Theory
Biogenetic Law and its Development

Haeckel and Mueller

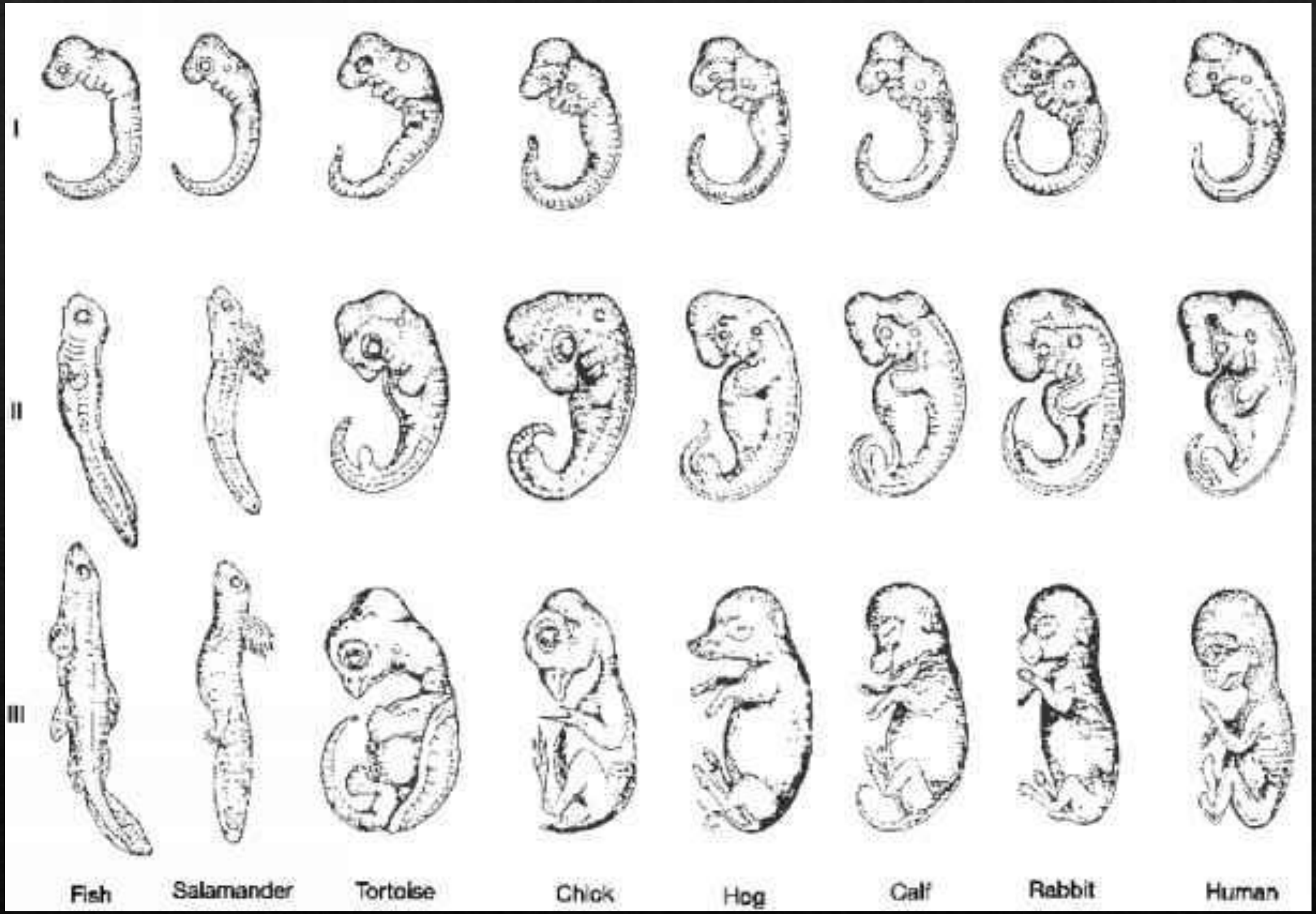
created by:- Arpit kaushik
Siddharamreddy Patil
To:- Svetlana Smirnova

Introduction

- The **theory of recapitulation**, also called the **biogenetic law** or **embryological parallelism**—often expressed using Ernst Haeckel's phrase "**ontogeny recapitulates phylogeny**"—is a historical hypothesis that the development of the embryo of an animal, from fertilization to gestation or hatching (ontogeny), goes through stages resembling or representing successive adult stages in the evolution of the animal's remote ancestors (phylogeny). It was formulated in the 1820s by Étienne Serres based on the work of Johann Friedrich Meckel, after whom it is also known as **Meckel–Serres law**.
- Since embryos also evolve in different ways, the shortcomings of the theory had been recognized by the early 20th century, and it had been relegated to "biological mythology"[1] by the mid-20th century

History

- Haeckel proposed the biogenetic law after reading Charles Darwin's theories in *The Origin of Species*. Haeckel championed Darwin's theory of evolution in Germany and praised him for using information from embryology to help form his theory of evolution. Darwin argued that one could explain facts about embryology, such as the early similarity between embryos of different species, by looking at them in terms of evolution by natural selection. The fact that the more general characters of a taxonomic group tend to be present earlier in the embryo, while specialized and variable characters tend to manifest later in the embryo, indicated that these specialized features are the most recent changes to the ancestral form. Darwin proposed that the embryos of currently living species would look similar to the embryos of their ancestors and that embryos of different taxonomic groups look similar to each other because they share a common ancestor. Haeckel interpreted the data differently than Darwin, and he purported instead that the embryonic stages of extant species represent adult forms of their previous ancestors.



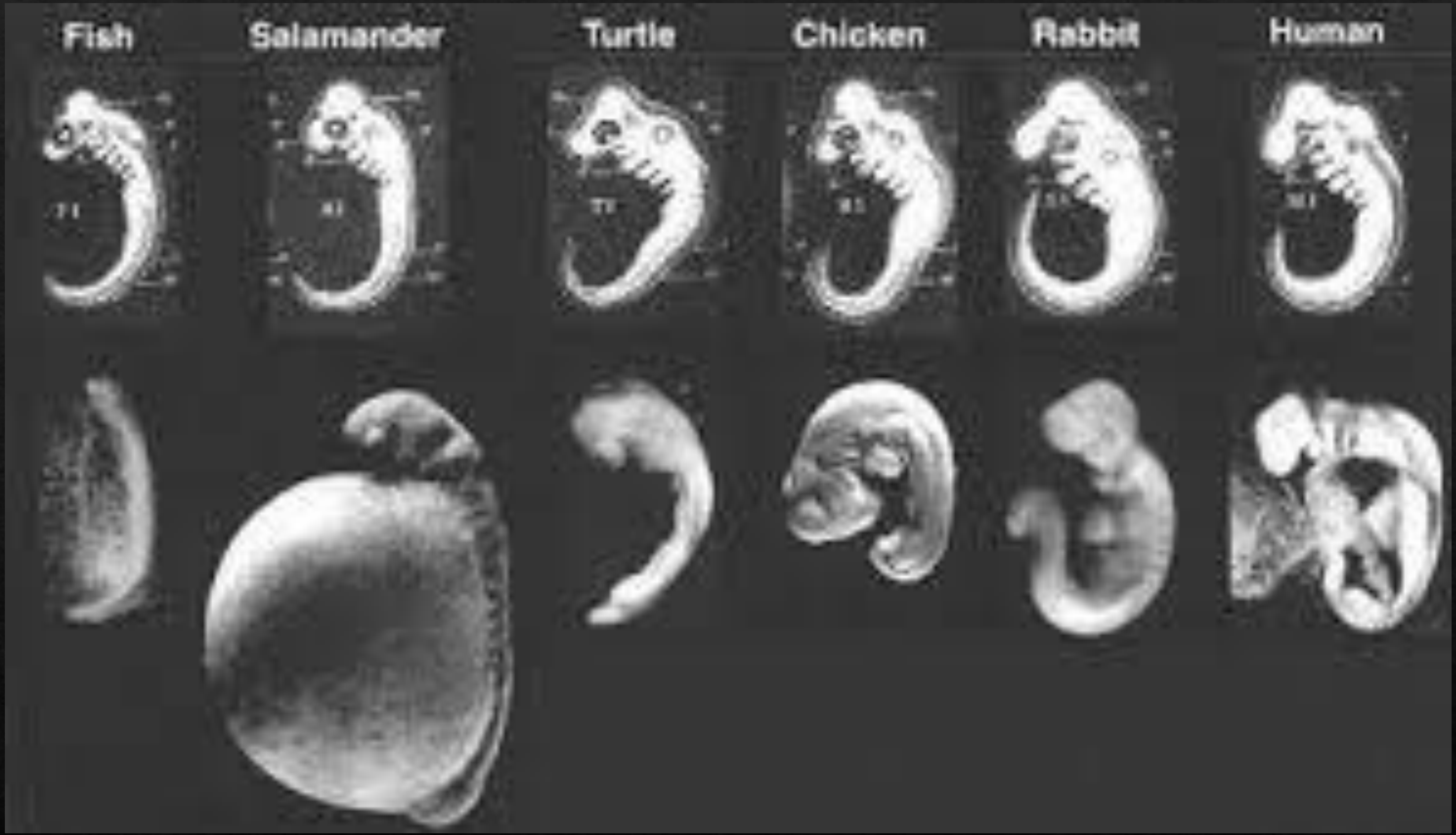
I
II
III
Fish
Salamander
Tortoise
Chick
Hog
Calf
Rabbit
Human

Modern Status

- The Haeckelian form of recapitulation theory is considered defunct. Embryos do undergo a period where their morphology is strongly shaped by their phylogenetic position, rather than selective pressures, but that means only that they resemble other embryos at that stage, not ancestral adults as Haeckel had claimed. The modern view is summarised by the University of California Museum of Paleontology:

Development

- According to Haeckel, the biogenetic law depends on three assumptions. He called the first assumption the law of correspondence, which states that each stage of development in higher animals, such as humans, corresponds to adult stages of lower animals, such as fish. For instance, gill slits in early human embryos correspond to the gill slits in adult fish. The second assumption of the biogenetic law was that phylogenesis must occur by the addition of new characters to the end of the normal developmental process. Haeckel said that the early stages of different species' embryos look similar to each other because of developmental constraints present early in development. These constraints disappear towards the end of development, which allow for the addition of new characters and for subsequent evolution. The third assumption was the principle of truncation. Haeckel argued that if new characters were continuously added to the end of normal ontogeny, the length of embryonic development would eventually become longer than gestation periods of organisms in extant species. As a result, he theorized that early stages of development must be faster in higher organisms than in lower ones.


Fish
Salamander
Turtle
Chicken
Rabbit
Human

Work

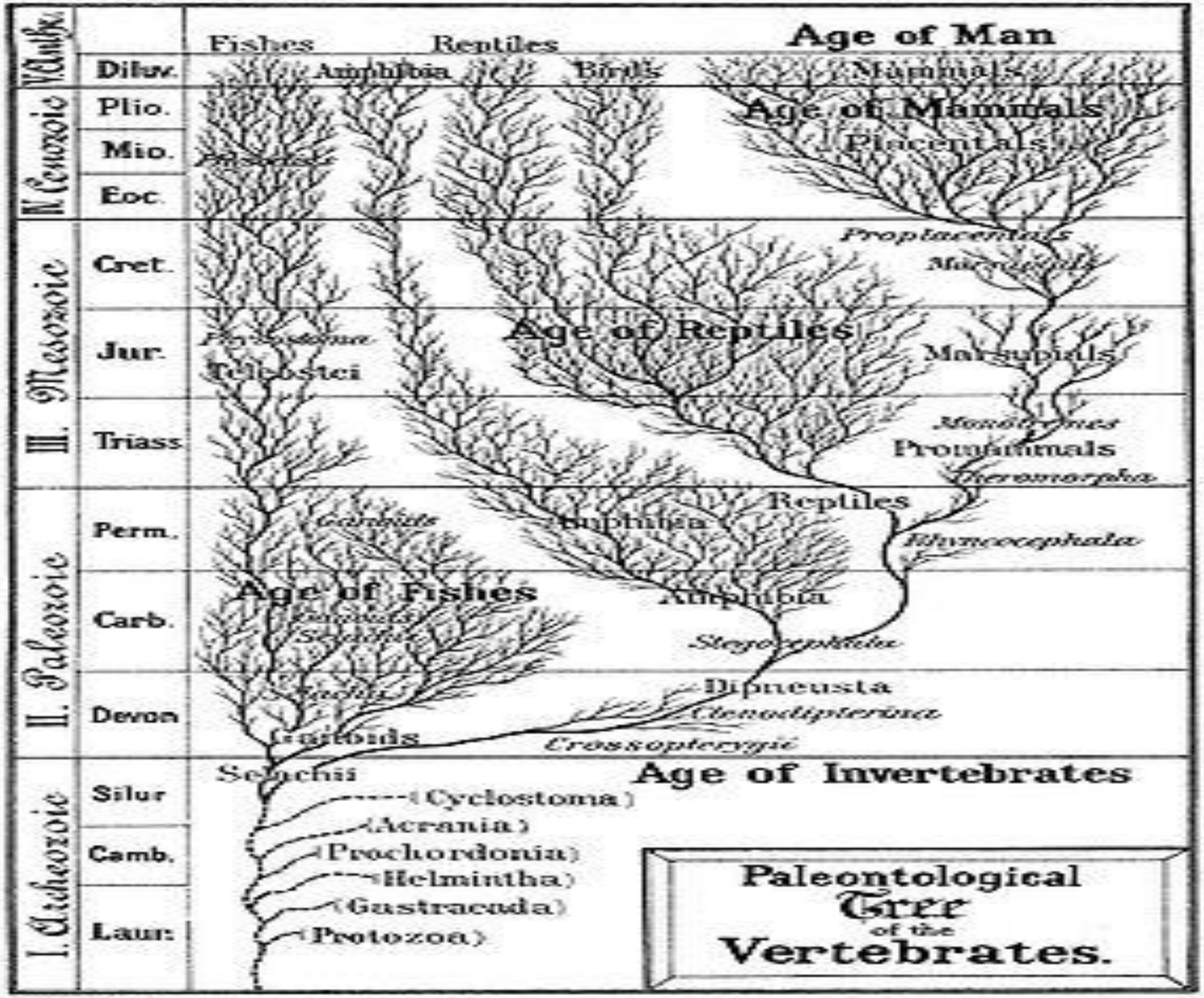
- Haeckel supported his biogenetic law with his drawings of embryos during different stages of development. In 1874, his work *Anthropogenie* included drawings of embryonic fish, salamanders, tortoises, chicks, pigs, cows, rabbits, and humans at different stages of development placed next to one another for comparison. Haeckel's drawings made the embryos of the different groups look almost identical in their earliest stages of development. He argued that they only become recognizable as species later in their respective developments. These similarities, according to Haeckel, demonstrated the linear progression from what he called lower forms to higher forms of animals, and he concluded that the stages recapitulated the evolutionary history of the organisms' ancestors.

Phylogeny

- The result of these analyses is a phylogeny (also known as a phylogenetic tree) – a diagrammatic hypothesis about the history of the evolutionary relationships of a group of organisms.[6] Phylogenetic analyses have become central to understanding biodiversity, evolution, ecological genetics and genomes.

Cladistics

- Cladistics is an approach to biological classification in which organisms are categorized based on shared, derived characteristics that can be traced to a group's most recent common ancestor and are not present in more distant ancestors. Therefore, members of a group are assumed to share a common history and are considered to be closely related.
- The cladistic method interprets each character state transformation implied by the distribution of shared character states among taxa (or other terminals) as a potential piece of evidence for grouping. The outcome of a cladistic analysis is a cladogram – a tree-shaped diagram (dendrogram)[] that is interpreted to represent the best hypothesis of phylogenetic relationships.


Paleontological Tree of the Vertebrates.
Age of Man
Age of Mammals
Age of Reptiles
Age of Fishes
Age of Invertebrates
Fishes
Reptiles
Amphibia
Birds
Mammals
Placentals
Proplacentals
Marsupials
Monotremes
Promammals
Theromorpha
Reptiles
Rhyncocephala
Amphibia
Stegocephala
Dipneusta
Ctenodipterina
Crossopterygii
Teleostei
Ganoids
Selachii
(Cyclostoma)
(Acrania)
(Prochordonia)
(Helmintha)
(Gastraeada)
(Protozoa)
V. Anthr.
Diluv.
IV. Cenozoic
Plio.
Mio.
Eoc.
III. Mesozoic
Cret.
Jur.
Triass.
II. Paleozoic
Perm.
Carb.
Devon
I. Archeozoic
Silur
Camb.
Laur.

Cognitive Development

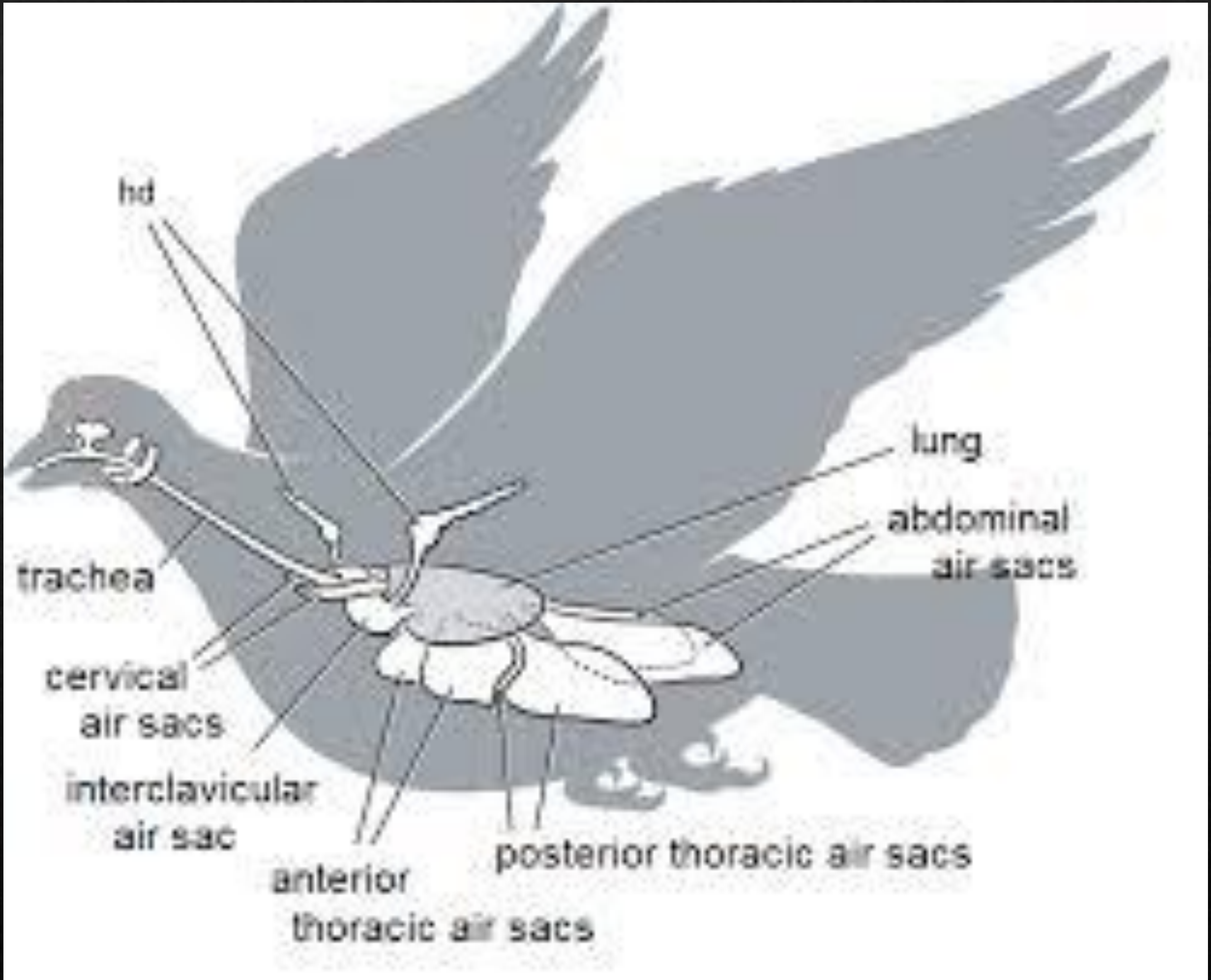
- Haeckel's theories as the basis for his theories of child development. His most influential work, "Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education" in 1908 suggested that each individual's life course recapitulated humanity's evolution from "savagery" to "civilization". Though he has influenced later childhood development theories, Hall's conception is now generally considered racist Developmental psychologist Jean Piaget favored a weaker version of the formula, according to which ontogeny *parallels* phylogeny because the two are subject to similar external constraints
- The Austrian pioneer of psychoanalysis, Sigmund Freud, also favored Haeckel's doctrine. He was trained as a biologist under the influence of recapitulation theory during its heyday, and retained a Lamarckian outlook with justification from the recapitulation theory.[26] Freud also distinguished between physical and mental recapitulation, in which the differences would become an essential argument for his theory of neuroses
- In the late 20th century, studies of symbolism and learning in the field of cultural anthropology suggested that "both biological evolution and the stages in the child's cognitive development follow much the same progression of evolutionary stages as that suggested in the archaeological record"

Contemporary Criticism

- Haeckel's drawings misrepresented observed human embryonic development to such an extent that he attracted the opposition of several members of the scientific community, including the anatomist Wilhelm His, who had developed a rival "causal-mechanical theory" of human embryonic development.[12][13] His's work specifically criticised Haeckel's methodology, arguing that the shapes of embryos were caused most immediately by mechanical pressures resulting from local differences in growth. These differences were, in turn, caused by "heredity". His compared the shapes of embryonic structures to those of rubber tubes that could be slit and bent, illustrating these comparisons with accurate drawings. Stephen Jay Gould noted in his 1977 book *Ontogeny and Phylogeny* that His's attack on Haeckel's recapitulation theory was far more fundamental than that of any empirical critic, as it effectively stated that Haeckel's "biogenetic law" was irrelevant.

Chord Avian Respiratory System

- There are many distinct differences (morphologic, physiologic, and mechanical) between the bird's lung-air-sac respiratory system and the mammalian bronchoalveolar lung. In this paper, we review the physiology of the avian respiratory system with attention to those mechanisms that may lead to significantly different results, relative to those in mammals, following exposure to toxic gases and airborne particulates. We suggest that these differences can be productively exploited to further our understanding of the basic mechanisms of inhalant toxicology (gases and particulates). The large mass-specific gas uptake by the avian respiratory system, at rest and especially during exercise, could be exploited as a sensitive monitor of air quality. Birds have much to offer in our understanding of respiratory toxicology, but that expectation can only be realized by investigating, in a wide variety of avian taxa, the pathophysiologic interactions of a broad range of inhaled toxicants on the bird's unique respiratory system.

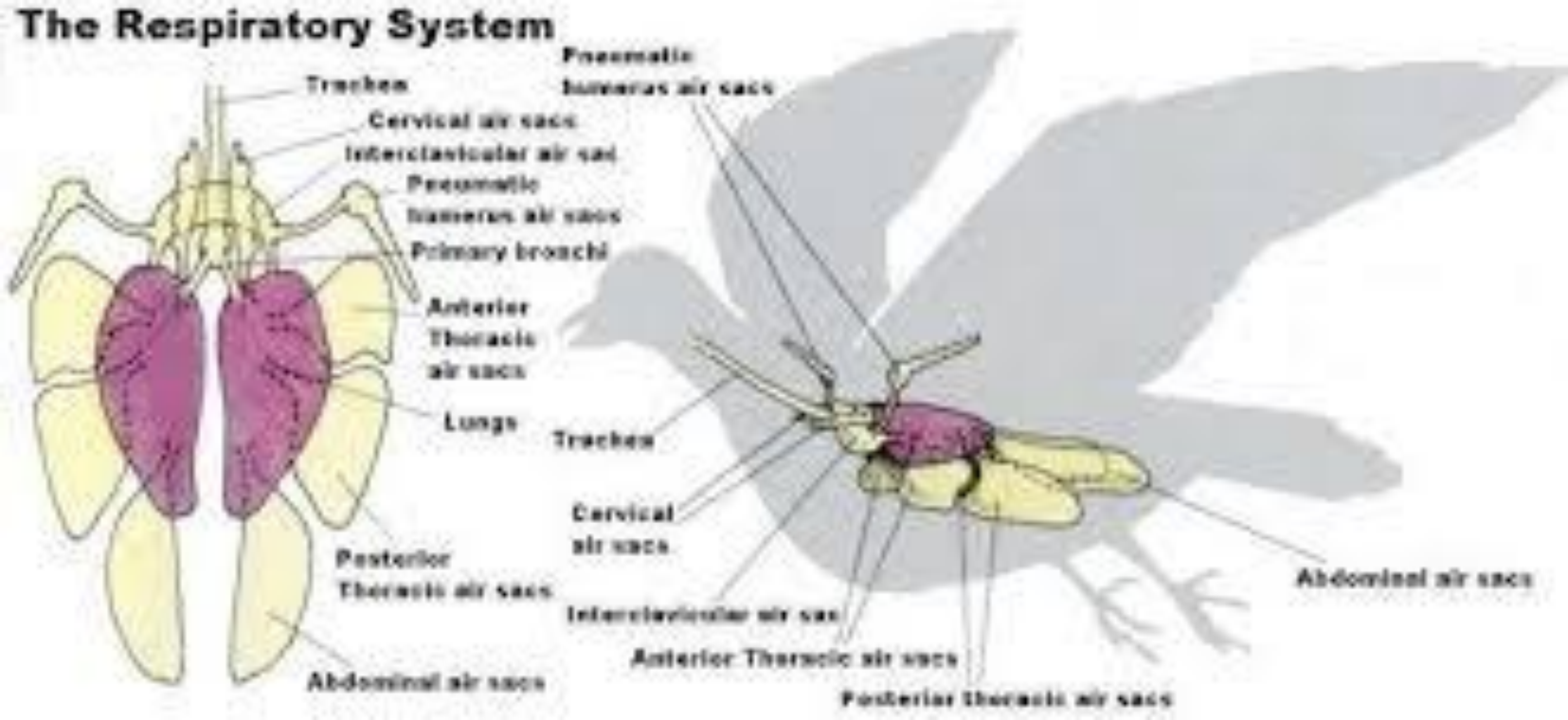

hd
lung
abdominal air sacs
trachea
cervical air sacs
interclavicular air sac
posterior thoracic air sacs
anterior thoracic air sacs

Avian Respiratory System

- The air sacs permit a unidirectional flow of air through the lungs. Unidirectional flow means that air moving through bird lungs is largely 'fresh' air & has a higher oxygen content. In contrast, air flow is 'bidirectional' in mammals, moving back and forth into and out of the lungs. As a result, air coming into a mammal's lungs is mixed with 'old' air (air that has been in the lungs for a while) & this 'mixed air' has less oxygen. So, in bird lungs, more oxygen is available to diffuse into the blood (avian respiratory system).
- The alveolar lungs of mammals (Rhesus monkey; *A*) and parabronchial lungs of birds (pigeon; *B*) are subdivided into large
  numbers of extremely small alveoli (A, inset) or air capillaries (radiating from the parabronchi; B, inset). The mammalian respiratory
  system is partitioned homogeneously, so the functions of ventilation and gas exchange are shared by alveoli and much of the lung volume.
  The avian respiratory system is partitioned heterogeneously, so the functions of ventilation and gas exchange are separate in the air sacs
  (shaded in gray) and the parabronchial lung, respectively. Air sacs act as bellows to ventilate the tube-like parabronchi (Powell and Hopkins 2004).

Birds like respiratory system in dinasaur

- **Bird-like respiratory systems in dinosaurs** -- A recent analysis showing the presence of a very bird-like pulmonary, or lung, system in predatory dinosaurs provides more evidence of an evolutionary link between dinosaurs and birds. First proposed in the late 19th century, theories about the animals' relatedness enjoyed brief support but soon fell out of favor. Evidence gathered over the past 30 years has breathed new life into the hypothesis. O'Connor and Claessens (2005) make clear the unique pulmonary system of birds, which has fixed lungs and air sacs that penetrate the skeleton, has an older history than previously realized. It also dispels the theory that predatory dinosaurs had lungs similar to living reptiles, like crocodiles.
- The avian pulmonary system uses "flow-through ventilation," relying on a set of nine flexible air sacs that act like bellows to move air through the almost completely rigid lungs. Air sacs do not take part in the actual oxygen exchange, but do greatly enhance its efficiency and allow for the high metabolic rates found in birds. This system also keeps the volume of air in the lung nearly constant. O'Connor says the presence of an extensive pulmonary air sac system with flow-through ventilation of the lung suggests this group of dinosaurs could have maintained a stable and high metabolism, putting them much closer to a warm-blooded existence. "More and more characteristics that once defined birds--feathers, for example--are now known to have been present in dinosaurs, so, many avian features may really be dinosaurian," said O'Connor.


The Respiratory System
Trachea
Cervical air sacs
Interclavicular air sac
Pneumatic
humerus air sacs
Primary bronchi
Anterior
Thoracic
air sacs
Lungs
Posterior
Thoracic air sacs
Abdominal air sacs
Pneumatic
humerus air sacs
Trachea
Cervical
air sacs
Interclavicular air sac
Anterior Thoracic air sacs
Posterior thoracic air sacs
Abdominal air sacs

Developmental Disorder of Respiratory System in Humans

- **Development of the pulmonary pleura with special reference to the lung surface morphology: a study using human fetuses**---------------In and after the third trimester, the lung surface is likely to become smooth to facilitate respiratory movements. However, there are no detailed descriptions as to when and how the lung surface becomes regular. According to our observations of 33 fetuses at 9-16 weeks of gestation (crown-rump length [CRL], 39-125 mm), the lung surface, especially its lateral (costal) surface, was comparatively rough due to rapid branching and outward growing of bronchioli at the pseudoglandular stage of lung development.

Respiratory Developmental Dissorder

- develop in late embryonic to early fetal period.
- later in mid-fetal period clusters of these cells form neuroepithelial bodies (NEBs).
- first cell type to differentiate in the airway epithelium.
  - differentiation regulated by proneural genes - mammalian homolog of the achaete-scute complex (Mash-1) and hairy and enhancer of split1 (Hes-1).
- located in the fetal lung at bronchiole branching points.
- may stimulate mitosis to increase branching.
- secrete 2 peptides - gastrin-releasing peptide (GRP) and calcitonin gene related peptide (CGRP)

Rhinitis and laryngitis

Large particles are deposited in the nose, pharynx, and larynx. More soluble gases (e.g., sulfur dioxide) are absorbed by upper respiratory tract mucous membranes, causing edema and mucus hypersecretion.

Tracheitis, bronchitis, and bronchiolitis

Large particles (more than 10 µm in diameter) are deposited and then cleared by cilia. Small particles and fine fibers are deposited in bronchioles and bifurcations of alveolar ducts. Less soluble gases penetrate to deeper, small airways.

Asthma and chronic obstructive pulmonary disease

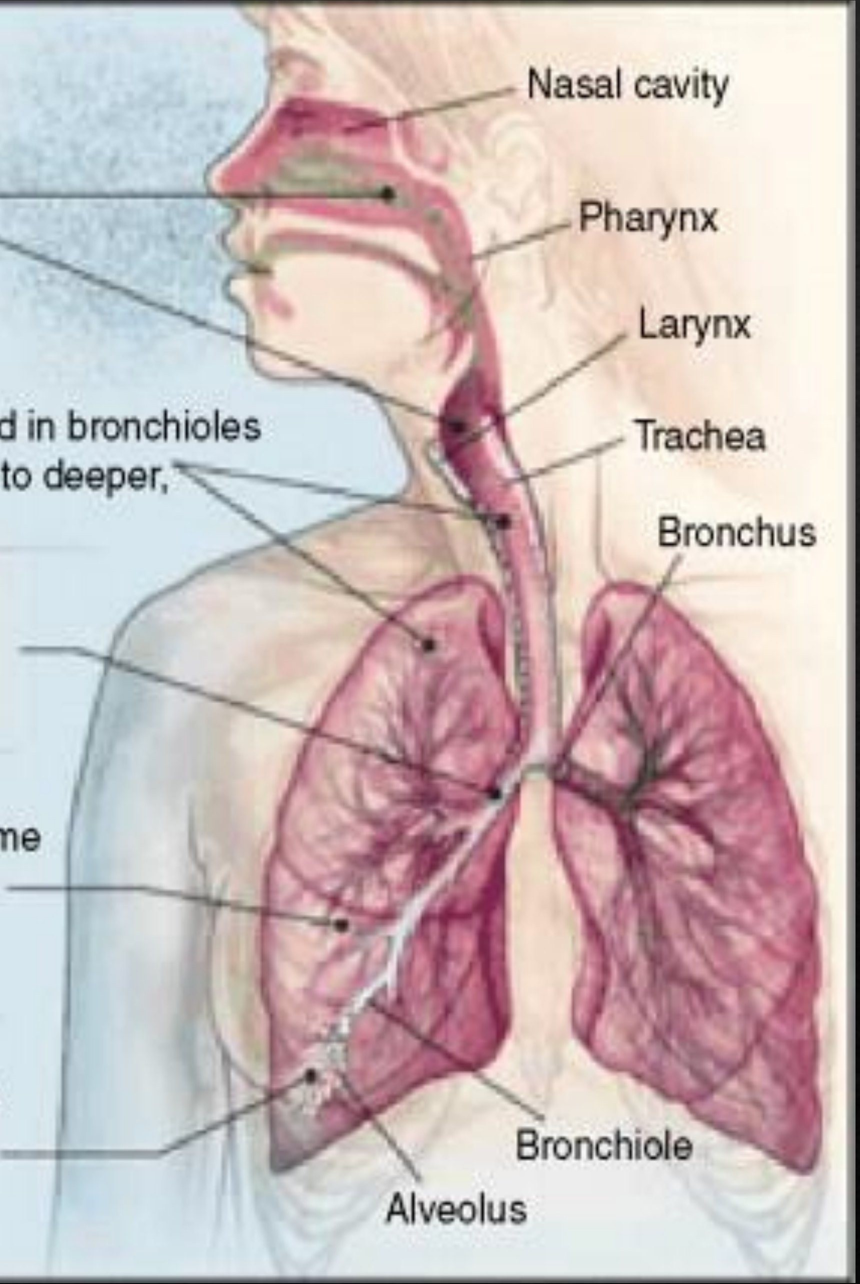
Allergens and irritants are deposited in large airways by turbulent flow, causing chronic inflammatory changes.

Cancer

Carcinogens (asbestos and polycyclic aromatic hydrocarbons) come into contact with bronchial epithelial cells, causing mutations in proto-oncogenes and tumor-suppressor genes. More than one such contact results in malignant transformation.

Interstitial disease

Small particles (less than 10 µm in diameter) and fibers are deposited in terminal bronchioles, alveolar ducts, and alveoli. Penetration to the interstitium results in fibrosis and the formation of granulomas.



Links

- https://youtu.be/5lXQ3FzHY04
- https://youtu.be/kWMmyVu1ueY
- Hihttps://youtu.be/yulXYwloq2


Thank you.