Department of Rural Technology and Social Development, GGU, Bilaspur (C.G.)
B.Sc. Ist Semester: End Semester Examination 2014
RTZ-104 Vertebrates (AU 7003)

Time: hours **Max Marks: 30**

Section A

1. Multiple choice (01 Mark each) **10 Marks**

1. (b) Dorsal tubular nerve cord

2. (b) Cyclostomata

3. (b) Head, trunk and tail

4. (b) Pipa

5. (a) About 69

6. (c) Aves

7. (b) Herpatology

8. (a) Eels

9. (b) Haemoglobin

10. (a) Non poisonous

Section B

Short answer type questions: (Attempt any four: 2.5 Marks each) **10 Marks**

2. Differences between chordates and non- chordates are as follows-

Characteristics	Chordates	Non- chordates
Presence of living endoskele-Ton	Presence of hard supporting skeleton of body framework Lying inside the body (Endoskeleton)	They either lack skeletal, but present it is outside the body (Exoskeleton) and is formed of non living chitin substance
Presence of a post anal tail	True tail which contains the extension of muscles, nerve cord, notochord or vertebral column and the blood vessel lacks the visceral organs	They have a tail which is fundamentally a different structure having no principal organs
Presence of ventral heart	Their heart is highly muscu -lar propulsive organ placed below the alimentary canal	Their heart is always dorsal to the alimentary canal
Presence of closed vascular system	Posses a definite system of cl blood vessels	Have open type of blood vascular system
Presence of hepatic portal sys Tem	The blood from the alimen-tary canal is first carried to th liver and not to heart.	They lack such hepatic portal system
Presence of red blood corpus-Cles	Their respiratory pigment, haemoglobin is found in R.B.Cs	Here haemoglobin, if present is found in dissolved state in plasma
Direction of blood flow	Blood always flow in anterior direction	Blood in the dorsal vessel flows from posterior to

		anterior end
Coelom	It is divided into several regions each with specific function, ie., dorsal myocoel, middle nephrocoel, lateral and ventral splenchnocoel	It occurs as a single wide perivisceral cavity around the visceral organs
Placement of neurons	In the nerve cord, nerve cells are arranged deep around the central canal	In the nerve cord, nerve cells are arranged superficially on the periphery
Origin of nerves	The nerves arise from the dor and ventral nerve Roots	The nerves arise mostly from segmental ganglia of the nerve cord
Presence of paired Appendages	The paired appendages are invariably two pairs	The paired appendages vary in number and may even correspond to number of segments
Presence of vertebral column	In higher chordates, notochord is replaced by vertebral column	This is not found

3. The **dorsal tubular nerve cord** is one of the embryonic features unique to chordates, along with a notochord, a post-anal tail, an endostyle, and pharyngeal slits. The dorsal nerve cord is a hollow cord dorsal which is situated mid- dorsally above the notochord and immediatly beneath the body wall. It is formed from a part of the ectoderm that rolls, forming the hollow tube, compared to other animal phyla, which have solid, ventral tubes. Its cavity is known as Neurocoel. In higher chordates, the dorsal nerve cord is later modified (in vertebrates) into the central nervous system which is composed of the brain and spinal cord. Dorsal nerve cord is mainly found in subphylum Vertebrata.

Pharyngeal gill slits are filter-feeding organs found in non chordates (lancelets and tunicates) and hemichordates living in aquatic environments. These repeated segments are controlled by similar developmental mechanisms. Some hemichordate species can have as many as 200 gill slits. Pharyngeal slits resembling gill slits are transiently present during the embryonic stages of tetrapod development. However, it is now accepted that it is the vertebrate pharyngeal pouches and not the neck slits that are homologous to the pharyngeal slits of invertebrate chordates. Gill slits or Branchial clefts are found universally, at some stage of life, in all chordates. These occur as paired series of perforations in the lateral wall of pharynx and lead to exterior. These develop as series of ectodermal inpushings from the exterior and their fusion with the similar outpushings of endoderm of pharynx. Such gill clefts appear during development of very chordate. In aquatic chordates (fishes), the visceral clefts develop vascular lamellae, called gills. These clefts are now known as gill clefts or gill slits.

4. General Characteristics of class Larvacea are as follows-

- Free swimming, pelagic and solitary forms.
- Adults with a permanent tail containing a notochord.
- Pharynx with two gill slits, which open to exterior directly.
- Separate atrial or peribranchial or cloacal cavities are absent.
- Test (commonly known as house) is not made up of tunicin and a temporary structure being thrown off periodically.
- Budding is absent

- Development includes no larval stage.
- Adult posses larval organization and represents neotenous form.
  Example: *Oikopleura*

5. Aquatic adaptations in ***Scoliodon*** are as follows-

- Scoliodon lives in the open sea and depends on fast movements for capturing prey and save itself from enemies.
- It has a perfectly streamlined spindle- shaped body with a flattened snout and tapering tail. Its body shape offers least resistance while swimming. The pointed snout cuts the water easily and makes way for the passage of the body.
- All the fins are directed backward and offer no resistance while swimming.
- Dorsal fins provide stability against rolling and help in turning movements.
- Mouth, jaws and backwardly pointed teeth are adapted for capturing and holding the prey.
- Niticating membrane over the eyes protects it from water without obstructing vision.
- Gills are effective respiratory organs.
- Exoskeleton of minute placoid scales protect the body.
- Lateral line sense organs detect disturbances in the water.
- Its sense of smell is well developed. It smells blood from a long distance.

6. Direct Parental care in Amphibians-

Looking after the eggs or young until they are independent to defend from predators, is known as parental care. It is very important factor for survival. Animals show a great diversity in caring for their eggs and young during their development. Anurans show much greater diversity than urodeles and apodens. The methods of caring by amphibian generally fall under two broad categories:

(1) Protection by nest, nurseries and shelters

(2) Direct caring by parents –

a) **Coiling around eggs**: In *Amphuima, Ichthyophis* and *Hypogeophis*, female lays eggs in burrow of damp soil and carefully guards them until they hatch. In *Magalobatrachus maximus*, the males coil around the eggs.

b) **Transferring tadpoles to water**- some species of small frog (eg. Phylobates, Arthroleptis, Pelobates, etc.) deposit their eggs on ground. The tadpole hatching out, fasten themselves to back of one of the parents with their sucker like mouth and transported to water.

c) **Eggs glued to body**- Many amphibians carry the eggs glued to their body. In Desmognathus focus, female carries eggs glued around her neck and Alytes obstraticans entangles eggs around her legs.

d) **Eggs in back pouches**- In marsupial frogs or toads, female carries eggs on her back, ither in an open oval depression or in pockets. The eggs dvelop into miniature frogs before they leave their mother's back. In Brazilian tree toad, Hyla goeldii, eggs remains in posterior part of female having brood pouch where eggs remain exposed. In Nototrema, eggs are covered by skin that forms a single large brood pouch which opens posteriorly in front of cloacal aperture. Similar adaptation is seen in aquatic Surinam toad.

e) **Pipa**- In breeding season, skin of female's back becomes thick, vascular, soft and gelatinous. The male presss fertilized eggs onto female's back where they sink inti

individual pits. Each egg is covered by small capsule whre complet metamorphosis occurs. The tiny toads without tail comes out from mother and do not enter into water.

f) **Organs as brooding pouches**- Male of the terrestrial South American Darwin's frog, Rhinoderma darwinii, pushes atleast two fertilized eggs into his relatively large vocal sac. Here, they undergo complete development to emerge out as fully formed froglets. In West African Tree Frog, Hylambates breviceps, the femal carries eggs in her buccal cavity. In Arthroleptis, it's the male who keeps the larva in his mouth. Australian frog, Rheobatrachus silus, gastric incubation occurs for development. The femmaqle keeps the eggs in her stomach. The tadpols are expelled through mouth after metamorphosis.

g) **Viviparity**- some anurans are ovo- viviparous. They retain eggs in oviducts and the female give birth to living youngs. African toad, Nectophrynoids and Pseudophryne, give birth to little frogs. The European Salamander, Salamandra salamandra, produces twenty or more small youngs while the Alpine Salamandr, Salamandra atra, gives birth to one or two fully developed young. Viviparity occurs in order Gymnophiona and three out of four families have this mode of reproduction.

7. Classification and general characteristics of Class Aves-

Sub class- I: Archaeornithes (example- Archaeopteryx and Archaeornis**)**

1. Extinct.
2. Elongated body with all developed wings by which they could fly for a shorter distance.
3. Tail long and pointed like a lizard-tail and was provided with feathers.
4. Each hand bearing three unfused and clawed fingers.
5. Tail with 18-20 free caudal vertebrae.
6. Sternum without a keel.
7. Each limb had 3 clawed digits.
8. Teeth present on both jaws.
9. Abdominal ribs present.
10. Sternum was without any keel.
11. Cerebellum small.

Sub class II: Neornithes (example- ostrich, emus , kiwis, rheas, elephant birds, moas, etc.**)**

1. Modern birds
2. Both living and extinct birds are present under the sub class.
3. Wings well developed can fly well.
4. Tail short and small.
5. Tail feathers (rectrices) are arranged as a fan.
6. The digits of forelimb generally without any claws.
7. Except some fossil birds modern birds have no teech.
8. Vertebrae heterocaelous type.
9. Abdominal ribs absent.
10. Teeth absent except in some fossil birds.
11. Few caudal vertebrae free. Rest fused into a pygostyle.
12. Sternum with well developed keel.
13. Thoracic ribs with uncinate process.

Section C

Long answer type questions: (Attempt any two: 05 Marks each) 10 Marks

8. Classification of Class Mammalia-

Subclass Eutheria (Placental mammals) (example- bear, rabbit)
Subclass Metatheria (marsupials, about 270 species of mammals whose young are in an immature state, most females have pouches) (example- Kangaroos, Koalas)
Subclass Prototheria (example- Platypus, anteaters**)**

Living mammal species can be identified by the presence of sweat glands, including those that are specialized to produce milk to nourish their young. Many traits shared by all living mammals appeared among the earliest members of the group:

Jaw joint - The dentary (the lower jaw bone which carries the teeth) and the squamosal (a small cranial bone) meet to form the joint. In most gnathostomes, including early therapsids, the joint consists of the articular (a small bone at the back of the lower jaw) and the quadrate (a small bone at the back of the upper jaw).

Middle ear - In crown-group mammals, sound is carried from the eardrum by a chain of three bones, the malleus, theincus, and the stapes. Ancestrally, the malleus and the incus are derived from the articular and the quadrate bones that constituted the jaw joint of early therapsids.

Tooth replacement - Teeth are replaced once or (as in toothed whales and murid rodents) not at all, rather than being replaced continually throughout life.[9]

Prismatic enamel - The enamel coating on the surface of a tooth consists of prisms, solid, rod-like structures extending from the dentin to the tooth's surface.

Occipital condyles - Two knobs at the base of the skull fit into the topmost neck vertebra; most tetrapods, in contrast, have only one such knob.

Among the mammals, there are three major variations in reproductive systems. This is the basis for dividing them into subclasses and infraclasses.

Members of the subclass *Prototheria* lay eggs like most non-mammalian vertebrates. However, they feed their newborn with mammary gland secretions like all other mammals. They lack nipples, but the skin over their mammary glands exude milk for their babies. The *Prototheria* are also referred to as monotremes, which literally means that they have one opening for excretion and reproduction. This is similar to birds and reptiles. The *Prototheria* are also similar to reptiles in some aspects of their skeletons. Notably, their legs are on the sides of their bodies rather than underneath them. This results in a reptile-like gait. There are only three surviving rare species groups of *Prototheria*. These are the Australian platypus and 2 echidna (spiny anteater) species of Australia and New Guinea.

All other living mammalian species, including humans, are in the subclass *Theria*. They have in common the fact that they give birth to live young. Therian mammals apparently did not evolve from the *Prototheria*. The relatively primitive prototherian reproductive system evidently

evolved after their evolutionary line separated from the other early mammals.The oldest infraclass of therian mammals is the *Metatheria* , or the marsupials. Their young are born very immature and cannot live without further development in the mother's pouch. The word marsupial comes from *marsupium*, the Latin word for purse. Marsupials include kangaroos, koalas, opossums, and many other similar animals. Most of them are native only to Australia and New Guinea.

Most mammal species, including humans, are in the infraclass *Eutheria*. They are also referred to as placental mammals. Eutherian mothers carry their unborn children within the uterus where they are nourished and protected until an advanced stage is reached. This is made possible by the umbilical cord and placenta which connects the fetus to the uterus wall and enables nutrients and oxygen to get to the offspring as well as provides a means of eliminating its waste. At the same time, the placenta functions as a barrier to keep the blood cells and other components of the immune systems of the mother and her fetuses separate to prevent their destruction**.**

Giant pandas are an exception among the placental mammals. Their babies are born at only 1/4 the size predicted for the general placental mammal pattern. Marsupial babies are born at an even more immature stage because their rudimentary placentas are comparatively inefficient in nurturing fetuses.

Placental mammals have been extremely successful in out-competing monotremes and marsupials for ecological niches. This is mostly due to the fact that their babies are born more mature, which increases their chances of survival. This is particularly true of herbivores that are predated on by carnivores. Marsupials give birth to early stage fetuses. Placental mammals give birth after fetuses are much more developed. The downside is that pregnant placental mammals must consume significantly more calories to nurture their fetuses and themselves, especially during the second half of their pregnancies. Like monotremes and marsupials, placental mammals feed their babies with milk from their mammary glands. Species that have multiple births at the same time generally have more mammary glands. The number ranges from 2 in primates, goats, sheep, and horses to 18 in pigs.

Placental mammals are found on all continents, in the air, and in the seas. Primates, cats, dogs, bears, hoofed animals, rodents, bats, seals, dolphins, and whales are among the dominant placental mammal groups today. Nearly 94% of all mammal species now are placental mammals (5,080 species out of 5,416).

9. Migration is the movement of large number of animals from one place to another for feeding, reproduction or to escape weather extremes. When large numbers of fishes come together and move socially it is called **shoaling.** But sometimes migrating fishes exhibit high degree of coordination in their movements and carry out synchronized manoeuvres to produce different types of shapes. This is called **schooling,** as seen in tunas and sardines.

Feeding or alimental migration takes place in fishes for feeding. In high populations fishes exhaust food resources in an area quickly and therefore must migrate constantly in search of new feeding resources. Salmons, cods and sword fish constantly migrate for food from one place to another in the sea.

Spawning migration takes place in breeding season in those fishes which have spawning grounds far away from feeding places. Migratory fishes such as eels and salmons and a large number of riverine fishes spawn in tributaries of river in hills and migrate in large number for laying eggs in these oxygen rich waters.
Juvenile migration involves larval stages of fishes which hatch in spawning grounds and must migrate long distances in order to reach the feeding habitats of their parents.
Recruitment migration takes place when large number of larvae moves from nursery habitat to the habitat of adults which may sometimes be distinctly different. Adults of eels live in rivers in Europe and America but their larval stages live and grown in sea and migrate to reach rivers which may take one to two years.
Seasonal migration takes place in fishes that inhabit arctic areas where in summer climate is conducive and food abundant but as winter approaches temperatures fall below zero and food becomes scarce. Hence fishes must migrate towards subtropical and tropical areas to escape extremes of weather conditions.

TYPES OF MIGRATION IN FISHES

Fishes live in two different types of aquatic habitats, namely, freshwater and marine habitats, which pose different osmotic problems because of which it is difficult to migrate from one type of habitat to another. Nevertheless, some fishes do migrate.

POTAMODROMOUS MIGRATION

When fishes migrate from one freshwater habitat to another in search of food or for spawning, it is called potamodromous migration. There are about 8,000 known species that migrate within lakes and rivers, generally for food on daily basis as the availability of food differs from place to place and from season to season. Fishes also must migrate to lay their eggs in places where oxygen concentration in water is more and where there is abundance of food for juveniles when they hatch from eggs.

OCEANODROMOUS MIGRATION

This migration is from sea water to sea water. There are no barriers within the sea and fishes have learned to migrate in order to take advantage of favourable conditions wherever they occur. Thus there are about 12,000 marine species that regularly migrate within sea water. Herrings, sardines, mackerels, cods, roaches and tunas migrate in large numbers in search of food by way of **shoaling**(migrating together socially but without much coordination) or **schooling** (swimming with high degree of coordination and synchronized manoeuvres).

DIADROMOUS MIGRATION

When fishes can migrate from fresh water to sea or from sea to fresh water, it is called diadromous migration. There are about 120 species of fishes that are capable of overcoming osmotic barriers and migrate in these two different types of habitats. This migration is of three types.

Catadromous migration

This type of migration involves movement of large number of individuals from fresh water to sea water, generally for spawning as happens in the case of eels *(Anguilla)* inhabiting European and North American rivers.

Both European eel *(Anguilla anguilla* or *Anguilla vulgaris)* and the American eel *(Anguilla rostrata)* migrate from the continental rivers to Sargasso Sea off Bermuda in south Atlantic for spawning, crossing Atlantic Ocean during the journey and covering a distance of about 5,600 km. The adult eels that inhabit rivers are about a

metre long, yellow in colour and spend 8-15 years feeding and growing. Before migration the following changes take place in their bodies:

- They deposit large amount of fat in their bodies which serves as reserve food during the long journey to Sargasso Sea.
- Colour changes from yellow to metallic silvery grey.
- Digestive tract shrinks and feeding stops.
- Eyes are enlarged and vision sharpens. Other sensory organs also become sensitive.
- Skin becomes respiratory.
- Gonads get matured and enlarged.
- They become restless and develop strong urge to migrate in groups.

They migrate through the rivers and reach coastal areas of the sea where they are joined by the males and then together they swim in large numbers, reaching Sargasso Sea in about two months. They spawn and die. Each female lays about 20 million eggs which are soon fertilized by males.

First clue about life cycle of eels was given by two Italian scientists Grassi & Calandruccio in 1896. Details of migration and life cycle were later studied by Johann Schmidt (1905). Eggs hatch into leaf-like, semitransparent, larvae having small head called **Leptocephalus.** Leptocephali of American eels take about 10 months to fully grow while those of European eels take about 18 months. Upon reaching coastal waters leptocephali metamorphose into another larval stage called **Elver** or Glass eel. Female elvers ascend to the rivers and metamorphose into yellow-coloured adults, while males stay back in the river mouth and wait for the females to return for spawning journey.

Anadromous migration

Adults of anadromous fishes live and feed in ocean waters but their spawning grounds lie in the tributaries of rivers. Salmons, sturgeons, Hilsa and lampreys are some of the marine fishes that undertake anadromous migration to spawn in rivers.

Atlantic salmon *(Salmo salar)* migrates to the North American rivers for spawning while six species of Pacific salmon *(Onchorhynchus)* migrate to various rivers of Asian countries.

Salmons living in sea are metallic silvery grey in colour but before migration they turn reddish-brown in colour. During fall, they enter rivers and swim energetically against water currents (**contranatent**), clearing all obstacles, including waterfalls and reach tributaries in hilly areas where they make a saucer-like pit in which female lays eggs and male releases smelt over them. Eggs take 2-3months to hatch in the following spring, when the juvenile stage called **Alvin** emerges out but remains within the nest, obtaining its nourishment from the yolk sac attached to its belly. Alvin then transforms into **Fry** which feed on planktons. Fries are **denatant** (they swim along with water current) and feed and grow into fingerlings which take the shape of adult fish. They change into **Smolt** which congregate at the river mouth in large numbers and then enter sea water in to metamorphose into adult salmons.

10. The Tunicata "sea squirts" (=Urochordata) comprise a subphylum of the phylum Chordata, the group that includes vertebrates.

The body of an adult tunicate is quite simple, being essentially a sack with two siphons through which water enters and exits. Water is filtered inside the sack-shaped body.

However, many tunicates have a larva that is free-swimming and exhibits all chordate characteristics: it has a notochord, a dorsal nerve cord, pharyngeal slits, and a post-anal tail.

This "tadpole larva" will swim for some time; in many tunicates, it eventually attaches to a hard substrate, it loses its tail and ability to move, and its nervous system largely disintegrates. Some tunicates are entirely pelagic; known as salps, they typically have barrel-shaped bodies and may be extremely abundant in the open ocean.

Subphylum Urochordata is divided into three classes-

CLASS 1. ASCIDIACEA:

1. These are sedentary tunicates.
2. The body is covered by a test.
3. Pharynx is large and contains gill-slits.
4. Notochord, nerve-cord and tail are absent
5. These are Bisexual animals.
6. Life-history includes a typicalTadpole larva. The class Ascidiacea is divided into two orders.

Ex: Ascidia and Ciona, Herdmania, Botryllus.

CLASS 2. THALIACEA :-

1. These Urochordates are free-swimming and pelagic forms.
2. They are covered by transparent test.
3. The brachial and atrial apertures are placed at anterior and posterior ends.
4. Pharynx is small.
5. Gill-slits number is less.
6. Notochord, nerve-cord and tail are absent in the adult.
7. Asexual reproduction is by budding.
‘8. These are bisexual animals.
9. Tailed larva may be present or absent.
10. Alternation of generations can be seen in the life history.

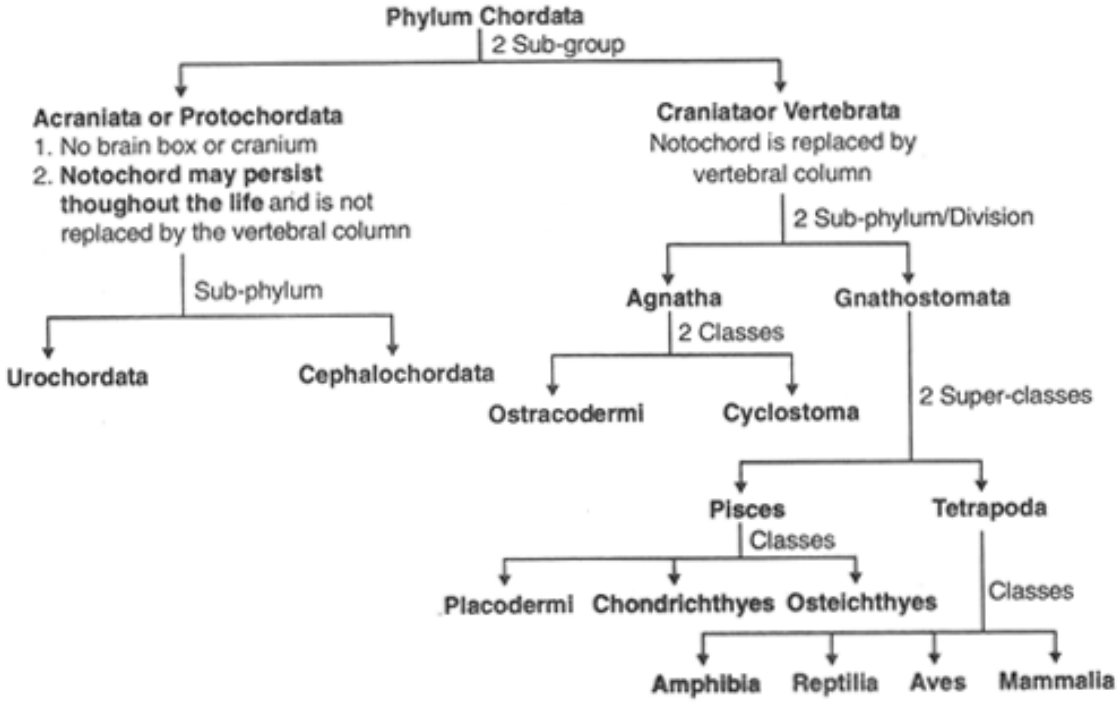
Ex :Doliolum, Pyrosoma (Luminescent colonial form), Salpa.

CLASS : 3 . LARVACEA (APPENDICULARIA)

1. These are free - swimming, pelagic tunicates.
2. True’ test covering is lacking
3. They show loose gelatinous house.
4. This house is useful for filter feeding.
5. Two gill slits re present.
6. Atrium is absent. ..
7. Notochord and nerve cord are Persistent
8. They show tail throughout their life.
9. Neotenic forms are included.

Ex: Oikopleura.

11. The classification of Phylum Chordata-



Primary Chordate Features-

1. **Presence of Notochord or Chorda Dorsalis**
2. **Presence of dorsal tubular central nervous system**
3. **Presence of branchial clefts or pharyngeal clefts**

Urochordata (tunicates)- sea squirts, salpians, larvacians.
Cephalochordata (lancelets)- Branchiostoma (Amphioxus)
Vertebrata (the vertebrates)- Have backbone of cartilage or bone. Brain is encased in protective skull.
Eight Vertebrate Classes-
1. Agnatha - jawless fishes
2. Placodermi - jawed armored fishes (extinct)
3. Chondrichthyes - cartilaginous fishes
4. Osteichthyes - bony fishes
5. Amphibia - Amphibians
6. Reptilia - Reptiles
7. Aves - Birds
8. Mammalia - Mammals