

Protein coding sequence constitute > 2 % of human genome has no chimp homology.

This contains the main difference between chimps and humans

Non-protein coding does have a role – yet to be confirmed what it exactly is.

2) Skeletal Support

- Exoskeleton needs to be shed when the organism needs to grow (effective until its time to grow)
- Internal Skeleton of mammals is easier for it to grow, allows vertebrates to have greater flexibility and manoeuvrability

3) Internal Transport system

As body size increases, the threshold is reached when simple diffusion is no longer sufficient to service needs of cells.

Metazoans require large internal transport systems for chemical exchange with the environment.

This requires openings and large exchange surfaces within the body.

Taken from Wikipedia

Metazoan (plural **metazoans**)

1. (**zoology**) Any **animal** that undergoes **development** from an **embryo** stage with three **tissue** layers, namely the **ectoderm**, **mesoderm**, and **endoderm**. The term applies to all animals except the **sponges**.
2. (**zoology**) Any animal that is multicellular.

3a) Gas Exchange

- Simple diffusion throughout the body surface as seen in many invertebrates.

- Plants use stomata to do the gas exchanges
- Fishes use gills.
- Plants make use of stomata to facilitate gas exchange.
- Insects have tracheae – gases enter tracheae and diffuse directly into cells.

Gills in Fish are to facilitate gas exchange while water is pumped across the gills.

Terrestrial vertebrates in particular achieve gas exchange through lung structure, which uses a two-way flow.

3b) Ingestion & Digestion

Simpler animals ingest food and excrete waste through the same opening

Other animals have more specialized systems to ingest food through one opening and excrete through another

4) Intercellular communication

- Co-ordination between cells requires communication
- Communication is achieved by hormonal and nervous means

Diversity of multicellular animals

Cellular life has 3 branches (domains)

-Archea, Bacteria and Eukarya

The first two are single cell organisms and the third is multicellular.

Within the Eukarya domain, there are several branches of which one of them is animal.

This is the only domain which there are multi-cellular organisms.

QN: What is an animal?

Multicellular life forms that feed on other organisms and move around and responds to stimuli.

> 1 billion years ago, there was **possibly** a single celled organism that lived and was the common ancestor of all animals.

Diversification from this point has resulted in - Today we have about 1.5 M formally identified species of animals (this number is increasing).

Each lineage of animal is classified using systematics.

This is the study of diversification of organisms and the relationship between them.

Inferences of evolutionary relationships include:

- Morphological (how it looks like)
- Physiological
- Molecular

Each lineages share a common body plan and evolutionary history.

Using systematics, we classify/ categorize living organisms into 35 major lineages.

Body Plan

- A key concept in making sense of animal diversity. This is the underlying structure if the profusion of the species.

A body plan is a particular set of morphological and developmental traits, integrated into a functional whole—the living animal.

Variation on a few, distinctive themes can account for all of this diversity – one of which is the theme of the body plan.

E.g. arthropods have about >1.2 M Species and a large range of diversity but all of them share the same body plan:

- Segmented body
- Exoskeleton that is moulted in order to grow
- Jointed appendages

Each Lineage has its own unique body plan and evolution history.

Carl Von Linnaeus – the father of modern taxonomy

- Created the defined hierarchy of organisational categories to classify organisms.
 - Kingdom, Phylum, Class, Order, Family, Genus and Species

This segregation makes sense for the individual species but doesn't help with comparison.

It also encourages pigeon holing of the species rather than considering broader comparative evolutionary history.

May lead to misunderstandings

The Linnaean classification was introduced by anthropocentrism such as Scala Naturae (the great chain of being and finalism).

- This means that all living creatures where classified according to their degree of perfection where humans at the top (perfection)
- And that evolution is mysteriously driven to the emergence of man (that the end goal was to create man)

Anthropocentrism (from Greek "human being"; and, kéntron, "center") is the belief **that human beings are the central** or most significant species on the planet (in the sense that they are considered to have a moral status or value higher than that of other animals), or the assessment of reality through an exclusively human perspective.

- Evolution of life is not a linear event (Simple --> Complex) there are simple species that evolve from complex ancestors. Hence it can be concluded that the process has no goal.
- There are a vast majority of animals who are both 'simple' and 'successful'
- Highly evolved means it's fit for purpose.

Animal Diversity-Understanding diversity

There are 35 major lineages which translates to 35 'body plans'

'Tree' of evolutionary relationships suggests that there are 5 distinct branches of animal life when it was first produced.

- Porifera (sponges)

- Placozoa (Placozoans)
- Cnidaria (Jellyfish etc)
- Ctenophora (comb jellies)
- Bilateria
 - The first 4 are structurally less complex than Bilaterians.

>> Look from page 658 of online text – CAMPBELL

Porifera (sponges)

- Ancient branch of animal tree of life where fossils from Australia have been found to exist 640-650 MYO
- No internal systems but have a network of pores which water moves
- They can live for a long time (100+ years)
- They have no mouth, gut, nerves, muscles, and respiratory or circulatory system.
- Sponges have no true tissues so are often considered basal to other animals
- Placozoa, Ctenophora and Cnidaria have a body made up of two cell layers – they are **'diploblastic'**

A lot of marine species have medical properties

Placozoa – How do they eat?

- Think gelatinous disc composed of around 1000 cells of 4 distinct types
- They don't have a head, mouth or gut & there is no sign of nervous, excretory, respiratory or reproductive system

Cnidaria (includes jelly fish, corals, sea anemones, sea pen, hydra)

- All carnivores
- Live singly as polyps or medusae; may collect into colonies
- Use their cnidocytes to catch and subdue a range of prey --> like a small harpoon
 - It is stimulated chemically and mechanically for the endocyst to be fired off

Medusae - A body form of certain cnidarians such as jellyfish, consisting of a dome-shaped structure with a mouth underneath surrounded by tentacles, and in most species constituting the free-swimming sexual stage of the organism.

Polyps - a solitary or colonial sedentary form of a coelenterate such as a sea anemone, typically having a columnar body with the mouth uppermost surrounded by a ring of tentacles. In some species, polyps are a phase in the life cycle which alternates with a medusoid phase.

A **cnidocyte** (also known as a cnidoblast or nematocyte) is an explosive cell containing one giant secretory organelle or cnida (plural cnidae) that defines the phylum Cnidaria (corals, sea anemones, hydras, jellyfish, etc.). Cnidae are used for prey capture and defense from predators. Despite being morphologically simple, lacking a skeleton and many species being sessile, cnidarians prey on fish and crustaceans. A cnidocyte fires a structure that contains the toxin, from a characteristic subcellular organelle called a cnidocyst (also known as a cnida or nematocyst). This is responsible for the stings delivered by a cnidarian.

Annelids do not have a large conspicuous sense organs but are highly responsive

Annelids also consist of leeches

- Use its teeth / digestive secretions to breach the skin of its host.
- It exudes a potent and fast moving anaesthetic along with blood vessel dilators, anticoagulant & antibiotics. (Reduce the blood from dripping).
- *The antibiotics were to help themselves and not the host.
- Their feeding opportunities are rare so when they are able to eat, they will eat and eat and eat.
- They rely on symbiotic bacteria to do the digesting (it is these bacteria that produces the antibiotics.)

Mollusca – Molluscs

- **Made up of a range of microscopic sea slugs to enormous squids.**
- Their diversity is second only to arthropods
- **Unsegmented, soft-bodied animals with muscular foot.**
- Has a mantle that covers and protects the soft body.
- The mantle folds to create substantial cavity – often connected to outside by siphon
- Emerald sea slug only eats once in its life when it's a baby.
- Whelks drill into snail shells, secrete digestive liquids and eat the snail.
- Cone shells, the radula evolved into long and barbed harpoons which it shoots their enemies with.

Cephalopod molluscs, such as squid, cuttlefish and octopus, are among the most neurologically advanced of all invertebrates – and either the giant squid or the colossal squid is the largest known invertebrate species. The gastropods (snails and slugs) are by far the most numerous molluscs in terms of classified species, and account for 80% of the total. The scientific study of molluscs is called malacology.

Cephalopods – most intelligent of all invertebrates. (still part of the group above)

They demonstrate the ability of

- Classical conditioning
- Dexterity
- Coordination in groups
- Communication (they change colour to show their moods)
- Have shown to use tools like stones to crack open shell
- Have eyes similar to humans.

Platyhelminthes

- Flatworms, tubes, tapeworms, Flukes

These are ¼ free living and ¾ parasitic organisms

They kill their prey by

- Constriction – strangulation

- Slime
- Hook
- Stabbing – using a pointed penis
- They have a simple body plan – no respiratory or circulatory system
- Most have no gut and have to regurgitate waste.
- Most have hugely elongated, segmented bodies – looks segmented but not true segments
- Whale tapeworms are amongst the longest of all animals
- Tapeworms use elaborate suckers and hooks for keeping a grip on a host's digestive track.
- Flukes - go through several hosts throughout their lives
- They have a specific host/parasite relationship and they change the behaviours of their hosts.

Under the Deuterostomes:

Bilateria --> Deuterostomes

Hemichordata – Acorn worms and sea angels

Gets eaten by a predator but regenerates quickly.

Burrowing creatures of the sediment, sea angels are small colonial animals that live in tubes.

Echinodermata – sea stars, sea urchins , sea cucumbers etc

- Very important in molecular & developmental biology
- Found in marine niches, exclusively marine
- They have a tough exoskeleton which is reinforced by ossicles, composed of calcium carbonate.
- these are articulated to allow movement in sea stars but fused together to form a test in urchins
- Have a strange mutable connective tissue – that can be varied 'at will' and with little delay esp in sea cucumbers
- Has a water vascular system to create muscular pressure on its feet.
- This is unknown to other animals – they have a complex internal plumbing. Fluids shunted around by muscular pressure e.g. into tube feet.
- Exerts surprising pressure using suckers on tube feet.
- Brittle stars have powerful jaws and mobile arms for prey capture – including some surprising prey
- They have remarkable powers of regeneration which is used
 - By star fish for reproduction
 - By sea cucumbers for defense
 - Evisceration – vomits itself out and swallows the prey

Chordata – they are sometimes considered as a single lineage

-Notochord (hollow nerve cord that runs along the back).

The **notochord** is a longitudinal, flexible rod located between the digestive tube and the nerve cord. It is composed of large, fluid-filled cells encased in fairly stiff, fibrous tissue.

Cephalochordata – non-vertebrates (Thought to be the common ancestor of vertebrates)

Tunicata – sea squirts

- Their tunic is unique among animals - Contains a form of cellulose (possibly from their ancestors)
- Adult tunicates come in widely divergent forms. Vast majority are sessile – sea squirts filter feeders. Salps – like pelagic tubes that move like jets
- They accumulate heavy metals in tunic and noxious by-products of metabolism – few predators
- Tunicate larva looks like tadpoles clearly has all chordate features
- Metamorphosis strips larva of its distinctive features until it becomes little more than a feeding bag

Vertebrata / craniata*

- Jawless Fish
- Cartilaginous fishes
- Bony fishes
- Amphibians
- Reptiles
- Mammals
- Birds

- Has a CNS: Central Nervous system where the senses are all hooked up to

- Has a cranium and vertebral column (which replaces the notochord in most adults)
- Bony and / or cartilaginous endoskeleton
- With few exceptions, all vertebrates have well developed jaws

Fish is a paraphyletic group

- Huge diversity
- Found in almost all aquatic environments
- Massive differences in size as adults
- Wide range of reproductive strategies

Amphibians - generally need water to breed

- Majority frogs, salamanders & caelians
- Tetrapods
- Evolved from fleshy-finned fish and still intimately tied to water – permeable skin & breeding

- Amniotic egg allows gas to exchange with the outside world but not liquid. Enabled vertebrates to fully invade land

Reptiles – mostly lizards and snakes --> squamata

- Includes lizards, snakes, turtles, tuatara, crocodiles and testudinids
- Has scales, lungs, amniotic egg
- Not strictly a valid taxonomic group

Birds are dinosaurs

- They have a common ancestors with dinosaurs
- They have common properties with some dinosaurs
- Exothermy – ability to fly
- Feathers & Hollow bones (strong with honey comb structures)

Mammals – Endothermic Tetrapods

- Monotremes
- Marsupials (short gestations & altricial neonates --> Requires development outside their mom's bodies)
- Eutherias – long gestations

- Position of limbs
- Tension of visceral walls

Hearing

- Type of mechano-reception
 - Hearing receptors detect and amplify pressure waves of sound
 - activated by one frequency or a range of frequencies
- Membrane (tympanum) vibrates like surface of drum
 - in ears of vertebrates
 - on legs, body or wing bases of some species of insects
- Invertebrate ears, vibrations are amplified by small bones and transmitted to fluid-filled cochlea where sensory hairs are stimulated.

Humans are very sensitive to the frequency of human voices.

Nociception – the feeling of pain

Ability to tell us to move away from pain.

- Chemical pain receptors
- Silent/Sleeping receptors mostly in skin surface
- Mechanical pain receptors
- Thermal pain receptors
- Polymodal pain receptors

Visceral Control

- Internal organs are controlled by the autonomic nervous system
 - rate and strength of heart beat
 - diameter of pupil
 - formation and release of hormones
- Integrated with endocrine system
 - coordinates physiological functions
 - regulates internal environment

The endocrine system

- Hormones are molecules that regulate an organism's internal environment
- The Key component of the endocrine system are
 - Glands
 - Hormones
 - Target cells
- Hormones are secreted by glands and nerve cells in response to stimuli
- Transported via blood system or diffused through tissue to target organs and cells
- Modify action of target cells, tissues, organs

Sites of Action

- Local Regulators

- Autocrine and Paracrine hormones have highly localized effects e.g. histamine released at site of injury to constrict blood vessel walls and stop bleeding
- Pheromones
 - Affects other organisms, often over long distances, **as they are released externally**
- Endocrine Hormones
 - Affect distant cells, tissues and organs as **they circulate in blood** e.g. oestrogen, testosterone
 - **Hormones operate at very low concentrations in the blood**
 - **Hormones travel in blood**
 - They interact with their specific target cells
 - Depending on the hormone, **they can stimulate or inhibit cell activity**

Sleeping receptors – these only kick in when you get a cut.

What controls whether and when hormones are released?

- Non-hormonal regulation
 - e.g. blood glucose levels precipitate hormones such as insulin to be released
- Neuronal regulation
 - e.g. stress or injury may cause the release of norepinephrine for 'fight or flight'
- Hormonal
 - e.g. feedback mechanisms may stimulate or inhibit hormone production such as thyrotropin-releasing hormone (TRH)

Summary of the nervous & endocrine systems

Functional similarities

- Both systems play crucial, complementary roles in communication between parts of the body
- The systems regulate each other – neurons can trigger hormone secretion, hormones can stimulate or inhibit neurons
- Both systems use chemical communication: Neurons – the 'communication cells' of the nervous system. – Secrete neurotransmitters and the endocrine system secretes hormones

Functional differences

- Method of transmission
 - Nervous system transmitted by electrical impulses; endocrine system relies on hormones as messengers
- Speed and persistence of response
 - Nervous system reacts quickly (1-10 msec) and stops quickly
 - endocrine system reacts slowly (hormone release in seconds or days), effect may continue for weeks

- Area of effect
 - nervous system effects are typically more localised than the effects of the endocrine system

Lecture 5 – Nutrients

Lecture learning objectives

- Name the 5 groups of nutrients and describe 3 types of macronutrients
- Compare and contrast feeding and digestive tract structure in different animals
- Describe differences between foregut and hindgut fermentation
- Explain how jaws evolved

There are 5 groups of Nutrients and 3 types of Macro Nutrients

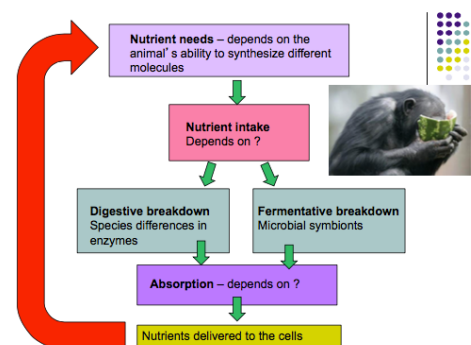
Nutrient needs

- Depends on the animal's ability to synthesize different molecules
- Essential amino acids are the type of amino acids which the animal cannot synthesize on its own.

Nutrient intake depends on **the essential amino acids that the animal cannot synthesize on its own.**

E.g. Termites can breakdown cellulose via an enzyme, which a cat doesn't have.

Absorption depends on **the breakdown of food in the small intestine**



The 5 main nutrients are

1. Carbohydrates