DESIGNER GENES - TRAINING GUIDE (2005)

by Karen L. Lancour

Note: This event may be run as stations but it need not be. It is a very different event when run as paper pencil. The best competition is still as stations using process skills and problem solving.

MENDELIAN GENETICS AND POPULATION GENETICS

gene - a unit of inheritance that usually is directly responsible for one trait or character. Each individual has two genes for each trait, one comes from dad and the other from mom

allele - alternate forms of a gene. Usually there are two alleles for every gene, sometimes as many a three or four present in a population

homozygous - when the two alleles are the same

heterozygous - when the two alleles are different

dominant - a trait (allele) that is expressed irregardless of the second allele

recessive - a trait that is only expressed when the second allele is the same (e.g. short plants are homozygous for the recessive allele)

hybrid – an individual who has one dominant and one recessive gene for a trait

incomplete dominance – a trait where the phenotype of a hybrid displays a blending of the two alleles

phenotype - the physical expression of the genes for the trait by an individual

genotype - the gene makeup of an organism. Phenotype is the trait of an individual expresses while genotype is the two genes that cause that trait

punnett square - probability diagram illustrating the possible offspring of a mating male genes on top of columns and female traits on side of rows

monohybrid cross – a cross involving only one trait. (phenotype ratio – 3:1 and genotype ratio 1:2:1)

dihybrid cross – a cross involving two traits. (phenotype ratio-9:3:3:1 and genotype ratio- 1:2:1:2:4:2:1:2:1)

Probability – ratios or percents

multiple alleles – three or more alleles for a gene as blood type as skin color

multifactorial traits – more than 1 pair of genes plus environment

Incomplete dominance – one allele (gene) is not completely dominant over another resulting in a blending of traits

Codominance – both dominant alleles (genes) in an individual are expressed as blood types

Pleiotrophy – the action of an allele (gene) affects many parts of the body as sickle cell anemia

Variable expressivity – an allele (gene) can be expressed differently in different people

sex-linkage – allele (gene) is located on a sex chromosome and it

Barr bodies – tightly coiled X chromosome in females – inactive X chromosome.

Calico cats – usually on females. yellow and black alleles on X chromosome - female has 2 X's

epistasis – one pair of genes alters the expression of another pair of genes as albino

pedigree analysis - pedigree is a family tree**.** Squares are males and circles are females

nondisjunction – chromosomes do not separate during meiosis. Results in monosomy and trisomy

karyotype analysis - karyotype is print of human chromosomes

The numbered chromosome pairs termed autosomes are arranged longest to shortest

Chromosomes come in pairs

The sex (X & Y) chromosomes are placed last with normal females having XX and normal males having XY

If only X chromosomes are present, it will be female

If X and Y chromosomes are present, it will be male

Bent chromosomes are not abnormal. It is just the way they were photographed

If an individual has an extra chromosome, it is termed **trisomy** and if a chromosome is missing, it is termed **monosomy**

Population genetics – studying genetic makeup of a population.

Gene pools and gene frequencies

Hardy Weinberg principle – sexual shifting of alleles due to meiosis and random fertilization does not effect overall genetic structure $p^2 + 2pq + q^2 = 1$

MOLECULAR GENETICS AND BIOTECHNOLOGY

DNA structure – double helix with sugar (deoxyribose), phosphate and nitrogen bases (Adenine, thymine, guanine, and cytosine) Pairing – AT and GC

Nucleotide - basic unit of sugar, phosphate and nitrogen base. 4 kinds

Stop codes – ATT, ATC, ACT

DNA replication - Okazaki fragments- made 3 prime to 5 prime - occurs in the nucleus

Gene – section of DNA with carries the blueprint for making a protein or part of a protein

Mutations - changes in genetic code of genes or chromosomes and causes

Causes of mutations – chemicals, radiation, temperature

Exons– genes (5%) and **Interons** – between genes (95%)

Transcription - production of RNA

Kinds of RNA – three kinds of RNA

Messenger RNA – carries genetic code from DNA into cytoplasm

Transfer RNA – transfers amino acids for building of protein

Ribosomal RNA – reads the code of M-RNA and allow T-RNA to attach

Translation – genetic code used to form amino acid sequence using M-RNA, T-RNA, and R-RNA occurs in the cytoplasm at the ribosome

Plasmids and restriction enzymes – in bacteria, circular DNA. Enzymes to cut DNA at a particular spot.

DNA analysis technologies - in interons

sequencing – determining the nucleotide sequence of a gene

fingerprinting – PFLP or restriction fragment length polymorphism

PCR – Polymerase Chain Reaction – clones DNA segments in a test tube

Gene therapy - changing the expression of a person's genes - body (somatic) or germ cells

Human genetic disorders – can be dominant, recessive, sex-linked, epistatic, variable expressed

Chromosome mapping – location of genes on a chromosome

Crossover frequency – during meiosis, pieces trade places – determining frequency

Genome Project – entire gene make up of humans

Trinucleotide repeats – sequences of 3 nucleotides is repeated, often several times in a gene (exon

Mitochondrial Inheritance – genetic make-up of mitochondria, genetic code and patterns

Bioethics - Major concerns concerning safety and ethics of recombinant DNA technology.

Designer Genes- Some Types of Station Problems (05)

- Monohybrid crosses with dominant/recessive, incomplete dominance, test crosses, and codominance as blood types
- Crosses with two, three, or four traits illustrating homozygous/heterozygous dominant/recessive, incomplete dominance, epistasis, sex linkage, and lethal gene
- Genotype and phenotype ratios or probabilities based upon stated crosses
- Genetic disorders and the types of genes that cause them
- Karyotype analysis
- Pedigree analysis
- Using Hardy-Weinberg equilibrium theory and data derived from gel electrophoresis and PCR
- Determine allele frequencies in a population
- Chromosome map units problems
- Cross over frequencies
- Restriction enzyme analysis
- Interpreting data from DNA fingerprinting studies
- Forensic Uses of Biotechnology
- Interpreting DNA analysis data + comparing RFLP and PCR forensic testing and analysis
- Analyzing blood chemistry, blood typing and blood cell genetic information
- Analyzing and interpreting chromosome maps and karyotypes
- Understanding and interpreting the uses of restriction enzymes

Designer Genes – Internet Resources (05)

Mendelian Genetics Resources
http://www.kensbiorefs.com/MendelGen.html#anchor119130
Molecular Genetics Resources
http://www.kensbiorefs.com/MolecularGen.html
Genetic Science Learning Center – Univ. of Utah
http://gslc.genetics.utah.edu/
DNA files – resources
http://www.dnafiles.org/resources/res01.html
Univ. of Chicago – Genetics Resources
http://www.uic.edu/depts/mcgn/genres.html
Human Genome Project – Education Resources
http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml
Qualitative Genetic Resources (University of Arizona)
http://nitro.biosci.arizona.edu/zbook/book.html
Monohybrid Problem Set (The Biology Project, U of AZ) Tutorial on single-trait crosses.
http://www.biology.arizona.edu/mendelian_genetics/problem_sets/monohybrid_cross/monohybrid_cross.html
Dihybrid Problem Set (The Biology Project, U of AZ) Tutorial on two-trait crosses.
http://www.biology.arizona.edu/mendelian_genetics/problem_sets/dihybrid_cross/dihybrid_cross.html
Genetics Education Center at the University of Kansas
http://www.kumc.edu/gec/lessons.html
Department of Molecular Technology at the University of Washington
http://chroma.mbt.washington.edu/outreach/genetics/classact.html
National Human Genome Research Institute
http://www.genome.gov/
Educational website of genetic conditions
http://www.yourgenesyourhealth.org/ygyh/mason/index
DNA primer on the basics of DNA, genes, and heredity (DNA Learning Center at Cold Spring Harbor laboratory)
http://www.dnaftb.org/dnaftb/
Mitochondria (DNA Learning Center at Cold Spring Harbor Laboratory)
http://www.geneticorigins.org/geneticorigins/mito/mitoframeset.htm
Free Curriculum Supplements with activities about the latest topics in genetics from the National Institute of Health
http://science-education.nih.gov/customers.nsf/highschool.htm
National Human Genome Research Institute Educational page for students and teachers
http://www.genome.gov/Education/
University of New, York, Case Studies to use when teaching science.
http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm#genetics
At the National Health Museum- teacher written activities and current events in genetics.
http://www.accessexcellence.com/