift"). This is why there are new flu vaccines produced every year.

260

Cytokines are messenging molecules for the immune system that are released by cells infected with a virus.

259

There are 18 subtypes of H-influenza and 11 subtypes of N-influenza.

262

There is a localised epedemic, every 2-3 years.

261

Since they have a very good immune system, and there will be a large response, which can cause death (lots of fever etc). This is called a cytokine storm.

264

Every ten to fourty years?

263

Talk about hong kong bird flu.

265

There is lots of drug resistance for anti-virals for flu because [redacted].

266

Ebola virus has a [redacted] *shape under the electron microscope. It has* [redacted] *of RNA, and the natural host is* [redacted]*. It is spread by* [redacted].

267

What is the mortality rate of ebola

268

Symptoms of ebola?

269

Ebola infects [redacted] *cells, which then trigger an immune response, and usually release a cytokine called* [redacted]*, which acts as a warning system for nearby cells. Ebola lets* [redacted] *be produced, but stops the immune cells working, which means that cells repond to the cytokines and die/slow down protein synthesis etc.*

270

What are the ebola drugs?

271

What diagnostic tests are there for ebola?

272

Hong Kong Bird flu (1997, H5N1) went from birds to humans. Increased pathogenesis, efficient viral replication and cytokine storm. Mortality rate was about 55%. Probably caught via bird faeces.

265

There is lots of drug resistance for anti-virals for flu because the virus mutates so rapidly.

266

Ebola virus has a shepherd's crook shape under the electron microscope. It has one long strand of RNA, and the natural host is probably fruit bats. It is spread by bodily contact with humans.

267

30-50 percent.

268

Asymptomatic for 2-21 days. and not infectious for that time. Abrupt manifestation after that, fever, chills, muscle pain and other infections. Then more (nausea, vomoting, headache etc). After that, haemorrhagic manifestations (coughing up blood etc) in 30-50 percent of patients. Post infection complications.

269

Ebola infects immune system cells, which then trigger an immune response, and usually release a cytokine called interferon, which acts as a warning system for nearby cells. Ebola lets interferon be produced, but stops the immune cells working, which means that cells repond to the cytokines and die/slow down protein synthesis etc.

270

Most support blood pressure and fluids. There are several unapproved treatments but these can only be used with patient consent.

271

Can't detect antibody response for ebola sometimes since the immune system is partially deactivated, and also that people die before a measurable antibody reponse is detected (and patients often die before then). Electron microscopes can be used to identify the virus.

272

Ebola has a biosafety level of [redacted], where there is a high risk of transmission through the air, and can cause severe and fatal disease where there is no vaccine.	*Why is it unlikely that ebola will become airborn?*
273	274

There has been no virus that has been transmitted by bodily fluids that has mutated to become transmitted through the air.

274

Ebola has a biosafety level of 4, where there is a high risk of transmission through the air, and can cause severe and fatal disease where there is no vaccine.

273