Genetics

Course outline

1) extension of Mendelian genetics
2) Chromosomes structure and changes
3) Vertebrate development

Interactions between Genes, Alleles, and Phenotypes

Incomplete dominance

Genetic/ molecular cause

The recessive allele does not produce any functioning protein. The dominant allele does function protein but not in high enough quantities to result in the same phenotypic effect as a heterozygous dominant

phenotypic effect

A heterozygous individual will display a phenotype intermediate to that of homozygous dominant and homozygous recessive

Dominance

Genetic/molecular cause

The recessive allele does not produce any functioning protein. The dominant allele does function protein, which it produces in comparative amount to a homozygous dominant individual

Phenotypic consequence.

the heterozygous phenotype is identical to that of the heterozygous dominant individual.

Co-dominance

Genetic/ molecular cause

Both alleles are transcribed/translated to form a functioning protein

phenotypic effect

The effect comes from the full expression of both alleles

Dominance hierarchies.

It is often the case that there will be a number of alleles for one gene. In which case a dominance hierarchy is usually present such that allele A is Dominant to B is dominant to C and so forth (ie dominance in a hierarchy is transitive)

Pleiotropy

Genetic/molecular cause One gene locus affects the expression of several characteristics. Phenotypic cause Phenotype of one characteristic will change in conjunction with the phenotype of another characteristic

Notes about colour

As many genetic examples are based on colour it is worth understanding the basics of colouring in animals. colour results from pigments which are proteins, individual genes can either code directly for the production of these proteins or as an intermediate/enzyme which aids in the production of these proteins.

White

white does not result from a specific pigment but rather from a lack of pigment.

Co-dominance and Incomplete dominance

a co-dominant colour combination can look like an intermediate if it is the combination of two pigments, however in the case where one of the phenotypes is white then a intermediate can only be a result of incomplete dominance

Sex linked traits

Sex limited traits,

Important examples

BG 2032

13/02/2108

Phenylketonuria

single mutation can affect brain development however if the correct diet is followed then all detrimental health consequences can be ignored.

diabetes type II

lifestyle disease, the genetic component is estimated to change the likelihood of developing the disease by 2%, but the main causative factors of the disease relate to diet.

Lactose intolerance.

Individuals with lactose intolerance cant digest lactose, however the bacteria in their gut van which leads to the build up of gas. this can be very painful for the person in question.In humans lactose intolerance would naturally occur after weening however as cow milk is a staple part of most human diabetes the genes controlling lactase production are never switched off and the ability to digest lactose is not normally lost.

Himalayan Phenotype.

Cancer

basics

A cancer is a group of cells whose proliferation is uncontrolled, and which can spread to other locations in the body which are normally populated bu other cell types.

benigin tumours

grow but do not spread.

malignant tumours

over proliferate and invade other body tissues/ areas in the body.

types of cancers

Carcinomas

derived form epithelial cells

Sarcomas

derived from connective or muscle tissues. Known as Osteosarcoma in the case of bone tissue and Kaposi sarcoma in the case of soft connective tissue.

Lymphoma and leukaemias

1. Cancers of the hematopoietic system.
2. Lymphoma (solid tumour)
3. Leukaemia excess of circulating immature blood cell precursors. ##### Cancer of the nervous system brain and central nervous system.

NOTE: most common in children

Germ-line cancer.

Cancers of breast, prostate, lung, pancreas, and colon.

Causes of cancer.

In most cases cancer is not inherited. In breast cancer/ovarian cancer BS1, BS2 play some role in genetic disposition, perhaps 5-10%

hereditary.

Cancer normally sets in during old age as cells must accumulate a series of a specific set of notations, (exactly which set of mutations accumulated lead to cancer is highly individual)

Environmental factors

1. UV
2. X rays
3. Alcohol
4. Overcooked food (hetercyclic amines,polycyclic aromatic hydrocarbons-meat. acrylamide- potatoes
5. Azo dyes
6. tartrazine (food colourants)
7. Nitrate cured foods
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agents which cause DNA damage (mutagens). these factors may be chemical, biological (such as HPV- human papilloma virus cause latent genetic damage- Cancer predisposition.

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5. large tumour capable of invading near by tissue (metastasis)

NOTE: cancer results from a series of somatic mutations, affecting the same cell, and different cancers are genetically heterogeneous.

Genetic instability in cancers.

deficient local DNA repair leads to the accumulation of point mutations increased chromosomal instability and gross genome abnormalities.

summary of key properties

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5. metastatic (survive and proliferate in foreign) sites.

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reflects the range of expressions of the gene/allele present in the population.

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NOTE: Rufus albinism leads to a phenotype with reddish hair, lighter skin, and blue grey eyes.

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centromere is more to the one side of the chromosome than the other,

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the centromere is very far to the one side of the chromosome, with a long arm containing most of the genes and a short arm containing predominantly temolmeric DNA.

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bands were named and used to locate specific genes. the banding patterns are due to uneven DNA densities in the coiled structure of the chromosome.

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Each cell is has at least one extra chromosome or is missing at least one chromosome

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NOTE: only 8% survival past the first year.

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Too many X's ,XXY , XXXY, XXXXY, XXXXXY. (XXYY) Effects: 1. Decrease in testosterone levels 2. the more X's the higher the chance of brain damage.

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XYY has the phenotype of a normal make. men with 2 Y chromosomes tend to be tall as there is a cumulative effect adding to height. (they may also exhibit increased aggression but this in unclear)

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Examples

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bicentric chromosomes (breakage in mitosis)

breakage fusion bridge cycles in cancer.

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Hinny vs mule

Mule

horse mother donkey father hardy and obedient

Hinny

donkey mother, horse father. temperamental, untrainable.

Intersistial deletion of chromosome 15

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Cause: deletion from father, ZNF127 and IPW inactivated on the maternal copy. effects: 1. mental retardation 2. obesity 3. diminished growth.

Angelman syndrome

1. deletion from mother: UBE3A inactivated on paternal copy.

2. mental retardation
3. epilepsy
4. lack of motor development.

X inactivation

the inactivation of one of two X chromosomes in females via DNA methylation.

NOTE: which X chromosome is inactivated varies randomly from cell to cell.this inactivation process turns the inactive X into a bar body, (highly methylated and rolled up in histone proteins).

Frog colour

details

the skin colour of a certain from is controlled by one allele. There are three different phenotypes observed, these are red, blue, and purple.

explanation

This is an example of co-dominance as the purple colour comes from a combination of the red and blue pigments. that is both red and blue pigments have been produced. We can conclude that the purple from is heterozygous, the blue frog is homozygous blue and the red frog is homozygous red.

Fruit flies eye colour.

details.

the colour of fruit flies eyes is determined by two gene loci. a fly with dominant alleles at the red locus will be red eyed, while a fly with dominant alleles at the brown locus will be brown eyed. However a fly with both dominant brown and cinnabar will be white eyed.

explanation

the white eyed phenotype is due to a form of inhibition similar to epistasis stops either of the pigments form being produced if both pigment genes are present.

Rabbit Skin Colour

details

the skin colour of rabbits is determined by one gene locus, which has four possible Alleles. All alleles code for the enzyme tyrosinase which acts to convert tyrosine into dopamine a critical first set in the production of hair pigment.

#1 non functional

The most recessive Allele codes for a nonfunctioning version of tyrosinase leading to albino rabbit.

#2 heat sensitive

The next most recessive allele codes for a heat inactivated version of tyrosine meaning that the final colour of the rabbits fur will depend on the temperature conditions it was raised in, and also that within a certain temperature range there will be a distinct colour difference between the warmer and colder parts of the animal.

#3 localised functionality

The next most recessive allele codes for a version of tyrosinase does not fold quite "correctly" and as such does not glycosalate in the same way as the dominant version. melanocytes which produce the grey pigment will still accept this tyrosinase into their cytoplasm and as such grey pigment will be produced. however as intracellular transport is affected the tyrosinase either cannot reach or cannot enter melanocytes capable of producing the brown pigments and so they rabbits are full grey

#4 fully functional

the most dominant allele codes for a fully functional form of tyrosinase and the combination of grey and orange pigments produced gives the rabbits a full brown coat.

human Blood types.

details

human blood types are determined by one gene locus with three alleles. allele O is recessive, and codes for no functioning protein. allele A and B are co dominant and each code for different sugars which are attached to the outside of red blood cells.

Bombay phenotype

details

parents A and AB, child O, mates with A, results B, AB and O.

explanation

A and B sugars are attached to red blood cells by appending them onto the end of glycoproteins called Substance H which are already attached to the cell. If a individual is homozygous recessive for substance H genes, none will be produced and so even if the have A or B alleles they will have a functionally O phenotype.

###Alleles and genes A gene is a collection/ group of alleles which could occur the same locus and which are associated with the same traits.

###lethal alleles alleles which are incompatible with the organisms continued survival

dominance

most lethal alleles are recessive because dominant lethal alleles produce non functioning proteins only so any individual with even one of the dominant allele would be unlikely to survive to reproductive age, and so the Allele would very quickly be bread out of the population.

sex chromosomes

lethal alleles, or alleles linked with low fertility located on the Y chromosome in humans are very rare. disease related to homozygous XX are more likely to be suffered by woman, as they will have one working copy of the given gene so they can survive but one defective copy which leads to the illness. males on the other hand will either survive and be entirely healthy with a working copy or die, if they are even born if they have only a defective copy.

lethal dominants

lethal dominants may occur in one of two cases. First, if the onset of the disease/ defect related to the Allele only occurs after reproductive age. Secondly if a De Novo (random, once off) DNA mutation occurs in a given individual. lethal dominants can also result from an Allele which interferes with the formation of aggregates of the protein which the gene codes for, or receptors of that protein,or finally if it has a detrimental effect on another protein or gene (such as the yellow mice)

examples

Yellow Mice.

details

Y allele codes for the yellow coloured pigment. y codes for other pigment/no pigment. Y is a lethal Dominant(?) Allele. As a YY individual with not develop bast the early stages of implantation into the uterine wall.

molecular/genetic explanation

When the Y allele is present at the gene loci it causes a deletion in which, its own gene promoter, as well as the coding sequence of the gene upstream of it(the MERC gene necessary in RNA processing) are removed. the net result being that proteins relating to the gene upstream are no longer removed, and the pigment gene is now promoter by the MERC promoter instead of its own promoter

Result and Phenotype

the result is that Yy individual still produce enough RNA processing proteins to survive/ avoid miscarriage,but they are more susceptible to diseases such as obesity and cancer. Also their yellow pigment gene is promoted heavily during early development leading to yellow coloured fur. YY miscarriages early in pregnancy as it cant produce necessary RNA processing proteins. yy is health individual without yellow colour. birth rations will be skewed by the fact that YY individuals are not actually born. NOTE: this is an example of incomplete dominance of Y with respect to MERC.

Effective Of the environment on genetic expression.

examples

Myopia(short sightedness):

Populations where book learning is not inforced/encouraged from an early age do not show high rates of myopia even though the genetic dispostion between the two populations is very similar.

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