

Emergence of evolutionary thought

1. Greek Theories

Theory of Special Creation: This is the idea that species were created by a supernatural being and are immutable, not evolving over time.

Autobiogenesis: Autobiogenesis is the idea that life arises spontaneously from non-living matter without any involvement of previous life.

Biogenesis: Biogenesis is the scientific theory that life originates only from other living things. It is opposed to the theory of autogenesis.

Transpermiesis: Transpermiesis is the transfer of genetic material between organisms, including the transfer of genetic material between different species. This can lead to the evolution of new species over time.

- **Redi's Experiment:** Francesco Redi conducted an experiment in 1668 to test the theory of spontaneous generation, which held that life could arise spontaneously from non-living matter. He set up jars containing meat, one with a lid and one open, and observed that maggots only appeared in the open jar, not in the sealed jar. This showed that maggots did not arise spontaneously from the meat but from flies that had laid eggs on it.
- **Spallanzani's Experiment:** Lazzaro Spallanzani conducted an experiment in the late 1700s to further test the theory of spontaneous generation. He boiled broth in flasks, some of which were sealed and some left open, and showed that no microorganisms grew in the sealed flasks, while they did grow in the open flasks. This demonstrated that microorganisms only grew if they were introduced from the outside, and not spontaneously generated.
- **Pasteur's Experiment:** Louis Pasteur conducted a series of experiments in the 1860s to definitively prove the theory of biogenesis, that life originates only from other living things. He showed that microorganisms only grow in sterilized broth if air is allowed in, but not if the broth is sealed and kept free of contamination. This showed that microorganisms could not spontaneously generate, but only grow if they were introduced from the outside.

2. Pre Darwin Theories:

- Theory of uniformitarianism (J. Hutton): All animals generated as it is now.
- Theory of inheritance of acquired character

3. Theory Since Darwin

- Theory of natural selection (Darwin)
- Theory of Mutation (Hugo de Vries)
- Modern Theory of evolution (T. Dobzhansky, Fisher) – aka Synthetic theory

Natural Selection

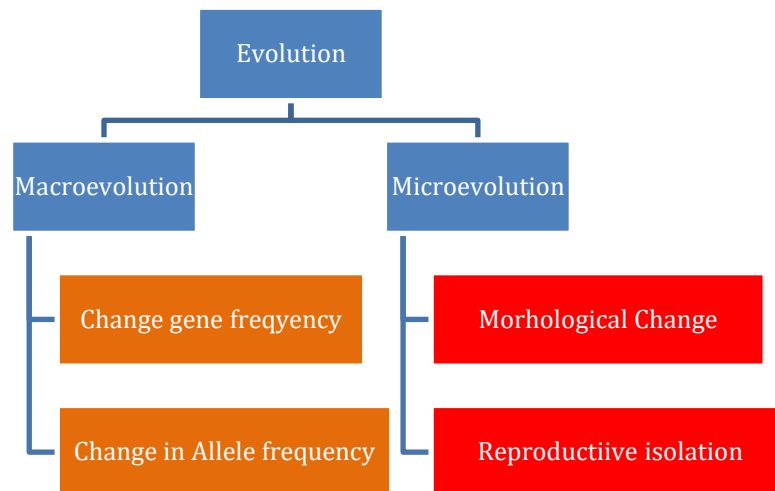
- Overproduction
- Struggle for existence
- Natural Selection

- ❖ Tells about survival of the fittest but silent about arrival of the fittest
- ❖ Exception is Artificial selection
 - Domestic dog
 - Cultivated crop
 - Ornamental Pigeon
- ❖ Sexual Selection
 - Peacock
 - Singing bird
 - Dimorphism

- **Origin of species**
- **Reproductive isolation**
- **Origin of species**

Example:

- Industrial melanism
- Antibiotic plate
- DDT resistant mosquito
- MDR Bacteria



Positive selection: when mutation increase fitness

Negative selection: when mutation decrease fitness or sometimes lethal

Neutral selection: when mutation in have no effect on the organism

$$\frac{dN}{dS} > 1 = \textit{Positive Selection}$$

$$\frac{dN}{dS} < 1 = \textit{Negative Selection}$$

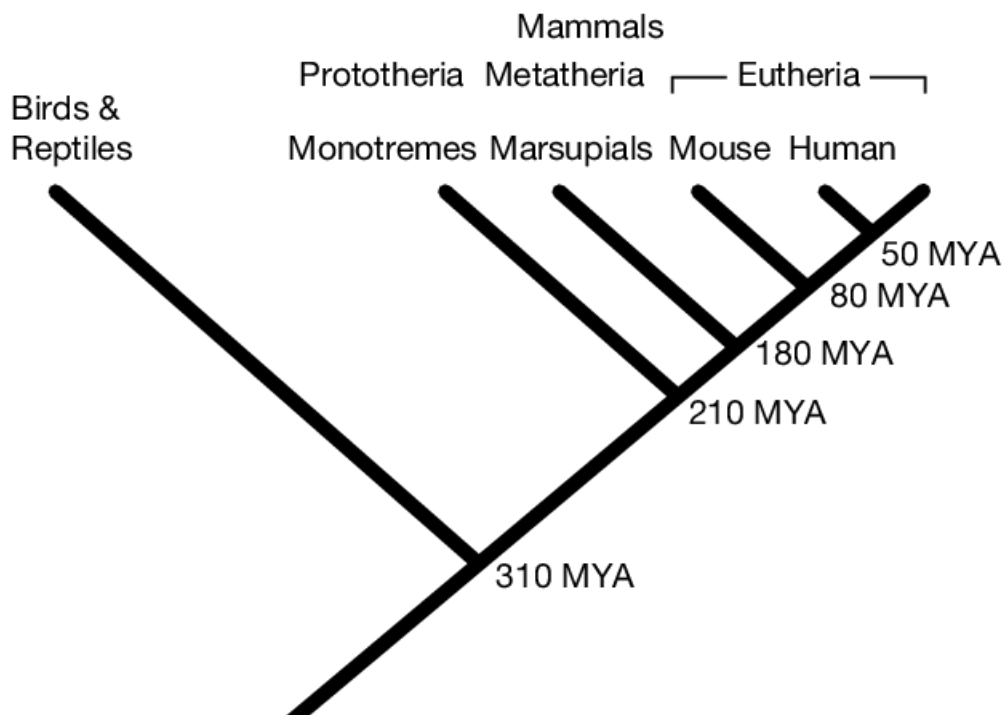
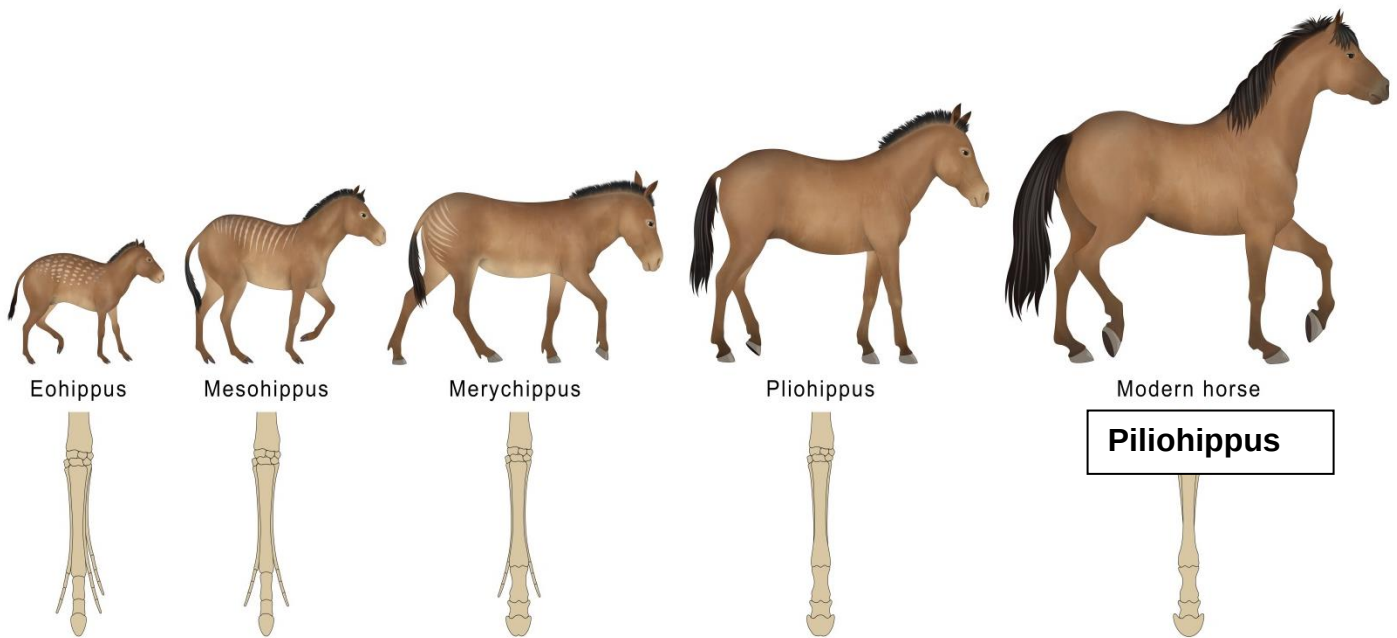
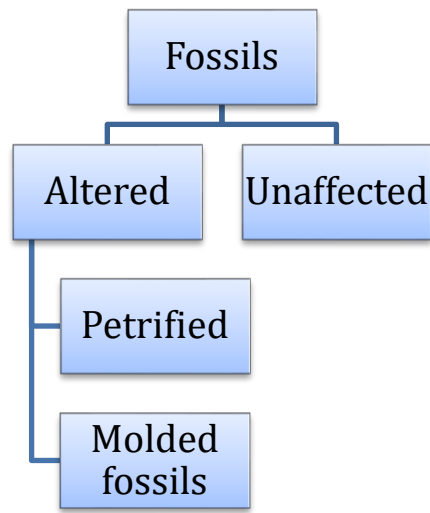
$$\frac{dN}{dS} = 1 = \textit{Neutral Selection}$$

Evidences of evolution

Paleontological Evidence

- Fossils
- Sedimentary rock (Connecting link)

Father of palaeontology: **George Cuvier**



Comparative anatomy and morphology Evidence

1. Organism
 - Circulatory Evolution
 - Sensory system
 - Digestive system
 - Respiratory system
2. Homologous organ (Divergent Evolution)
3. Analogous character (Convergent Evolution)
4. Vestigial Teeth – Wisdom teeth, Canion in human, Vermiorm Appendix, Hairs on the body
5. Atavism
 - Reversal o ancestral trait
 - Moving ear pinnae
 - Hypertrichosis (Excessive hair growth)

Comparative embryology Evidence

1. Similarity gametogenesis and fertilization
2. Resemblance in young vertebrate embryo (Von Bear) {*Embrodevelopment become increasingly diverse*}
3. **Ontogeny** (Life History) repeats **Phylogeny** (Evolutionary History) (Hackel)
4. Theory of embryonic structure (Larva → Adult)
 - Retrogressive metamorphosis (*Reduction of advanced character during development*)

Bio-geographical Evidence

1. Large combination of continents
 - a. Pangia
 - b. Lauresia | Gondwana
2. Mammal Evolution and continental drift
 - a. **Convergence** of placental (Theria) and marsupial(Metatheria) mammal

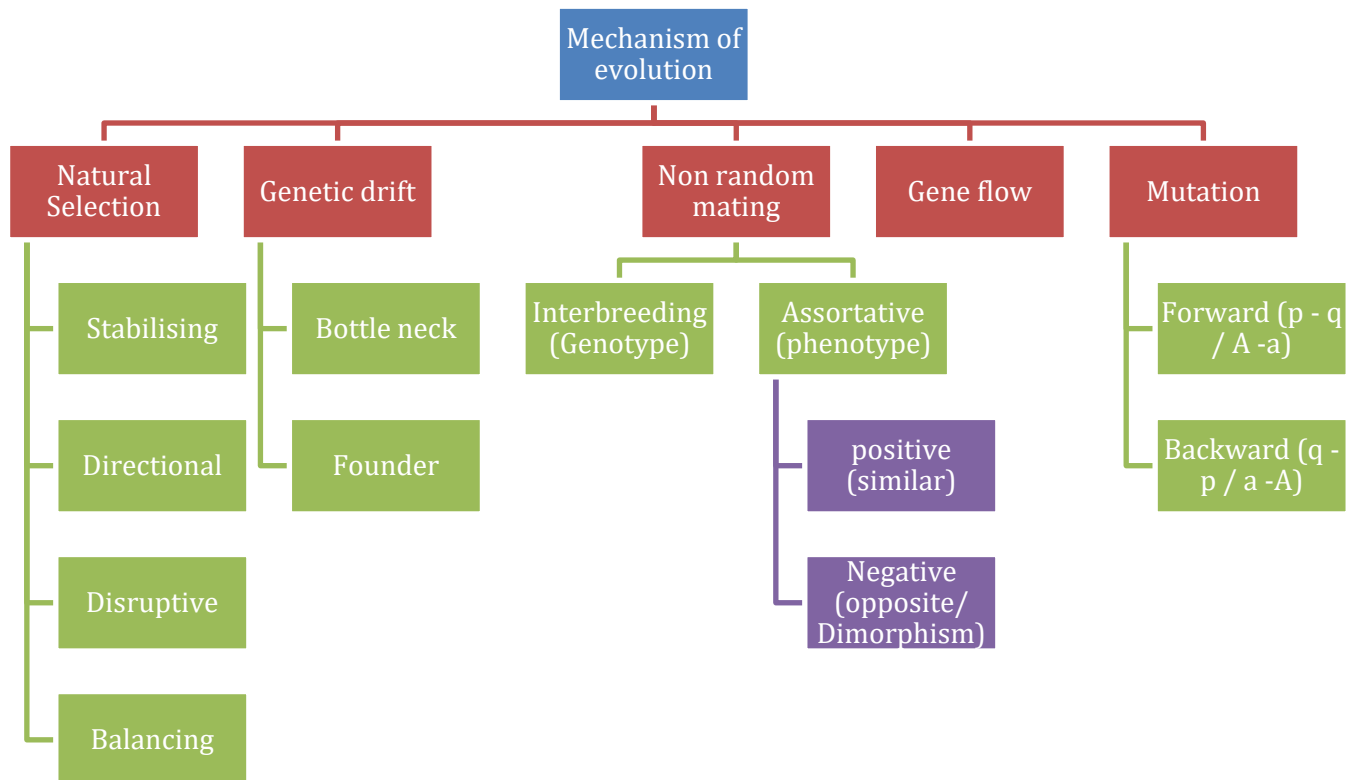
Biochemical and molecular Evidence

<u>Molecules</u>	<u>Process</u>
1. DNA	Replication
2. RNA	Transcription
3. Amino Acid	Translation
4. Triplet Codon	""
5. ATP	Glycolysis
6. Enzymes	

Gene and allele frequency

Genotype	Number of individual	Gene frequency	Allele frequency
AA	40	P² 0.4	$A = \frac{2N_{AA} + N_{Aa}}{N} = 1$
Aa	20	2pq 0.2	
aa	40	q² 0.4	$A = \frac{2N_{aa} + N_{Aa}}{N} = 1$
Total	100		

The mechanism of evolution



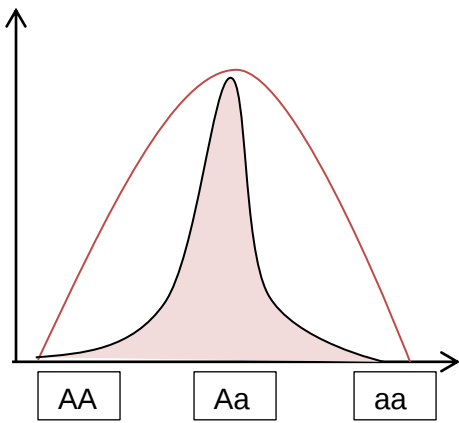
➤ Natural Selection

Herdy Weinberg equation

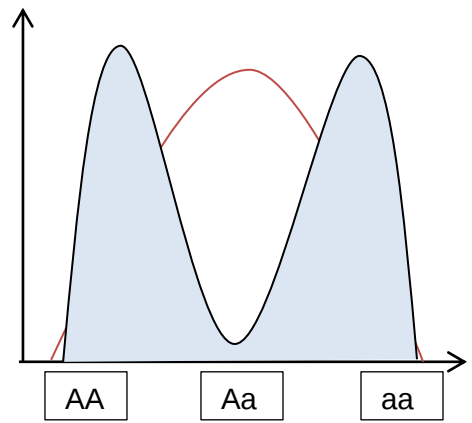
$$p^2 + 2pq + q^2 = 1 \text{ (it works only in equilibrium/Non-evolving population)}$$

$$(p + q)^2 = 1$$

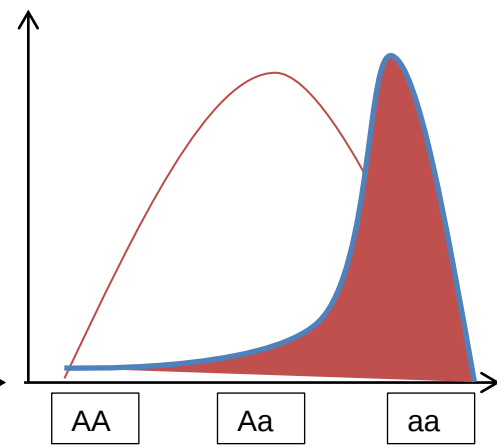
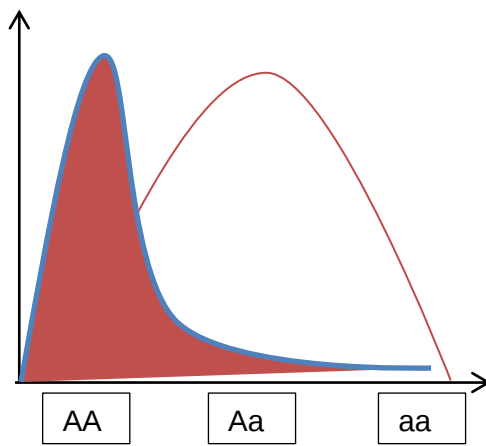
Natural selection may biased toward any of the 3 genotype, on the basis of which natural selection can be divided into 4 types



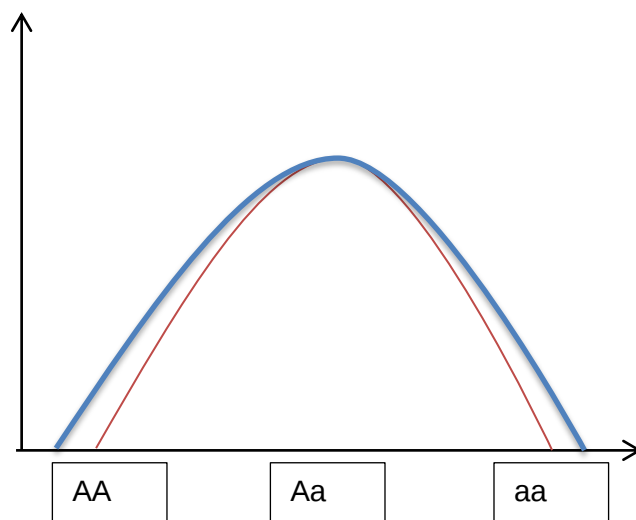
Stabilizing Selection



Disruptive Selection



Directional Selection



Balancing Selection

➤ **Non random Mating**

Interbreed mating or genotypic mating
Assortative mating or phenotypic mating

$$\begin{aligned}\text{Inbreeding coefficient (F)} &= 1 - C \\ &= 1 - \frac{\text{Observed heterogeneity}}{\text{Expected heterogeneity}} \\ &= 1 - \frac{\text{Observed heterogeneity}}{2pq}\end{aligned}$$

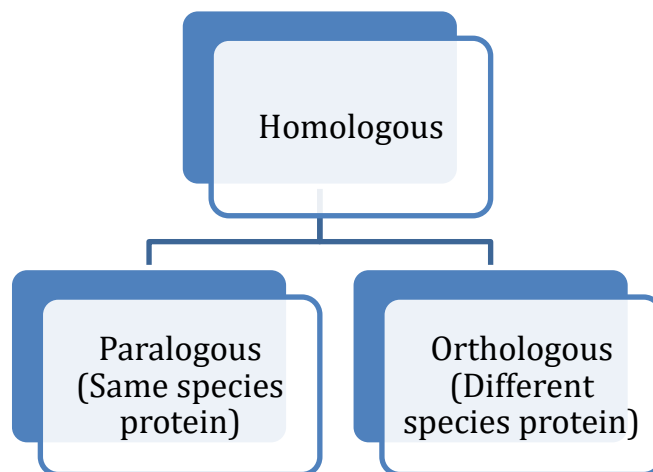
F = 0 means Complete heterogeneous **F = 1** absolute homogenous

$$\Delta q = \mu p - rq$$

$$\Delta p = rq - \mu p$$

$$q = \frac{\mu}{\mu + r}$$

➤ **Mutation**



- 4.
- 5.

Gene creation

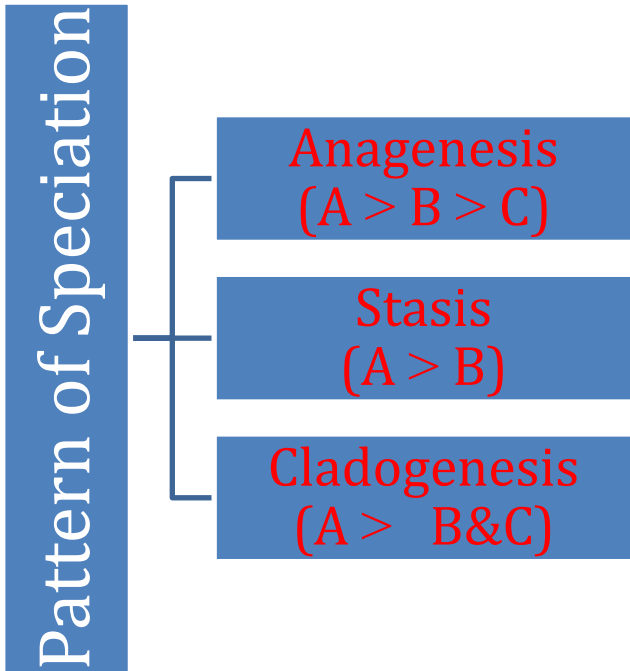
- Mutation
- Duplication
- Retrotransposone
- Unequal crossing over
- Exon shuffling
- Whole genome duplication

Macroevolution

Species Concept

1. Morphological species concept
2. Genetic species concept
3. Phylogenetic species concept
4. Recognition species concept
5. **Biological species concept**

Sibling species: Morphologically similar species but cannot interbreed



Punctuated Equilibrium	Phyletic gradualism

Brain behaviour and evolution

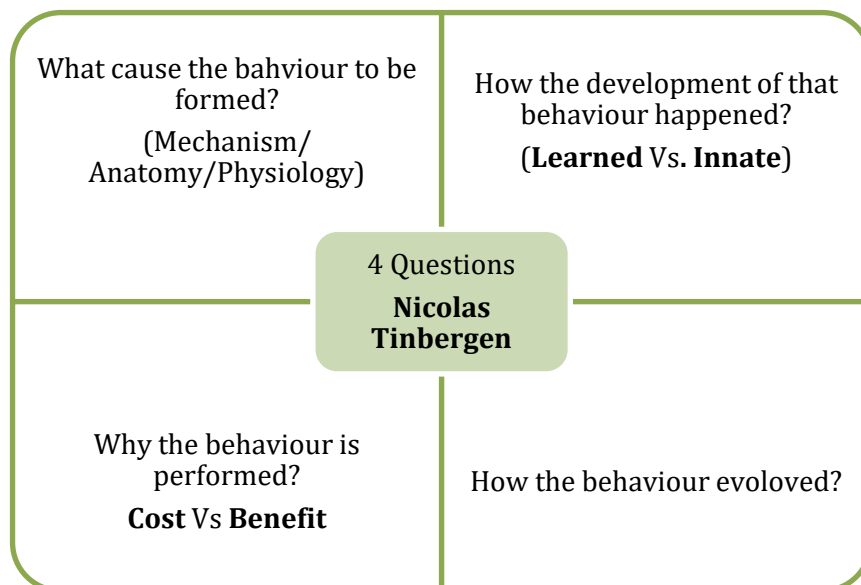
#Causation o Behaviour#

Proximate causation (Mechanism)

Genes
Receptors
Signalling
Organ/Muscle
Response

Ultimate causation (Mechanism)

Relative fitness
Cost < Benefit



- 1) Innate Behaviour
 - a. No Need of practice
 - b. Best performance is in 1st attempt
 - c. Stereotype
 - d. Genetics involved

- Kinesis: random movement toward
- Taxis: Directional movement toward
- Reflexes: Involuntary response
- Egg retrieval
- Egg throwing by cuckoo
- Defensive response: Fight/Flight

- 2) Learned behaviour
 - a. Need practice, trial and error
 - b. No stereotype

- Habituation
- Associated learning
 - Classical conditioning
 - Operant Conditioning
 - Observational learning
 - Imitation
- Exploratory learning

3) Mixed Behaviour

- a. Innate + Learned
- b. Imprinting: Learning to imitate or follow during critical time period
- c. Spatial learning: Learning to follow space
- d. Cognitive learning: Complex thought and processing involved

- Imprinting
- Cognitive Learning

EXPERIMENTAL STUDY TO UNDERSTAND ANIMAL BEHAVIOUR

Deprivation experiment

Isolation of young Rabbit just after breeding and grow them on liquid nutrition, after it grows someday it was given a rabbit and it cut and eat it easily without any learning This was a proof of innate behaviour

Hybridization

Gene knockout method

Learned s Innate

- Habituation

Learn to ignore a stimulus

- Associated learning

Also known as conditioning

- Classical conditioning

Association between two different event or stimulus

- Operant Conditioning / Trial and error

Association between a behaviour/Output with a stimulus

- Observational learning

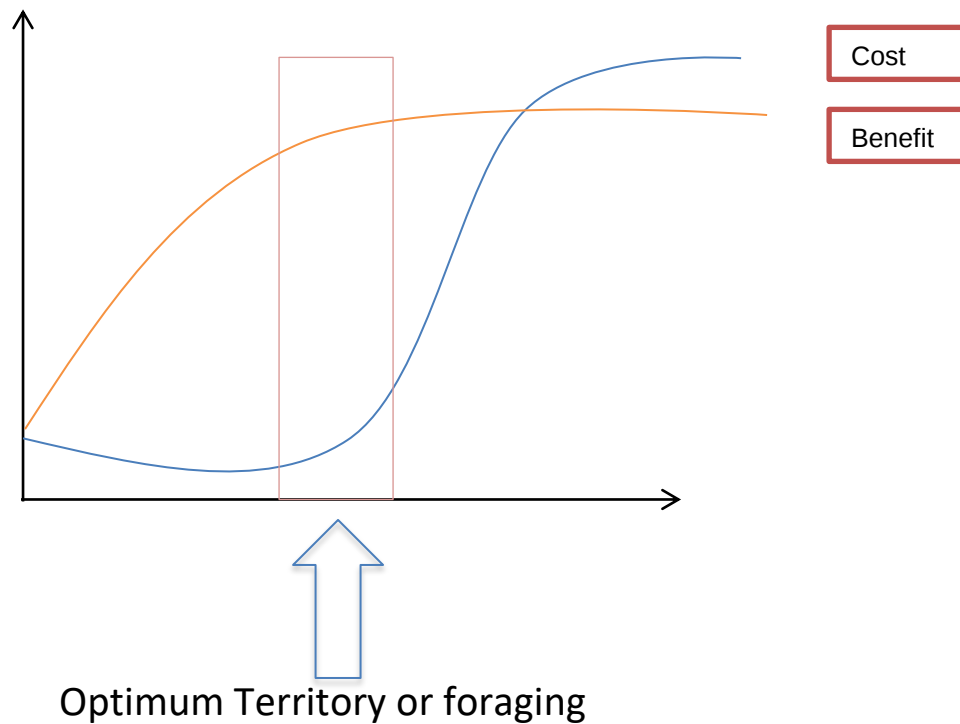
- Imitation

Learn to do just by observation no involvement of complex cognition, like baby's facial expression

- Exploratory learning

Like a chimpanzee use of available tools for a problem solving

Cost Vs. Benefit



Monogamous	Polygyny	Polyandry
Reproductive cost equal	Reproductive more in female	Reproductive more in male
Parental care equal	Parental care more by female	Parental care more by male
Equal selection power and selection pressure	Selection power with female	Selection power is with male
	Selection pressure on male	Selection pressure on female
No sexual Dimorphism	✓ Sexual dimorphism	✓ Sexual dimorphism

Handicap Rule

Reproductive success > Survival Chance

Runaway Hypothesis

Reproductive success = Survival Chance ()