BIOL115 GENES TO ORGANISMS
Lecture notes

Lecture 1: Introduction

Lecture 2: Scientific Method/Evolution
Scientific Inquiry
- Discovery science = describing nature
- Hypothesis-based science = explaining nature
- Provided us with an understanding of us and the world around us
- Science and technology drives society

Data – collection of observations
- Qualitative
- Quantitative

Hypothesis – answer to a well-framed question, leads to predictions
- Must be testable and falsifiable
- Never proven – research supports, can be refuted, one observation needed
- Many studies that support = hypothesis → theory

Scientific Method STEPS
1. Observation (previous work included)
2. Hypothesis
3. Prediction
4. Experiment
    a. Design experiment, including how data will be analysed
    b. Collect data
    c. Analyse data
5. Refute/Support hypothesis
6. Communicate (Discussion)

Advantages/Disadvantages
- Advantages – objective, logical series of steps, repeatable, easy to communicate, importance of prediction and evidence
- Disadvantages – not all science is done in this way, science is almost never a linear progression of steps

Deductive/Inductive Reasoning
- Deductive = general principles to deduce the answer to q's
- Inductive = series of examples from which to draw general conclusions

Words and Meanings
- Law – generalisation about data, statement of relationships between variables
- Hypothesis – conclusions based on experience, background, knowledge, observation and logic, also possesses explanatory power
- Theory – broad explanation for phenomena, supported by many lines of evidence

Controls
- Experiments must include a treatment group and non-treatment control group
- Placebo effect = people given no medically active treatment have a strong positive improvement in condition
- Effect size of the treatment is the difference between the treatment group and the control group NOT the different between treatment and no treatment

Scientific understanding
- Resistance to changing long-held beliefs
- Public get scientific info form secondary/tertiary sources – info is miscommunication

Scientific Communication
- Collaborative, ideas/discoveries discusses at conferences, publications
- Ideas are peer reviewed before publishes, ensures validity of inquiry/conclusions

Swales outline
- What is the problem?
- Why is it important?

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- What has been done so far?
- What hasn't been done?
- What did you do?

Evolution
- Organisms reproduce → offspring like parents but slightly different (sexual reproduction)
- Some variants survive better than others
- Environment has a finite carrying capacity → fitter offspring will reproduce more offspring
- Populations will adapt to environments over time
- Terminology:
    o Natural selection – 'internal' or 'external' factors affect survival or reproduce ability, those which survive to reproduce = fitter
    o Populations evolve over time
    o Natural selection can only increase or decrease traits that an heritable
- E.g. Sickle Cell Anaemia
- Evolutionary relationships – phylogenetic trees used to describe relationships among taxa
- Explains both unity and diversity of life and influences all levels of biological organisation

Lecture Vocab
- Controlled variable
- Controlled experiment
- Data
- Deductive reasoning
- Dependant Variable
- Hypothesis
- Independence Variable
- Inductive Reasoning
- Observation
- Science
- Scientific Inquiry
- Theory

Lecture 3: DNA – the molecule of heredity
Biological Information
- Serves 2 functions:
    o Direct expression of proteins (structure/function of cells)
    o Passed onto subsequent generation
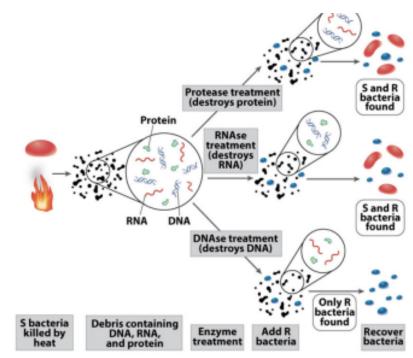- Darwin could not explain mechanism of inheritance

Mendel: traits are encoded by 'heritable factors;
- Mendel examined inheritance using pea plants – observed breeding
- Heritable factors are passed on to the next generation in defined ratios = genes
- Ability for factors to be passed on = heredity

Drosophila chromosomes
- Morgan – chromosomes caused sex, and variation can be sex-linked
- Heritable factor is on chromosome
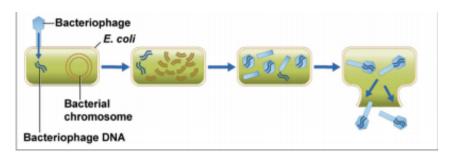
Griffith experiment

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- 'Transforming principle' – change nonvirulent R into virulent S strain
- A bacteria's strain and virulence must be encoded in a non-living chemical – info can be transferred from dead to living bacteria

Avery Bioassay
- DNA not RNA or protein is the 'transforming principle"

Erwin Chargaff
- DNA nitrogenous bases – A-T, C-G

Hershey-Chase experiment
- Bacteriophage viruses (Phages) to show that DNA, not protein, was the essential component for transfer of genetic info
- DNA core or protein coat of phage was radioactively labelled
- Labelled phages used to infect bacteria, infected cells were separated by centrifugation
- Pellet contained the cell contents while the supernatant contained phage particles that did not enter the cell
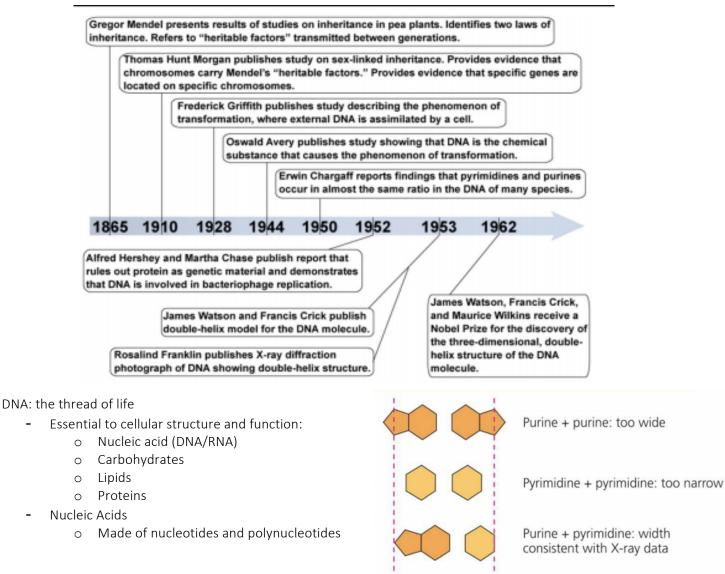- Only radioactively labelled DNA was found in the pellet, indicating that DNA entered the cell

Rosalind Franklin
- Structure of DNA deduced form X-ray crystallography = scatter pattern of X-rays passing through a crystal of DNA molecules
- X-ray crystallography reveals repeating patterns in DNA with dimensions of 0.34nm, 3.4nm and 2nm

Watson and Crick
- Discovered the structure of DNA in 1953

DNA: the thread of life
- Essential to cellular structure and function:
  o Nucleic acid (DNA/RNA)
  o Carbohydrates
  o Lipids
  o Proteins
- Nucleic Acids
  o Made of nucleotides and polynucleotides

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- o Phosphate group (phosphate backbone), sugar (deoxyribose) and nitrogenous base (A, T, C, G)
- o Pyrimidine – 4 carbon ring connected by nitrogen atoms at the 1 and 3 end
- o Purine – pyrimidine ring connected to an imidazole ring (double ring)
- o Four bases: A = adenine, T = thymine, C = cytosine, G = guanine – complementary base pairs (Chargraff)
- o A and G = purines (long molecule), C and T = pyrimidine (short molecule)
- Other Structural Characteristics of DNA
  - o 2 polynucleotide strands with sugar-phosphate backbones linked with purine-pyrimidine pairs
  - o Strand has directionality
  - o 5' → 3' direction of one strand is opposite to the complementary strand which is 3' → 5'
  - o Antiparallel – two complementary strands running in opposite directions
- Replication of DNA – Semiconservative

Lecture 4: DNA, genes and chromosomes
Information Transfer

- DNA → organisms
- Info carrying molecule – nucleus contains DNA and protein, 4 DNA bases, 20 amino acids, many people thought it was proteins
- 1953 – Watson and Crick showed info carrying molecule was DNA
- Prokaryotes – DNA is single, circular, no nucleus, many other sources of DNA
- Eukaryotes – DNA is arranged into a number of linear chromosomes, one set form father and one from mother, n = haploid (half), 2n = diploid

Chromosomes

- Protein and DNA, equal mass of each
- Fixed by species e.g. human = 46 chromosomes (23 pairs)
- Eukaryotic chromosomes exist in an uncondensed state called chromatid, condenses during replication
- Eukaryotes – chromosomes are in nucleus, mitochondria and chloroplasts
- Prokaryotes – found in cytoplasmic region called nucleoid, small circular pieces of DNA called plasmids
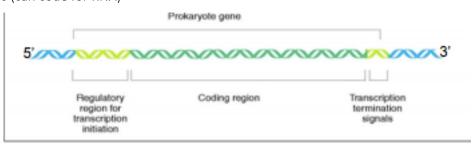- Bacterial chromosomes are small, eukaryotic chromosomes are large

Lecture 5: DNA, genes and genomes
Vocab - Gene density, genome, gene, genotype, promoter, regulatory regions, open reading frame, introns, exons
Arginine Synthesis

- Beadle and Tatum – mould was mutated, enzyme wasn't produced – faulty enzyme
- Each enzyme was encoded by a different gene

What is a gene?

- Carried on chromosomes, DNA = molecule of hereditary
- Muller – X-rays caused mutations in genes
- Beadle and Tatum – bread mould (Neurospora) irradiated with X-rays couldn't make some enzymes
  - o Each gene contain info for making one enzyme (one gene-one enzyme hypothesis)
  - o One gene-one protein → one gene-one polypeptide hypothesis → further updated as genes don't always code for polypeptides (can code for RNA)
- Specify biological traits (Mendel, Griffiths)
- Contained in chromosomes – sex linkage, sex determination
- When damages by X-rays, fails for produce enzymes (protein)
- The gene is the basic physical and functional unit of heredity. It consists of a specific sequence of nucleotides at a given position on a given chromosome that codes for a specific protein (or, in some cases, an RNA molecule).

Prokaryote gene

5' 3'

Regulatory region for transcription initiation — Coding region — Transcription termination signals

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