Lecture 1: *Introduction*.

Environmental change

- Correlation is not sufficient enough to explain cause and effect.
- Need to understand physiology, evolution and ecology to determine how an organism will respond to an environmental change. Too simple to assume only one possible explanation.
- Correlations of animal population shifts with increasing temperature can suggest climate change is the cause, however this may be due to other factors such as fishing, hunting, introduced species, etc.
- Need to use experimental manipulation to explain cause and effect (experimental biology).
- **Example**: Atlantic cod moved north and disappeared from the south, correlated with increase in north sea temperature however, was actually due to removal of fish from humans; English butterfly moved north, correlated with them chasing the climate they evolved in however, was actually due to them escaping the urbanisation (soot created from coalmines) during the industrial revolution.

Reading: Platt, J. R. 1964. Strong inference. Science 146, 347-353.

- What is strong inference? The designing of experiments and the suggestion of alternate hypotheses. They need to be rational and based on the hypothesis you have accepted or excluded.
- What are its advantages? Based on strong intellectual basis, process is sped up and is more specific. A method for reaching firm inductive conclusions one after the other, as rapidly as possible to limit bias and erratic behaviour.
- Does that fact that “no two cells are alike” prevent inference? No, can be used to discover something great and unknown, just like how other simplified models have been used to uncover ground breaking information.
- Do you agree with the idea that: “If you have a hypothesis and I have enough hypothesis, evidently one must be eliminated”? No, disproving something is very hard to do. There can be multiple reasons for one explanation. It is too simplistic to assume that there can be only a single explanation, most processes have multiple causes and their interactions.

Lecture 2: *Phenotypic variance*.

Sources of variation

Individuals	Principal target for selection, differences in individuals allows those with more preferable traits to be selected for. Association of traits can be used to explain function. **Example**: Rats with faster muscle activation have lower ryanodine receptor mRNA.
Populations	Population variance = genetic effects + environmental effects + interaction between genetic effects and environment + error. Genetic effects: populations are different in the same environment. Environmental effects: same populations change in different environments. Gene-environment effects: different populations have different responses in different environments. Some increase of decrease more than others.

Phenotypic plasticity

- Environmentally sensitive production of alternate phenotypes by a given genotype. Every individual inherits the genetic capability to produce each of the different phenotypes, however the actual phenotype depends on the particular environment it experiences.
- Reaction norm: phenotypic expression of a single genotype exposed to different acute environmental conditions. Phenotypic plasticity causes a shift in a reaction norm due to a chronic change in environment.

Mechanisms underlying phenotypic plasticity

Development	Genotype stays the same but access to different gene altered. Genetic capability maintained across generations. Developmental modifiers selected for.
Acclimation	Physiological change in response to an environmental factor. Reversible change within adult phenotypes. Genetic capability not altered.
Selection	Changes in genotype, genetic capability to produce phenotypes may also change. Selection for phenotypes that are suited to those conditions, or maintain performance across a broad range of conditions.

Reading: Huey and Hertz 1984. Is a jack-of all-temperatures a master of none? Evolution 38, 441-444.

- What is the principal of allocation? If an organism allocated energy to one function, it reduces the amount of energy available to other functions. Partitioning of resources to maximize fitness.
- How would individual plasticity influence selection and the generalist specialist trade-off? Weaken selection because phenotypes can change independently from sequence changes.

Lecture 3: *Experimental design*.
Generalist-specialist trade-off

If phenotypes are heritable, then specialization to that environment occurs.
Variable environments favour performance of generalists.
The trade-off is: maximum performance of generalists is lower than that of specialists, their reaction norm is wider but the peak is not as tall as specialists.
Similar to reaction rate vs. temperature where: specialists have small changes in temp with large changes in reaction rates; generalists have small change in temp with small change in reaction rate.

Reading: Drummond, G. B. and Vowler, S. L. 2012. Different tests for a difference: how do we do research? J. Physiol 590.2, 235-238.

- What is "frequentist" statistics? Statistics that determines how frequently would a result like this be observed. Calculates false discovery rates using confidence intervals, effect size, power analysis.
- What is the "straw man" in frequentist statistics? Set-up experiments to test for an effect, but the logic behind the tests is to look for lack of support. H_o will never be true, because there will always be some differences.
- What is the Bayesian logic? Bayesian approaches use experimental data to update this prior knowledge (from experiments and theory).
- What are the strengths of Bayesian logic? Use of data, not the underlying distributions.
- What are permutation tests? Randomization of data to test how frequently one would get a result as extreme or more extreme as the experimental results, relative to the total number of permutations. Advantageous because most studies have relatively small sample sizes
- that cannot represent assumed distributions, also has no assumptions.