DOWNLOAD PDF ECHINODERM THEORY OF ORIGIN OF CHORDATES

Chapter 1 : CHORDATES- ORIGIN-CHARACTERISTICS-CLASSIFICATION

ECHINODERM -HEMICHORDATE THEORY-ORIGIN OF CHORDATES: This theory infers origin of chordates, hemichordates and echinoderms from a common ancestor. This theory is based on the following evidences. This theory is based on the following evidences.

The phylum chordate was established by Balfour in This phylum includes animals such as ascidians, lancelets, fishes, amphibians, reptiles, birds and mammals including man. Most of the chordates are free living and none is strictly parasitic. There are some 65, known living chordates besides the fossil remains of many extinct forms. However these animals exhibit some common characters which show their common ancestry. The ancestral chordates have appeared in the early part of Palaeozoic era. There are different opinions about the origin of chordates. Garstang was of the opinion that chordates were evolved from the auricularia larva of Echinodermata. The chordates are closely related to the echinoderms and hemichordates. It is evident by the following resemblances. The phosphogens used in muscle contraction are similar in hemichordates and echinoderms. The phosphogen is in the form of creatine in all vertebrates and arginine in invertebrates. In hemichordates and echinoderms both creatine and arginine are present. The tornaria larva of hemichordates resembles the larval forms of echinoderms. It is believed that the ancestral chordates might have evolved from the larvae of echinoderms by paedogenesis Chordata is the highly evolved phylum of the animal kingdom. The largest vertebrate animal is blue whale, Balaenoptera musculus. It grows upto 35 meters length and weighs about tons. The whale shark, Rhincodon typhus is the second largest vertebrate. It grows to 20 meters length. It is a stiff elastic mid-dorsal longitudinal rod lying between the nerve cord and alimentary canal. So, it is called Chordadorsalis. It is a skeletal or supporting structure present in the embryonic stages of all chordates. It is made of vacuolated cells and enclosed by two connective tissue sheaths. It persists throughout life in Amphioxus, and vertebrates like cyclostomes. Notochord serves as an organ of internal support and also provides surface for the attachment of muscles. In vertebrates, the notochord is replaced by vertebral column. Hence all vertebrates are chordates but all chordates are not vertebrates. The notochord is chorda mesodermal in origin. In mammals, notochord is in the form of vestigial swellings in the vertebral column. They are called Nuclei pulposi. During the development, it is formed from the mid dorsal region of the early embryo from ectodermal cells i. It persists through out life in most chordates, but in higher chordates, the nerve cord is differentiated into an anterior brain and a posterior spinal cord. The nerve cord gets degenerated during metamorphosis in ascidians. Such gill-clefts appear during the development of every chordate, but in many aquatic forms they are lined with vascular lamellae which form gills for respiration. In terrestrial chordates which never breath by gills, traces of gill-clefts are present during early development but most of them disappear before adult life. Gill- clefts are also called gill â€" slits or pharyngeal â€" clefts. Such gill â€" clefts which do not bear gills are usually called visceral â€" clefts. In lower chordates the visceral â€" clefts often form some endocrine glands. Even though the three primary characters of chordates are well developed, the dorsal tubular nerve cord is reduced in some and in urochordata the central nervous system degenerated in the adult. However the three primary characters are possessed only by chordates. Higher chordates also possess the following characters: Bilateral symmetry Various organs of the body are symmetrically arranged on right and left sides of the median longitudinal axis. In a bilaterally symmetrical animal, the body can be divided into two equal halves only in one plane sagittal which may be the mirror images of each other. Triploblastic condition Various organs in the chordate body are derived from three germ layers, namely ectoderm, endoderm and mesoderm. Thus, all chordates are triploblastic animals. In chordates, the mesoderm is formed as out pushings of archenteron, But in higher invertebrates the mesoderm arises as solid out growths from cells which lie at the juncture of ectoderm and endoderm. Coelom A true coelom or body cavity which develops from mesoderm is present in all chordates. But it is called enterocoelus coelom in chordates, as it develops from archenteron. The coelom is externally lined by parietal or somatic layer and internally by visceral or splanchnic layer. In higher chordates like mammals, the coelom is divided into anterior thoracic and posterior abdominal cavities by a diaphragm. Metamerism Segmentation The linear repetition of the body organs is called metamerism. Among the chordates the metamerism is visible only internally. The body musculature, the nervous system, the circulatory system, the excretory system, etc. The segmentation in chordates is referred to as heteronomous segmentation, as the segmentation is not uniform. Metamerism is clearly seen in the embryo, but it becomes obscured by condensation in the adult in some organs such as the kidneys and limbs and it is completely lost in the head. Cephalization All the higher chordates possess well developed head having complex brain and specialised sense organs. This trend towards the prominence of head is called cephalization. In the chordate series there is a steady increase in size and specialization of the head. Thus there is greater prominance and domination of the head over the rest of the body. Circulatory system As the blood flows through a system of tubes, the blood vascular system is of closed type. In dorsal vessel the blood flows from anterior to the posterior end and in the ventral vessel from posterior to anterior. Ventral heart The heart is a muscular and contractile organ situated towards ventral side inbetween the lungs below the oesophagus. The heart is surrounded by double walled pericardium. It is 2 to 4 chambered in various groups of vertebrates. Hepatic portal system Hepatic portal system is present in all the chordates. Blood that is collected from various parts of alimentary canal is not carried directly to heart but to liver. The blood then goes to heart. Thus the hepatic portal vein not only begins but also ends in capillaries or it acts both as afferent and efferent vessel. Red Blood Corpuscles In higher chordates, the respiratory pigment haemoglobin is always found in the specialised cells called red blood corpuscles or erythrocytes. Higher chordates posses two paired appendages in the form of fins or limbs. It is a posterior prolongation of the body. It is without coelom and viscera. But it has extensions of muscles, nerve cord, notochord. Vertebrata or Craniata Of these three subphyla, the first two and also Hemichordata are generally referred to as protochordates. All protochordates are characterised by the absence of cranium, so they are also called acraniates. The protochordates stand between invertebrates and vertebrates. Bateson included Hemichordata in this phylum. Now a days, the group Hemichordata is treated as a separate minor phylum. Some are sedentary and some are pelagic forms i. These are degenerated chordates. Their body is enveloped by a tunic or test made up of tunicin cellulose like material. So they are called tunicates. In the larval form, notochord is present only in the tail region, hence the name urochordata. It is absent in the adult stages. But in Larvacea, the notochord is present in adults also. Dorsal tubular nerve cord is found only in the larval stage, but degenerates in the form of small ganglia in adults. Numerous gill slits are present. Heart is ventral, simple and tubular. Coelom is completely absent. Sexes are united i. The larval form is called Tadpole and it exhibits retrogressive metamorphosis. The transformation of well-organized larva with all the chordate characters into a degenerated and less developed adult is called, retrogressive metamorphosis. Urochordata has been divided into three classes. Free swimming pelagic forms. Neotenic forms which retain the larval form throughout adult life. Posterior part of the body takes the form of a large locomotory appendage, the tail. Single pair of gill-slits is present. Anus opens ventrally on the surface of the body. Sexes are united, i.

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Chapter 2 : ORIGIN OF CHORDATES: | BIOZOOM

The following theories have been given to explain the origin of chordates: 1. Echinoderm Origin. The theory was given by Johannes Muller () and is based on the comparative studies of larval stages of echinoderms and hemichordates. Tornaria larva of hemichordates resembles echinoderm larvae such as Bipinnaria, Auricularia, Dipleurula and Doliolaria, which all possess ciliary bands and apical tuft of cilia.

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Chapter 3 : ORIGIN OF CHORDATES - WikiEducator

Development in echinoderms may be indirect, involving pelagic, bilaterally symmetrical, larval forms, or more or less direct, with the larval stage either reduced or omitted. Of the five living classes, only the Echinoidea are characterized by being predominantly of the type with indirect development.

It is difficult to determine from which invertebrate group the chordates were developed. Chordate ancestors were soft bodied animals. Hence they were not preserved as Fossils. Many biology theories were put forward to explain the Origin of Chordates. According to this theory chordates were developed from coelenterates. Radial symmetry coelenteron,cnidoblasts etc, were 1cst and advanced characters were developed to give rise to chordates. This theory infers that chordates might have acquired higher characters independently. It is not correct and hence this theory is not acceptable. This theory suggests that the chordates have evolved from an annelid stock. The annelids show bilateral symmetry, mesmerism, head, lateral Coelome complete digestive tract, closed circulatory system, hemoglobin, etc. The resemblance is enhanced if, an annelid is turned upside down. But the mouth would be dorsal which is unlike that of chordates. Metamerism and appendages of annelids differ in nature from those of the chordates. Bilateral symmetry, head and complete digestive tract occur in other non-chordate phyla also. Coelome is schizocoelic in annelids and enterocoelic in lower chordates. Haemoglobin is dissolved in the plasma in annelids but it is present in the red blood corpuscles in chordates. Annelid nerve cord is double, and, ventral in contrast to single, hollow, dorsal nerve cord of chordates. Some striking differences exist between the annelids and the chordates in their embryology. Hence it is difficult to accept this theory. This theory infers origin of chordates, hemichordates and echinoderms from a common ancestor. This theory is based on the following evidences. Both echinoderms and chordates have enterocoelic coelome, mesoderm and deuterostomous mouth. There is resemblance between the bipinnaria larva of certain echinoderms and the tornaria larva of hemichordates. In echinoderms chordates the central nervous system develops from a dorsal strip of ectoderm. A close similarity exists between the proteins of the body-fluid of chordates and echinoderms. Hence the chordates are more related to echinoderms. The radial symmetry of adult echinoderms will disprove their relationship with the bilaterally symmetrical chordates. In echinoderms radial symmetry is secondarily developed from a basically bilateral symmetry. Both the primitive and the early echinoderm larvae show bilateral symmetry. The generalised chordate ancestry is as follows: This was suggested by N. Hyman and others concluded that all the three groups have a common ancestor, Echinoderms and hemichordates branched off from a common evolutionary line which ended in the chordate group.

Chapter 4 : Calcichordate hypothesis - Wikipedia

Among the chordates the metamerism is visible only internally. The body musculature, the nervous system, the circulatory system, the excretory system, etc., are atleast, at the time of origin thoroughly calendrierdelascience.com segmentation in chordates is referred to as heteronomous segmentation, as the segmentation is not uniform.

Essay on the Origin of Vertebrates: The problem of searching into origin and ancestry of vertebrates has long been of particular interest to zoologists. But, like that of most of the animal phyla, the origin of vertebrates also remains obscure. Over the years, several hypothesis have been proposed to explain the origin of vertebrates, but none could stand the test of close scrutiny. The chordates constitute very ancient forms. The earliest known truly vertebrate animals were freshwater forms which were abundant during the late Silurian and middle Devonian periods. Their fossils are collectively known as ostracoderms. Ostracoderms are placed with living cyclostomes lampreys and hagfishes in the jawless group called Agnatha. Ostracoderms, as their name refers to, have their body covered by a dermal bony armour which forms an elaborate rounded solid shield on the head. Like cyclostomes, they had presumably a persistent notochord and no vertebrae. The mouth was anterior, ventral and devoid of jaws and teeth. They had no paired appendages homologous with those of vertebrates. Paired lateral eyes, median nostril and a median pineal eye were present on the top of the head. A variable number of pharyngeal gill-pouches opened by lateral common or separate gill-openings. They were adapted for filter feeding. The fragmentary remains of the invertebrate chordates have been recorded in the Cambrian strata and that of ostracoderms in the middle Ordovician time. The absence of any vertebrate fossils in rocks older than the Cambrian period, permits only speculation about the earlier history of the vertebrates. Which group was ancestral to the first true vertebrates ostracoderms? In fact, there have been no fossils intermediate between ostracoderms, which are already vertebrates, and any other earlier group of animals. As a result, there has been a great deal of speculation about the time of origin and the early progenitors of the vertebrates chordates. Probably the vertebrate organisation had been evolving for several millions of years before the appearance of the first, late Cambrian fossils. It can be said that the time of origin was not later than the beginning of the Ordovician, if not long before. The place of origin of vertebrates is not definitely known. There is no direct evidence for the exact site of origin. There are evidences that the vertebrates first appeared in the sea and migration into river system took place during the early phase of vertebrate evolution. In , the American geologist Chamberlain gave the idea of freshwater origin of vertebrates. This idea was also supported by Romer and Homer Smith. Romer and Smith argued that dilute body fluids, compared to sea water, and the glomerular kidney to get rid of excess water evolved an adaptation for freshwater conditions. However, there is also overwhelming evidence for marine origin of vertebrates. The protochordates and deuterostome invertebrate phyla are exclusively marine forms. All known Cambrian and Ordovician vertebrates also occur as marine fossils. Further, a glomerular kidney is found in hagfishes Myxiniformes , which are exclusively marine and have body fluids similar to sea water in salt concentration. As Professor James Robertson argues, the primary function of a glomerular kidney is excretory and not osmoregulatory, and it is valuable to an active and mobile vertebrate irrespective of whether it is adapted to sea, to freshwater, or to life on land. Hypothetical Vertebrate Ancestor Prevertebrate: There are no fossil records to show that whatever this ancestral vertebrate or prevertebrate may have been. There is reason to believe that it was soft-bodied, without any hard exo-or endoskeleton, which could be fossilised. The simplest chordates which are living today are the protochordates invertebrate chordates. These are belonging to the subphyla Hemichordata, Urochordata and Cephalochordata. They possess the notochord, dorsal nerve cord, pharyngeal gill-slits and post-anal tail. They lack the vertebrae and some other features of the earliest as well as the living vertebrates, but they exhibit closest affinities and certainly a common origin with the vertebrates. Thus, it seems most reasonable and logical to draw inferences about the imaginary, generalised or ancestral vertebrate among them. The American geologist Chamberlain, who proposed the theory of freshwater origin of vertebrates in , also proposed the plan of a hypothetical protovertebrate Fig. According to Chamberlain, it was an aquatic, motile, actively swimming fish-like animal having a bilaterally symmetrical body with definite head and tail ends. As in higher invertebrates and chordates, the basic internal organisation would be some sort of modified tube-within-a-tube arrangement with the major internal organs present inside a large body cavity or coelom. It would also possess all the diagnostic chordate-vertebrate features. It possessed an internal skeleton in the form of mid-dorsal, longitudinal flexible rod, the notochord, surrounded by the vertebrae. There were internal supports in fins, bony plates in the skin and a rigid cranium or skull encasing the brain and sense organs. V-shaped muscles were arranged segmentally along the sides of the body, particularly the tail. These muscles were forming the myotomes which were used in locomotion. There was a simple anteroventral opening without jaws called the mouth. Probably, it fed on microorganisms, filtered from the water or from bottom detritus. The water taken in through the mouth passed outwards through paired lateral pharyngeal gill-slits. The passing out water bathing the external gills for aquatic respiration. Liver and primitive kidneys were present. The presence of a circulatory system with a single differentiated heart in prevertebrate is uncertain. The sense organs including the lateral line organs were well developed. The endocrine system was probably already well developed in the prevertebrate. The gonads were paired. The fertilisation of eggs was external. It is thought that from such beginnings the vertebrates were evolved. Here we shall discuss the origin of earlier chordate ancestors of the vertebrates. That chordates have originated from the invertebrates is not questioned by most zoologist now-a-days. Since the earlier chordate ancestors were soft-bodied forms, they left no fossil remains to us clues as to their origin. Therefore, only basis for finding out the origin of earlier chordates is available from the resemblance between the lower chordates protochordates and the invertebrates. There are some structural features shared by them, such as bilateral symmetry, antero-posterior body axis, triploblastic coelomate condition, metameric segmentation, etc. Theories of Invertebrate Ancestry of Chordates: Similarities existing between some invertebrates and the chordates have led to the enunciation of several theories on the origin of chordates. All these theories postulate that the chordates originated either directly from some invertebrates or through the intervention of some invertebrate chordates protochordates. Almost every invertebrate phylumâ€”Coelenterata, Nemertean, Phoronida, Annelida, Arthropoda and Echinodermataâ€"has been suggested. But these theories are far from being satisfactory and convincing and have only a historical value. Only the echinoderm theory has received some attention and acceptance and shall be considered and evaluated under deuterostome line of chordate ancestry. The Bilateria is divided into two major subdivisions- Protostomia and Deuterostomia. The basis of division is the basic difference in embryonic and larval developments. Probably this division represent two main lines of evolution within the Animal Kingdom. The main differences between Protostomia and Deuterostomia are given in Table 9. Deuterostome Line of Chordate Evolution: These common features suggest strong evidence of embryological and biochemical nature of a closer evolutionary relationship between three main deuterostome phyla-Echinodermata, Hemichordata and Chordata. These common features are as follows: Early cleavages of zygote are indeterminate, i. Blastopore of gastrula forms the anus, while mouth is formed as a secondary opening. Folds or pockets arise from the endoderm of developing archenteron of the embryo. The fusion of spaces in the pockets forms the coelom enterocoelous, except in vertebrates and their walls become the mesoderm. The pelagic larva of echinoderms and hemichordates exhibit a close structural resemblance. The vertebrates, however, do not have floating larvae, having been lost in the course of evolution. Biochemically, all deuterostome use an identical phosphagen, the creatine, in the energy cycle of their muscular contraction. The invertebrates use the phosphagen, the arginine. However, certain hemichordates as well as echinoids use both arginine phosphate as well as creatine phosphate. From these facts, it is interpreted that hemichordates are connecting link between chordates and nonchordates. Serological tests demonstrate that the proteins of the three deuterostome phyla Echinodermata, Hemichordata and Chordata are more closely related to one another than those of any other phyla. The exact relationship of the three deuterostome phyla Echinodermata, Hemichordata and Chordata is still unknown, but there is little doubt that they have a common evolutionary history. Several workers have tried to explain the deuterostome line of chordate evolution. Some of the proposals are as follows: Echinoderm Ancestry Echinoderm Theory: On the basis of anatomical, embryological, palaeotological, biochemical and serological evidences, various, workers had tried to establish that the chordates probably had originated directly from some primitive echinoderm or some echinoderm larva. The tornaria larva of Balanoglossus Hemichordata and the larvae of echinoderms bipinnaria or alimentary dipleurula exhibit close similarity Fig. Johannes Muller and Bateson suggested that the tornaria larva Hemichordata and dipleurula larva Echinodermata have evolved from a common ancestral source. The common features are: But the presence of apical plate with eye spots in tornaria larva raises doubts about the common ancestry for the echinoderms and the hemichordates. Garstang and de Beer proposed the neotenous larva theory.

Chapter 5 : BIOLOGY DEAN: CHORDATES- ORIGIN-CHARACTERISTICS-CLASSIFICATION

The theory of chordate origin from echinoderm -hemichordates suggests that chordates. The embryonic development and genetic make up of these three organisms seem to have a common link. mesmerism. Canada that lend some support to his claim. complete digestive tract.

They may have evolved from some freshwater forms as Chamberlain pointed out that all modern chordates possess glomerular kidneys that are designed to remove excess water from body. However, early fossils of chordates have all been recovered from marine sediments and even modern protochordates are all marine forms. Also glomerular kidneys are also found in some marine forms such as myxinoids and sharks. That makes the marine origin of chordates more plausible. Chordates evolved from some deuterostome ancestor echinoderms, hemichordates, pogonophorans etc. Fossils of the earliest vertebrates are known from the Silurian-Devonian period, about million years ago. The following theories have been given to explain the origin of chordates: The theory was given by Johannes Muller and is based on the comparative studies of larval stages of echinoderms and hemichordates. Tornaria larva of hemichordates resembles echinoderm larvae such as Bipinnaria, Auricularia, Dipleurula and Doliolaria, which all possess ciliary bands and apical tuft of cilia. Garstang and DeBeers proposed that echinoderm larvae gave rise to chordates by neoteny. Also like chordates, echinoderms are also deuterostomes and possess mesodermal skeletal elements. The discovery of fossil echinoderms called Calcichordata from Ordovician period mya further confirms echinoderm ancestry of chordates. Calcichordates were asymmetrical animals which demonstrate affinities with both echinoderms and chordates but their skeleton is made of $CaCO_3$ whereas in vertebrates the bones are made of hydrated Ca and phosphate. They had large pharynx with a series of gill slits, each covered with flaps for filter feeding, a small segmented body and a postanal tail. A perforated pharynx for filter feeding appears to have evolved in diverse groups of animals during Cambrian-Orodovician periods when planktons were abundant in water. Romer suggested that ancestral deuterostomes were sedentary tentacle feeders whose mucous-laden ciliated tentacles served to trap planktons as they were waved in water as do the modern lophophorates and pterobranch hemichordates, Cephalodiscus and Rhabdopleura. By some mutation pharyngeal gill slits evolved in these ancestors, which made the pharynx sieve-like to trap planktons as the water current passed through it. Extant pterobranchs possess both ciliated arms and pharyngeal gill slits. Tornaria larva of hemichordates shows phylogenetic relationship with echinoderm larvae and hemichordates also show affinities with chordates. Garstang and N. Berrill gave importance to the tadpole-like larva of urochordates which carries typical chordate characters, namely, a notochord in tail along with segmented myotomes, dorsal hollow nerve cord, sense organs and pharyngeal gill slits. Garstang suggested that chordates evolved from some sessile filter feeding urochordate by the larval stage evolving into adult by neoteny and by losing the sedentary adult stage. Chamberlain studied the primitive and advanced characters of cephalochordates and proposed that while extant cephalochordates possess all chordate characters in typical state, they also show some primitive features of non-chordates, such as, absence of heart, head, sense organs, respiratory pigment, filter-feeding mode of food capture and excretion by solenocytes. Fossils of 60 specimens from mid-Cambrian of the earliest chordate, Pikaia gracilens have been discovered from Burgess Shale in British Columbia, Canada. The Amphioxus-like fossils show streamlined, ribbon-shaped, 5 cm long body having notochord in the posterior two-third of body and myomeres. It has a small head with two tentacles and gill slits in the neck region. Other chordate-like fossils are: Cathaymyrus from early Cambrian sediments in China and Palaeobranchiostomata from early Permian from South Africa that appears to be more similar to Amphioxus. Barrington combined all the above theories and proposed that the common ancestor of echinoderms and chordates was a sessile ciliary arm feeder that lived in the plankton-rich environment of the Cambrian. Modern Crinoidea Echinodermata , Pogonophora and Pterobranch hemichordates evolved from a similar ancestor by retaining the original mode of feeding, perhaps because they continued to inhabit the same environment as occurred in ancestral days. However, pharyngotremy perforation of pharynx with gill slits must have evolved in a large number of groups at that time, which must have been much more superior method of food gathering by filtering water through pharynx as compared to ciliated arm feeding. Hence, the sedentary Protoascidians of that time lost ciliated arm feeding and adopted pharyngeal filter feeding as the only method of food gathering. Sometime later, when the plankton population in water declined, free-swimming tailed larva of these urochordates did not metamorphose and became a neotenic adult, since free-swimming mode was superior in food searching at a time of food scarcity. Cephalochordate-like ancestors evolved by perfection and expansion of chordate characters that were already present in the ascidian tadpole larva. We already have fossils of such primitive chordates, e. Pikaia gracilens from mid-Cambrian.

Chapter 6 : Chordate evolution and the three-phylum system

Echinoderm theory: Garstang was of the opinion that chordates were evolved from the auricularia larva of Echinodermata. The chordates are closely related to the echinoderms and hemichordates.

Abstract How the radial body plan of echinoderms is related to the bilateral body plan of their deuterostome relatives, the hemichordates and the chordates, has been a long-standing problem. Now, using direct development in a sea urchin, I show that the first radially arranged structures, the five primary podia, form from a dorsal and a ventral hydrocoele at the oral end of the archenteron. There is a bilateral plane of symmetry through the podia, the mouth, the archenteron and the blastopore. This adult bilateral plane is thus homologous with the bilateral plane of bilateral metazoans and a relationship between the radial and bilateral body plans is identified. I conclude that echinoderms retain and use the bilateral patterning genes of the common deuterostome ancestor. Homologies with the early echinoderms of the Cambrian era and between the dorsal hydrocoele, the chordate notochord and the proboscis coelom of hemichordates become evident. Introduction The echinoderms have a radially arranged, pentamerous body structure that is very different from the bilateral body structure of the related deuterostome phyla, the hemichordates and the chordates. The way structures changed in form during the evolution of the radial echinoderms and which structures are homologous between the phyla are still problematic Smith et al. Some solutions were found here by investigating the embryonic origins of the first radially arranged structures, the five primary podia, in a sea urchin, Holopneustes purpurescens, that develops the adult echinoderm structures directly Morris without a feeding larval stage. The five primary podia head the echinoid growth zones from which grow the five ambulacra of the adult echinoderm Mooi et al. The embryonic origins of the primary podia were investigated here morphologically using the histological technique of serial sectioning. This method contrasts with the molecular approaches that have used gene expression studies in developing sea urchins to address problems relating to the origins of the echinoderm radial body plan Arenas-Mena et al. Material and methods Vestibula larvae of H. The larval stages were sectioned in the frontal and sagittal planes, and some were sectioned in the transverse plane. All stages were examined but only selected serial sections from 29 and 34 h larvae are shown here. Results Holopneustes purpurescens develops through a non-feeding vestibula larva figure 1 a , metamorphosing into a juvenile sea urchin figure 1 b within a few days of fertilization Morris The five primary podia figure 1 , which are the earliest structures to show the pentamery that characterizes the echinoderm body plan, are well developed in a vestibula larva of 44 h figure 1 a. They are named from A to E figure 1 , using the Carpenter labels Hyman , based on the position of genital plate 2 and the hydropore between podia C and D Morris The way in which these podia develop in H. The development is described here from selected serial sections of 29 and 34 h larvae.

Chapter 7 : Origin of Chordates - Suneel's Zoology

That makes the marine origin of chordates more plausible. Chordates evolved from some deuterostome ancestor (echinoderms, hemichordates, pogonophorans etc.) as they have similarities in embryonic development, type of coelom and larval stages.

Received Jul 10; Accepted Aug This article has been cited by other articles in PMC. Abstract Traditional metazoan phylogeny classifies the Vertebrata as a subphylum of the phylum Chordata, together with two other subphyla, the Urochordata Tunicata and the Cephalochordata. The Chordata, together with the phyla Echinodermata and Hemichordata, comprise a major group, the Deuterostomia. Chordates invariably possess a notochord and a dorsal neural tube. Although the origin and evolution of chordates has been studied for more than a century, few authors have intimately discussed taxonomic ranking of the three chordate groups themselves. Accumulating evidence shows that echinoderms and hemichordates form a clade the Ambulacraria , and that within the Chordata, cephalochordates diverged first, with tunicates and vertebrates forming a sister group. Chordates share tadpole-type larvae containing a notochord and hollow nerve cord, whereas ambulacrarians have dipleurula-type larvae containing a hydrocoel. We propose that an evolutionary occurrence of tadpole-type larvae is fundamental to understanding mechanisms of chordate origin. Protostomes have now been reclassified into two major taxa, the Ecdysozoa and Lophotrochozoa, whose developmental pathways are characterized by ecdysis and trochophore larvae, respectively. Consistent with this classification, the profound dipleurula versus tadpole larval differences merit a category higher than the phylum. Thus, it is recommended that the Ecdysozoa, Lophotrochozoa, Ambulacraria and Chordata be classified at the superphylum level, with the Chordata further subdivided into three phyla, on the basis of their distinctive characteristics. Introduction Since Charles Darwin proposed the evolution of animals by means of natural selection [1], the origin and evolution of chordates from common ancestor s of deuterostomes have been investigated and discussed for more than years [2 â€" 20]. Chordates consist of three distinct animal groups: This review starts with a brief description of how the Phylum Chordata and its three subphyla were originally defined, and then discusses how we should reclassify the major chordate groups. The phylum chordata and subphylum vertebrata: Historically, this classification dates back to ca BC. During the ancient Hindi era, Charaka distinguished between the Jarayuja invertebrates and Anadaja vertebrates. In the ancient Greek era, Aristotle ca BC recognized animals with blood Enaima, or vertebrates and those without Anaima, or invertebrates. This recognition persisted even until Linnaeus [21]. Aristotle had already recognized solitary ascidians as Tethyon around BC. Carolus Linnaeus was a botanist who devised a system for naming plants and animals. In his book Systema naturae 12th edn, vol. Following anatomical investigations of ascidians by Cuvier [23] and others, Lamarck [24] recognized these as Tunicata, namely animals enclosed with a tunic tunica, in Latin, meaning garment. On the other hand, cephalochordates lancelets were first described in mid-to-late eighteenth century as molluscs. At that time, the Tunicata was still included, together with bryozoans, in the subphylum Himatega of the phylum Mollusca. He coined the name Chordonia for a hypothetical common ancestor of the Tunicata and the Vertebrata including lancelets by emphasizing the notochord as a significant diagnostic character shared by them. Later, Haeckel [30] redefined Chordonia i. Chordata to include the Tunicata and the Vertebrata themselves. In London, Lankester [31] gave subphylum status to the Urochordata, the Cephalochordata and the Craniata, altogether comprising the phylum Vertebrata. This constituted the first conception of the modern phylum Chordata. This system has been retained for more than a century due to robustness of the shared character set notochord, dorsal nerve cord and pharyngeal slits that Lankester defined. Today, however, molecular phylogenies have established that the Hemichordata is a sister group to Echinodermata [12 , 17 , 18]. The phylogeny of chordates: Urochordata Tunicata , Cephalochordata and Vertebrata figure 1 a. All three groups are characterized by possession of a notochord, a dorsal, hollow neural tube nerve cord , branchial slits, an endostyle, myotomes and a postanal tail. These characters will be discussed later in relation to evolutionary scenarios for chordates. Meanwhile, the Chordata belongs to the superphyletic Deuterostomia, together with the phyla Echinodermata and Hemichordata figure

1 a. Chordates are thought to have originated from a common ancestor or ancestors of the deuterostomes [7 , 12 , 17 â€" 20].

Chapter 8 : what are the 3 proposed theories of chordate evolution? | Yahoo Answers

ORIGIN OF CHORDATES CHORDATE ORIGINS: Members of Phylum CHORDATA have four primary characters, they are- a) A primitive endoskeleton structure called the NOTOCHORD present during the early embryonic life.

The phylum Chordata contains all animals that possess, at some time in their life cycles, a stiffening rod the notochord , as well as other common features. The subphylum Vertebrata is a member of this phylum and will be discussed later see below The vertebrateâ€¦ General features Tunicates are small animals, typically one to five centimetres 0. Cephalochordates range from one to three centimetres. Vertebrates range in size from tiny fish to the whales, which include the largest animals ever to have existed. Tunicates are marine animals, either benthic bottom dwellers or pelagic inhabitants of open water , that often form colonies by asexual reproduction. They feed by taking water in through the mouth, using the gill slits as a kind of filter. The feeding apparatus in cephalochordates is similar. They have a well-developed musculature and can swim rapidly by undulating the body. Cephalochordates usually live partially buried in marine sand and gravel. Vertebrates retain traces of a feeding apparatus like that of tunicates and cephalochordates. The gill slits, however, ceased to function as feeding structures, and then later as respiratory devices, as the vertebrate structure underwent evolutionary changes. Except in some early branches of the vertebrate lineage i. The fishlike habitus that evidently began with cephalochordates became modified by the development of fins that were later transformed into limbs. With the invasion of the vertebrates into fresh water and then onto land, there was a shift in means of breathingâ€”from gills to lungs. Other modifications, such as an egg that could develop on land, also emancipated the vertebrates from water. Elaboration of the locomotory apparatus and other developments allowed a diversification of structure and function that produced the amphibians, reptiles, birds, and mammals. Natural history Reproduction and life cycle The chordate life cycle begins with fertilization the union of sperm and egg. In its primitive form, fertilization occurs externally, in the water. Asexual reproduction takes place in tunicates and in some vertebrates females of some fish and lizards can reproduce without fertilization. Hermaphroditism possessing both male and female reproductive organs is found in tunicates and some fishes, but otherwise the sexes are separate. Larvae very young forms that differ considerably from the juveniles and adults , when they do occur, differ in structure from the larvae of nonchordates. Internal fertilization, viviparity giving birth to young that have undergone embryological development , and parental care are common in tunicates and vertebrates. Ecology and habitats Chordates are common in all major habitats. Tunicate larvae either seek out a place where they can attach and metamorphose into an adult or develop into adults that float in the open water. Cephalochordates develop in the open water, but as adults they lie partially or entirely buried in sand and gravel. In either case, they are filter feeders with simple behaviour. Vertebrates are much more complex and, in keeping with their more active manner of obtaining food, highly varied in their ecology and habits. Locomotion Chordates are capable of locomotion by means of muscular movements at some stage in life. In tunicate larvae, this is accomplished using a tail; in cephalochordates, by undulations of the body; and in vertebrates, by general body movements as in eels and snakes and by the action of fins and limbs, which in birds and some mammals are modified into wings. Associations Chordates enter into a wide variety of symbiotic relationships and are especially noteworthy as hosts for parasites. Family groups and societal relationships, in both a broad and narrow sense, are particularly well developed in vertebrates, due primarily to their elaborate nervous systems. This phenomenon is seen in schools of fish, flocks of birds, and herds of mammals, as well as in the primate associations that suggest the beginnings of human society. Form and function General features Chordates have many distinctive features, suggesting that there has been extensive modification from simple beginnings. The early stages of chordate development show features shared with some invertebrate phyla, especially the mouth that forms separately from the anus, as it does in the phyla Hemichordata , Echinodermata , and Chaetognatha. Likewise, as in these phyla, the coelom , or secondary body cavity around the viscera, develops as outpouchings of the gut. A coelom also is present in some more distantly related phyla, including Annelida , Arthropoda , and Mollusca , but the main organs of the body are arranged differently in these phyla. In chordates the main nerve cord is single and lies above the alimentary tract , while in other phyla it is paired and lies below the gut. Cephalochordates and vertebrates are segmented, as are the annelids and their relatives; however, segmentation in the two groups probably evolved independently. The gill slits and some other features that are common among the hemichordates and the chordates originated before the chordates became a separate group. Hemichordates have no tail above the gut and no mucus-secreting endostyle between the gill slits. External features An ancestral chordate, as suggested by the adult lancelet and the tadpole larva of tunicates, had a distinct front and hind end, an anterior mouth, a posterior tail above an anus, unpaired fins, and gill slits that opened directly to the exterior. A free-swimming tunicate larva metamorphoses into an attached, sessile adult with an atrium that surrounds the gills. The atrium of lancelets probably evolved independently. Internal features Skeleton and support The chordate notochord is a stiff rod with a turgid core and fibrous sheath. It keeps the animal from shortening when locomotory waves are produced through muscular contraction. The chordate body is supported by fluid in the body cavities. In tunicates, added support is provided by the tunic. Cartilaginous material supports the gills and other body parts of tunicates and cephalochordates. Immature vertebrate skeletons generally consist largely of cartilage , which becomes increasingly bony with age. The cartilaginous skeletons of sharks and some other vertebrates are thought to have evolved from more highly mineralized ones. Tissues and muscles In both cephalochordates and vertebrates, muscles used in locomotion are well developed and organized segmentally. The tail musculature of tunicates is simpler and without clear indications of segmentation. There is at least a small amount of musculature throughout the body of all chordates. As jaws, limbs, and other body parts have evolved in vertebrates, so have the muscles that operate them. Nervous system and sense organs The anterior end of the main nerve cord in chordates is enlarged to form at least the suggestion of a brain, but a brain is well developed only in vertebrates. Tunicate larvae have visual organs sensitive to light and sense organs responsive to the direction of gravity. Pigment spots and light receptors in the nerve cord of lancelets detect sudden changes in light intensity. The eyes and other sense organs of vertebrates are more elaborate and complex. The presence in cephalochordates and vertebrates of a nervous system with segmentally repeated nerves arising from the dorsal hollow nerve cord is suggestive of a common ancestry. The tunicate nervous system does not have the segmentally repeated nerves. The brains of all vertebrates are greatly enlarged and subdivided into functionally specialized regions. Digestion and nutrition Both tunicates and cephalochordates are filter feeders of small particles of food suspended in the water. Beating cilia hairlike cellular extensions on the gill slits draw a current of water into the mouth and through the pharynx, where a sheet of mucus , secreted by the endostyle a glandular organ lying below the two rows of gill slits , filters suspended food particles from the water. Cilia lining the pharynx move the food-rich sheet of mucus upward over the gill slits, and it is then rolled up and transported to the posterior part of the gut. The water current passes into the atrium and exits through the atrial opening. The difference is that the food consists of somewhat larger particles that have been deposited on the bottom detritus , and, instead of the feeding current being driven by cilia, the pharyngeal musculature pumps water and food particles across the gill slits. The earliest fishes probably fed on detritus, and a sucking action is retained by their extant representatives lampreys and hagfishes. With the development of jaws, it became possible for the vertebrates to capture and seize larger food items. The lower digestive tract of the primitive chordate is a simple tube with a saclike stomach. There are only indications of the specialized areas and of glandlike structures, such as the liver and pancreas, that occur in vertebrates. Excretion The excretion of wastes and the control of the chemical composition of the internal environment are largely effected by kidneys, although other parts of the body, including the gills, may play an important role. Tunicates and cephalochordates have a salt content essentially the same as seawater, but vertebrates, even marine species, have body fluids of low salt content, with the exception of hagfishes. A possible explanation is that the vertebrates evolved in fresh water, but it seems reasonable that hagfishes branched off while still marine and that the freshwater form evolved later. Respiration A primitive chordate gill is present in tunicates and cephalochordates, where it serves in both respiration and feeding. The vertebrate gill may retain some role in feeding, although the current is now produced by the action of muscles, not cilia. The gills became reduced in number in various lineages, and they were strengthened by supporting elements, some of which evolved into jaws. Lungs, already present in fishes, became the main respiratory organs of terrestrial vertebrates. Circulatory system The circulatory system in chordates has a characteristic pattern. In tunicates and vertebrates the blood is propelled by a distinct heart; in cephalochordates, by contraction of the blood vessels. Unoxygenated blood is driven forward via a vessel called the ventral aorta. It then passes through a series of branchial arteries in the gills, where gas exchange takes place, and the oxygenated blood flows to the body, much of it returning to its origin via a dorsal aorta. The blood of vertebrates passes through the tissues via tiny vessels called capillaries. In tunicates and cephalochordates, capillaries are absent and the blood passes through spaces in the tissues instead. Hormones In vertebrates, endocrine glands those of internal secretion produce hormones that regulate many physiological activities. In tunicates and cephalochordates, organs have been identified that correspond in anatomical position to the pituitary gland of vertebrates, but which hormones, if any, they secrete is uncertain. In vertebrates, the thyroid gland produces thyroxine, an iodine-containing hormone that helps regulate metabolism. The thyroid is a modified endostyle, as can be illustrated by larval lampreys in which the thyroid still secretes mucus for use in feeding. The endostyles of lancelets take up iodine and form thyroxine, but the thyroxine formed may not function as a hormone in the lancelets themselves. Features of defense and aggression Tunicates largely rely upon the passive defense afforded by their heavy tunic. Lancelets move rapidly through the substrate, and their well-developed locomotory apparatus evolved largely to provide a means of escaping predators. Vertebrates have ceased to feed on detritus brought to them by water currents. They have shifted to consuming larger foodstuffs and to actively locating, pursuing, and subduing what they eat. Evolution and paleontology Many scientists maintain that chordates originated sometime earlier than million years ago; that is, they predate the fossil record. Such early representatives were soft-bodied and therefore left a poor fossil record. The oldest known fossil chordate is Pikaia gracilens, a primitive cephalochordate dated to approximately million years ago. There is disagreement over whether older animalsâ€”such as Yunnanozoon lividum and Haikouella both of which date to million years ago and possess several chordate features â€”should be considered chordates. An extensive vertebrate fossil record begins about million years ago. Embryological evidence places the phylum Chordata within the deuterostomes bilaterally symmetrical animals with undeterminate cleavage and whose mouth does not arise from the blastopore , which also includes the phyla Hemichordata, Echinodermata, and Chaetognatha. The closest relatives of the chordates are probably the hemichordates, since these animals possess gill slits and other features not found in other animal phyla.

Chapter 9 : Chordate - Wikipedia

ECHINODERM -HEMICHORDATE THEORY-ORIGIN OF CHORDATES: This theory infers origin of chordates, hemichordates and echinoderms from a common ancestor. This theory is based on the following evidences.

The ancestral chordates have appeared in the early part of Palaeozoic era. There are different opinions about the origin of chordates. Garstang was of the opinion that chordates were evolved from the auricularia larva of Echinodermata. The chordates are closely related to the echinoderms and hemichordates. It is evident by the following resemblances. The phosphogens used in muscle contraction are similar in hemichordates and echinoderms. The phosphogen is in the form of creatine in all vertebrates and arginine in invertebrates. In hemichordates and echinoderms both creatine and arginine are present. The tornaria larva of hemichordates resembles the larval forms of echinoderms. It is believed that the ancestral chordates might have evolved from the larvae of echinoderms by paedogenesis Chordata is the highly evolved phylum of the animal kingdom. The largest vertebrate animal is blue whale, Balaenoptera musculus. It grows upto 35 meters length and weighs about tons. The whale shark, Rhincodon typhus is the second largest vertebrate. It grows to 20 meters length. It is a stiff elastic mid-dorsal longitudinal rod lying between the Nerve Cord and alimentary canal. So, it is called Chordadorsalis. It is a skeletal or supporting structure present in the embryonic stages of all chordates. It is made of vacuolated cells and enclosed by two connective tissue sheaths. It persists throughout life in Amphioxus, and vertebrates like cyclostomes. Notochord serves as an organ of internal support and also provides surface for the attachment of muscles. In vertebrates, the notochord is replaced by vertebral column. Hence all vertebrates are chordates but all chordates are not vertebrates. The notochord is chorda mesodermal in origin. In mammals, notochord is in the form of vestigial swellings in the vertebral column. They are called Nuclei pulposi. During the development, it is formed from the mid dorsal region of the early embryo from ectodermal cells i. It persists through out life in most chordates, but in higher chordates, the nerve cord is differentiated into an anterior brain and a posterior spinal cord. The nerve cord gets degenerated during metamorphosis in ascidians. Such gill-clefts appear during the development of every chordate, but in many aquatic forms they are lined with vascular lamellae which form gills for respiration. In terrestrial chordates which never breath by gills, traces of gill-clefts are present during early development but most of them disappear before adult life. Gill- clefts are also called gill â€" slits or pharyngeal â€" clefts. Such gill â€" clefts which do not bear gills are usually called visceral â€" clefts. In lower chordates the visceral â€" clefts often form some endocrine glands. Even though the three primary characters of chordates are well developed, the dorsal tubular nerve cord is reduced in some and in urochordata the central nervous system degenerated in the adult. However the three primary characters are possessed only by chordates. Higher chordates also possess the following characters: Bilateral symmetry Various organs of the body are symmetrically arranged on right and left sides of the median longitudinal axis. In a bilaterally symmetrical animal, the body can be divided into two equal halves only in one plane sagittal which may be the mirror images of each other. Triploblastic condition Various organs in the chordate body are derived from three germ layers, namely ectoderm, endoderm and mesoderm. Thus, all chordates are triploblastic animals. In chordates, the mesoderm is formed as out pushings of archenteron, But in higher invertebrates the mesoderm arises as solid out growths from cells which lie at the juncture of ectoderm and endoderm. Coelom A true coelom or body cavity which develops from mesoderm is present in all chordates. But it is called enterocoelus coelom in chordates, as it develops from archenteron. The coelom is externally lined by parietal or somatic layer and internally by visceral or splanchnic layer. In higher chordates like mammals, the coelom is divided into anterior thoracic and posterior abdominal cavities by a diaphragm. Metamerism Segmentation The linear repetition of the body organs is called metamerism. Among the chordates the metamerism is visible only internally. The body musculature, the nervous system, the circulatory system, the excretory system, etc. The segmentation in chordates is referred to as heteronomous segmentation, as the segmentation is not uniform. Metamerism is clearly seen in the embryo, but it becomes obscured by condensation in the adult in some organs such as the kidneys and limbs and it is completely lost in the head. Cephalization All the higher chordates possess well developed head having complex brain and specialised sense organs. This trend towards the prominence of head is called cephalization. In the chordate series there is a steady increase in size and specialization of the head. Thus there is greater prominance and domination of the head over the rest of the body. Circulatory system As the blood flows through a system of tubes, the blood vascular system is of closed type. In dorsal vessel the blood flows from anterior to the posterior end and in the ventral vessel from posterior to anterior. Ventral heart The heart is a muscular and contractile organ situated towards ventral side inbetween the lungs below the oesophagus. The heart is surrounded by double walled pericardium. It is 2 to 4 chambered in various groups of vertebrates. Hepatic portal system Hepatic portal system is present in all the chordates. Blood that is collected from various parts of alimentary canal is not carried directly to heart but to liver. The blood then goes to heart. Thus the hepatic portal vein not only begins but also ends in capillaries or it acts both as afferent and efferent vessel. Red Blood Corpuscles In higher chordates, the respiratory pigment haemoglobin is always found in the specialised cells called red blood corpuscles or erythrocytes. Higher chordates posses two paired appendages in the form of fins or limbs. It is a posterior prolongation of the body. It is without coelom and viscera. But it has extensions of muscles, nerve cord, notochord. Vertebrata or Craniata Of these three subphyla, the first two and also Hemichordata are generally referred to as protochordates. All protochordates are characterised by the absence of cranium, so they are also called acraniates. The protochordates stand between invertebrates and vertebrates. Bateson included Hemichordata in this phylum. Now a days, the group Hemichordata is treated as a separate minor phylum. Some are sedentary and some are pelagic forms i. These are degenerated chordates. Their body is enveloped by a tunic or test made up of tunicin cellulose like material. So they are called tunicates. In the larval form, notochord is present only in the tail region, hence the name urochordata. It is absent in the adult stages. But in Larvacea, the notochord is present in adults also. Dorsal tubular nerve cord is found only in the larval stage, but degenerates in the form of small ganglia in adults. Numerous gill slits are present. Heart is ventral, simple and tubular. Coelom is completely absent. Sexes are united i. The larval form is called Tadpole and it exhibits retrogressive metamorphosis. The transformation of well-organized larva with all the chordate characters into a degenerated and less developed adult is called, retrogressive metamorphosis. Urochordata has been divided into three classes. Free swimming pelagic forms. Neotenic forms which retain the larval form throughout adult life. Posterior part of the body takes the form of a large locomotory appendage, the tail. Single pair of gill-slits is present. Anus opens ventrally on the surface of the body. Sexes are united, i.