Biyani's Think Tank

Concept based notes

Diversity of Animals and Evolution

(Zoology Paper-I)

B.Sc. Part-I

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Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this Endeavour. They played an active role in coordinating the various stages of this Endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

Syllabus

B.Sc. Part-I (Zoology: Paper-I)

Diversity of Animals and Evolution

Section-A

Diversity of Animals

Zoogeographical distribution; principal zoogeographical regions of the world with special reference to their mammalian faunal; (2) Biodiversity of Fauna of India and world; (3) Adaptation to their modes of life and environment; (4) Conservation measures where required; (5) Continental drit.

Section-B

Diversity of Animals

1. General principles to taxonomy; concept of the five kingdom scheme.
2. Concept of Protozoa, Metazoa and Levels of organization.
3. Taxonomy of the basis classification of Non chordate and chordate symmetry, coelom, segmentation and embryogeny.
4. Detailed classification non-chordata and chordate habits and habitat of the prescribed types, viz, Amoeba, Paramecium, Euglena, Obelia, Sycon, Fasciola, Taenia, Nereis, hirudinaria, Palaemon, Pila, Lamelidens and Asteria, Balanoglossus, Amphioxus, herdmama, Petromyzon, Scoliodon, Labeo, any lung fish lchtyophis. Salamander. Frog Hemidactylus, Naja, Python, Crocodile, Pigeon, Great Indian Bustard, hare, camel Chinkara.

Section-C

Evolution

1. History of evolutionary thought (Lamarckism and Darwinism recalled).
2. Natural Selection (differential reproduction); genetic basis of evolution; speciation.
3. Variations, Isolation and adaptations.
4. Paleontology: fossils; geological divisions of the earth's crust; imperfection of the geological record.
5. Study of extinct forms: Dinosaurs, Archeopteryx.

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Content

Name of Topic
Section - A ■ Zoogeographical Distribution ■ Biodiversity of Fauna of India & World **Section - B** ■ Detailed Classification of Non-chordates & Chordates ■ General Principle of Taxonomy ■ Levels of Organisation **Section – C** ■ Evolution ■ Natural Selection ■ Variation ■ Adaptations ■ Study of Extinct Form ■ Isolation **Unsolved Papers 2011- 2008**

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Section A

Zoogeographical Distribution

Q.1 Write a short note on Palaearctic realm.

Ans.: Zoogeography is the study of geographical distribution of animal species. Such study indicates that the earth can be divided into several geographical regions, each having its own unique collection of animal species.

If we look at the map, we are surprised by the complementary shapes of America & Africa. This suggests that at one time America & Africa together with India, Australia and Antarctica were joined to form a massive super-continent. This has been called **Pangaea.**

Alfred Russel Walloce (1823-1913) first recognized that several major regions of the earth have distinctive faunas composed of taxonomic groups differing from those in adjacent regions. He named the largest of these zoogeographic realms, defined their geographic limits and listed the characteristic land animals in each. The regions area as follows:

Palaearctic region : It includes the northern part of old world extending over the whole of Europe, Asia, Japan, Mediterranean, and Manchuria etc. It has continuous boundaries with two of its neighboring realms, Ethiopian and oriental. This realm is chiefly temperate and includes both wet forest lands and dry open steppe, coniferous forest and tundra.

Due to climatic fluctuation, the fauna shows great variation. 135 families of terrestrial vertebrates include 33 families of mammals, 68 of birds, 24 of reptiles, 10 of amphibians & 13 of fishes.

(1) Mammals : They include a number of families of bats, two families of Myomorph rodents are endemic. Other mammals are beavers, moles, shrews, hedgehogs, pandas, pigs, squirrels, deer, dog and cat families.

(2) Birds : 17 of the 68 families of birds are more or less widely distributed while the rest are migratory exp. rails, hawks, herons, storks, ducks, wrens, cuckoos, kingfisher, woodpeckers, larks, swallows, thrushes, java, and crows.

(3) **Reptiles :** No single genus can be given the status of being endemic; lizards, tortoises, snakes etc. are included in this region.

(4) **Amphibians:** This fauna is rich with tailed representatives; exp. Necturus, Siren, Amphiuma, Proteus.

(5) **Fishes :** Freshwater fishes include Cyprinids, Catfishes, Analsantids, Channids etc.

The Palaearctic has been subdivided into four sub-regions :

(1) **Europeans Sub-region :** Comprises northern and central Europe, Black sea and Caucasus.

(2) **Mediterranean Sub-region :** Includes remaining part of Europe, North African and Arabian portions.

(3) **Siberian Sub-region :** Represented by Northern Asia, Alimalayan region.

(4) **Munchurain Sub-region :** Consist of Mongolia, Japan, Korea and Manchuria.

Q.2 Write a short note on Ethiopian and Oriental region.

Ans.: This includes Africa, South of Sahara, Madagascar and Southern Arabia. Sahara desert acts as a big barrier.

(1) **Mammals :** Short tailed monkeys (old world), anthropoids apes, elephants, camels, antelopes, giraffes, lions etc.

(2) **Birds :** Birds occupying this area have strong affinity towards the birds of oriented region. Of 67 families, 5 are worldwide, 3 shared with oriented region and 6 are exclusive. Hornbills, herons, thrushes, larks, parrots, swallows, ant eaters, bee eaters, guinea fowls etc.

(3) **Reptiles :** Numerous crocodiles and turtles, chameleons, spiny lizards and feylinds, typhlops, viperids.

(4) **Amphibians:** Represented by Bufonids, Ranids, Rhacophorids, Brevicipitids etc. The family Pipi dae is represented by Xenopus. The clawed toad which is confined to this region only. The tailed amphibians are absent.

(5) **Fishes:** Cat fishes, Cyprinids, Cyprinodonts and Cichlids, Protopterns.

Ethiopian region has been divided into following:

(i) **East African Sub-region :** Includes tropical Africa and Arabia.

(ii) West African Sub-region : Western part of Africa extending upto congo.

(iii) South African sub-region : Southern part of Africa.

(iv) Malagasy Sub-region : Includes Madagascar, Mauritius, Seychelles neighboring islands.

Oriental region : Includes India, Indochina, Sri Lanka, Burma, Thailand, Malaya, Sumatra, Java, Borneo, Taiwan, Philippines and South China.

Known for its varied physical features. It presents tropical and temperate regions both. Deserts and luxuriant tropical forests are equally prominent in this region.

Fauna resembles the Ethiopian region and the similarity is quite prominent and has compelled many to place both these regions in one group.

(1) Mammals : Of the 30 mammalian families, 4 are endemic, apes, pangolin, bamboo rats, elephants, rhinoceros, moles, deer etc. are commonly found.

(2) Birds : It includes 66 families of which 53 are widely distributed. Wood peckers hornbills, sunbirds, parrots, pigeons, pheasants honeyguides.

(3) Reptiles : Lizards, snakes, turtles are in plenty. Skinks, Chameleon, Varanus, Typhlops, pythons, viper, pitviper.

(4) Amphibians: Tailless amphibians are plenty though tailed ones are rare, Bufonids, Ranids, Hylids, Rhacophorids., Salamanders.

(5) Fishes: Fish fauna is dominated by carbs and at fishes. Other families are Notopteridar, Anabantid, Osteoglossids, Cypriniformes, Cobitildas, Nondidae.

The oriental region is divided into :

(i) Indian Sub-region : It includes central and northern India.

(ii) Ceylonese Sub-region : It includes Indian Peninsula and island of Sri Lanka.

(iii) Indo-China Sub-region : It includes China, south of Palaearctic boundary, Burma and Thailand.

(iv) Indo-Malayan Sub-region : It includes Malayan Peninsula and island of Malaya Archipelago.

The limits of each region and its fauna reflect the past history of animal groups and also of changes in earth's surface that either permitted or prevented animal migrations.

Q.3 Write a short essay on zoogeographical region.

Ans.: The regions are as follows :

(1) **Austrian :** Australian, Tasmania, New Guinea, New Zealand and oceanic islands of the Pacific. All monoframes, most marsupials (no placental mammals but bals and rodents), Emu, Cassowaries, brush turkeys, lyre birds, birds of paradise, most cockatoos, Australian lung fish. New Zealand has sphenodon and kiwi.

(2) **Oriental :** Asia South of Himalayas : India, Ceylon, Malay Peninsula, Sumatra, Borneo, Java, Celebes and the Philippines.

Tarsiers, macaq, gibbons, orangutan, Indian elephants and rhinoceros, Jungle fowl, peracock.

(3) **Ethiopian :** Africa including the Sahara Desert, Madagascan and adjacent islands. Gorilla, Chimpanzee, African elephant, rhinoceroses and lion, hippopotamus, zebras, giraffes, many horned antelopes, ostrich, guinea fowls, secretary bird. Many lemurs in Madagascans.

(4) **Neotropical :** South and Central America, Mexican lowlands and West Indies, Llama, alpaca, peccaries, arboreal sloths, armadillos, ant-eater, guinea pig., vampire bats, rheas, toucans, curassows and guans, most humming birds.

(5) **Nearcitic :** North America from the Mexican highlands to the Arctic island and Greenland. Mountain goat, prong-horned antelope, caribou muskrat.

(6) **Palaearctic :** Eurasia south to the Himalayas, Afghanistan, Persia and Africa north of the Sahara Hedge hog, wild boar fallow and roa deer.

The Australian region has evidently been is olated longest and has many unique animals and plants. Its mammals include the egg-laying monotremes and many marsupials, the latter having "radiated" into a great variety of forms from huge jumping kangaroos to small burrowing marsupial moles. There is much evidence to indicate that the great Asiatic land mass was for long a centre where various animal stocks originated and when they migrated to other regions. Thus the great flightless birds are now in southern regions, the emu and cassowaries in the Australian, the ostrich in the Ethiopian and the rheas in the Neotropical. Such discontinuous distribution occurs also with the tapirs in Malaysia and Central and South America. The limbless amphibians in the tropics of the New and Old worlds, and others. The Palaearctic and Nearctic regions are least separated and their faunas have much in common so that they are often combined as the Holarctic Region.

Holarctic Region : This is characterized by the elk (red deer), moose, bison, beaver, marmots, most bears and sheep, golden eagle, trouts and salmons.

The tiger occurs from India to Northern China, the opossum from South America into the United States, and the mountain lion and rattlesnakes through both the Americas. Various subdivisions of each region can be distinguished each with a more or less distinct fauna.

Biodiversity of Fauna of India and World

Q.4 What do you understand by the term Biodiversity?

Ans.: Biodiversity in the variety of species on earth Biodiversity can, however, be viewed at much similar and larger scales. We may wish to conserve as much genetic diversity as possible with in each species as insurance against future environmental change or new human uses of these resources. We may, therefore, wish to focus attention on genetically distinct subpopulations or subspecies such as heavy metal to leant strains of common grasses.

Q.5 What are the values of wild life conservation.

Ans.: Conservation includes all human efforts to preserve wild animals from extinction. It involves the protection and wise management of wild species and their environment. The conservation of wild life is of great importance.

If people ignore the need for wild life conservation, Doherty's endangered species will soon become extinct. Many other species will also face extinction. If this happens human beings will lose much of great value that cannot be replaced. Wild life is important to people for four main reasons.

(1) **Beauty :** Every kind of animal and plant differs form every other kind and thus contributes in a special way to the beauty of nature. Most people feel that such beauty enriches their life. It also heightens the enjoyment of camping and other forms of outdoor recreation.

(2) **Economic Value :** Wild species of animals and plants provide many valuable substances, such as wood and other plant products, fibres, meat and other foods and skins and furs. The financial value of wild life species is important to the economies of many nations. In industrialized nations, the recreational viewing of animals at zoos and wild life refuges is also a source of revenues.

(3) **Scientific Value :** The study of wild life provides valuable knowledge about various life processes. Such study has helped scientists understand

how the human body functions and why people behave as they do. Scientists have also gained medical knowledge and discovered important medical products by studying wild life. In addition by observing the effect of environmental pollution on animals, scientists have learned how pollution affects human life.

(4) **Survival value :** Every species of wild life plays a role in helping, maintain the balanced living system of the earth. These systems must continue to function if life is to survive. Thus the loss of any species can threaten the survival of all life, including human beings.

Q.6 What is the difference between Endangered and threatened species.

Ans.: **(A)** **Endangered Species :** These species face the most serious threat of extinction. They require direct human protection for survival. For ex. The California condor is endangered because only about so birds of this species still exist mot of them in captivity. In 1987 wild life biologists captured what was then the last remaining wild California condor. Since than more than 25 California condors have been born and revised in captivity and scientists have released some of these birds into the wild.

(B) **Threatened Species :** These are generally abundant in some areas, but still face serious dangers. These dangers may result from unfavorable changes in the environment. They may be also due to extensive hunting, fishing or trapping or even to hunting, fishing trapping or even to collecting by enthusiasts. The grey wolf, a threatened species, is plentiful in some places but its overall numbers worldwide are being steadily reduced by hunting trapping and poisoning.

Q.7 Write an essay on biodiversity.

Ans.: Biodiversity is the property of living systems of being distinct, that is different, unlike. Life comes in an almost infinite variety of forms. Species are in turn, formed by different kinds of populations, these by different kinds of individuals, and these by different types of organs, tissues, cells and genes. Biodiversity is not an entity, but a property, a characteristic of nature. Species, populations, certain kinds of tissues are resources but not their diversity as such. But diversity is a defining characteristic of life. Without diversity, life is not conceivable.

Types of Biodiversity :

Genetic diversity is the amount of genetic variability among individuals of a single species as also between species.

Species diversity refers to the variety of living organisms on earth and has been variously estimated to be between 5 and 50 million or more, though , only about 1.4 million have actually been described.

Ecosystem diversity relates to the variety of habitats, biotic communities and ecological processes in the biosphere as well as the tremendous diversity within ecosystems in terms of habitat difference and variety of ecological processes.

Some other categories of biodiversity are also known. They are named with reference to a specific ecosystem, species, etc.

Agrobio diversity is the component of biodiversity that is directly related to agriculture. It includes crop plants and their wild relatives, livestock and beneficial organisms such as pollinators, decomposers and predators which are normally associated with cultivated areas.

Endemic biodiversity refers to those forms of life that are exclusive to the given geographical area or ecosystem. For the sake of convenience, endemic biodiversity is often assessed within political boundaries. Islands for example are rich in endemic biodiversity.

Introduced biodiversity refers to diversity of micro-organisms, plants and animals that have been accidentally or deliberately transported by humans to landscapes, countries, regions or continents where they never occurred naturally. Disease causing organisms, weeds, insects, pests and rats are examples of introduced biodiversity.

Microbial diversity refers to the variety in micro-organisms such as virus, bacteria, yeast, amoeba and certain fungi.

There is so much diversity that one wonders where all this diversity came from. Fundamentally it derives from the properties of a variety of macromolecules, most notably DNA and proteins. Their characteristics made biodiversity possible.

All the tremendous and marvelous diversity of life emanates from the DNA molecule-the absence of a rule regarding the order in which the nitrogenous base pairs must occur along the chain. Since the order of the A - T and G – C does not matter from the physico-chemical point of view, one base pair can be substituted for another without affecting the thermodynamic stability of the molecule (mutation). But a shift in the order of the bases will affect the genetic code. Such a change can affect the characteristics of the protein that the modified gene makes. A change in the order of the amino acids can be (i) **Neutral,** (ii) **Lethal or semi-lethal** or (iii) **improved** (resulting protein is more efficient). The first type of mutation can accumulate and create diversity that apparently does not affect function. The second kind of mutations are eliminated by natural selection. The last type of mutation is the material that ultimately gives rise to all biological diversity. Arising from this variation at the DNA level, are the diversity of

populations, geographical races, species, and higher categories – genera, families, orders and classes.

This enormous diversity is disappearing at an alarming and accelerating rate: whilst it is estimated that early this century the earth may have lost one species a year, we are currently losing between one and 50 species a day. Industrialized countries, in particular, have suffered huge losses in the genetic diversity of their crops and domesticated animals. For example, since the turn of the century 97% of the varieties of 75 vegetable species in the U.S. have become extinct. Some scientists predict that if we continue current practices, the world will lose a quarter of all our biological wealth by the middle of the next century.

Q .8 Explain the factors responsible for the loss of biodiversity.

Ans.: Biodiversity is the property of living systems of being distinct, that is different, unlike. Life comes in an almost infinite variety of forms. Species are in turn, formed by different kinds of populations, these by different kinds of individuals, and these by different types of organs, tissues, cells and genes. Biodiversity is not an entity, but a property, a characteristic of nature. Species, populations, certain kinds of tissues are resources but not their diversity as such. But diversity is a defining characteristic of life. Without diversity, life is not conceivable.

The factors contributing to the loss of biodiversity are :

(1) Habitat Loss and Fragmentation : The number and size of relatively undisturbed ecosystems in the world have shrunk dramatically as global population and resource consumption have grown. For example, only 2% of the tropical dry forest along Central America's Pacific coast remains. Thailand lost 22% of its mangrove swamps between 1961 and 1985, largely due to prawn cultivation for export. Worldwide dams have destroyed large sections of river and shore ecosystems. A major cause of tropical rain forest loss in the expansion of marginal agriculture and utilization for commercial timber.

(2) Introduced Species : Introduced species are responsible for many recorded species extinctions especially on islands, In these isolated ecosystems, a new predator competition or pathogen, can rapidly imperil species that did not coevolve with the newcomer. In Hawaii, some 86 introduced plants seriously threaten native biodiversity-one introduced tree species has now displaced more than 30,000 acres of native forest.

(3) Over-exploitation of Plants and Animals : Throughout the world numerous forests, fisheries and wildlife resources have been over-

exploited sometimes to the point of extinction. Historically, both the great auk and the passenger pigeon succumbed to such pressure and the Lebanon cedar that once blanketed 5,00,000 hectares is now found only in a few scattered remains forest. Many 'big game' animals. Such as Sumatran and Javan rhinos, have been hunted to the verge of extinction. Many extinctions are linked to the harvesting of food by people, but the Qt fro collectors items, pets and curiosities has also obliterated some populations.

(4) **Pollution :** Pollutants put pressure on ecosystems and may reduce or eliminate populations of sensitive species. Contamination can reverberate along the food chain. Acid rain has made thousands of lakes and pools virtually lifeless, and in combination with other kinds of air pollution, has damaged forests throughout Europe. Marine pollution has affected the Mediterranean and many estuaries and coastal seas throughout the world.

(5) **Global Climate Change :** In the coming decades, a massive 'side effect' of air pollution-global warming –could play havoc with the world's ecosystems. Human caused increases in greenhouse gases in the atmosphere are likely to produce a global temperature rise of 1-3^{0}C during the next century, with an associated rise in sea-level of 1-2 metres. It is estimated that each 1^{0}C rise in temperature will displace the limits of tolerance of land species some 125 km towards the poles of 150 m vertically into the mountains. Many species will not be able to redistribute themselves fast enough to keep up with the projected changes, and considerable alterations in ecosystem structure and function are likely. Many of the world's islands would be completely submerged if the more extreme projections for rises in sea level prove to be accurate-wiping out their flora and fauna.

(6) **Industrial Agriculture and Forestry :** Onfarm diversity is shrinking fast as a result of modern plant breading programmes. Similar trends are transforming diverse forest ecosystems into high-yielding mono-cultural tree plantations.

Other immediate causes include the migration of farmers from over-populated areas to fragile ecosystems, the pollutions of wetlands, modern farming practices and the over-exploitation of resources to meet the ever increasing demands of the rich industrialized countries.

Industrial countries, which contain only 26% of the world's population, consume 80% of its energy and about 40% of its food. They also produce 68% of the world's industrial waste and 38% of the gases that we thought to cause global warming.

The excessive demands of the industrialized countries threaten biodiversity throughout the world, but the impact is particularly clear in the developing

world, partly because these countries have so much biodiversity to lose, and partly because exploitative practices are often imposed by commercial forces from the North. The affluent north has come to depend on the developing south to provide it with cheap raw materials such as timber, cocaine and plant and animal genes.

The replacement of myriads of species grown traditionally by new uniform crops is yet another cause leading to a loss of the genetic mosaic of local crops, wild plants and animals.

Q.9 Describe the biodiversity distribution at Indian and global level with its economic value.

Ans.: India is one of the richest nations in terms of biological diversity. The two factors responsible for this are-the variety of climatic zones and the existence of islands like the Andaman and Nicobar and Lakshadweep with their own variety of endemic species.

India is among the world's top twelve megadiverse nations. Given below are Tables to show the proportion of India's biodiversity of the world total and India's biodiversity in absolute numbers.

Countries leading in the Diversity of Species

Countries	No. of mammals	No. of birds	No. of reptiles	No. of amphibians
Indonesia	515	1519	600	270
Mexico	449	-	717	282
Brazil	428	622	467	516
China	394	1195	-	265
Peru	361	1703	297	251
Columbia	359	1721	383	407
India	350	1200	353	-

Comparison between the number of species in India and the World

Group	No. of species in India	No. of species in the World
Mammals	372	4231

Birds	1175	8400
Reptiles	399	5375
Amphibians	181	2000
Fishes	1693	23400
Insects	60000	800000
Flowering plants	15000	250000

Economic Value : Losses in biodiversity could have devastating economic effects. The number of species of plants and animals on which society depends is very narrow. Twenty species of plants and five species of animals account for over 90% of all human sustenance and international commerce in foodstuffs. Only 0.01% of all biodiversity has some human economic value. But the economic argument for the preservation of wild relatives of key domesticated species is: they represent a potential source of commercially useful genetic material, "germ plasm."

In the past century, scientific breeders of plants and animals have reached back into the evolutionary history of domesticated species to recapture useful genetic traits from their wild relatives- sometimes from the true ancestral species, sometimes from evolutionary cousins. Resistance to disease, pests or stress, nutrients balance, growth from and fruit shape or quality have been developed in crops through hybridization with wild relatives, followed by complex breeding programs to combine desired traits in a single strain. Improved breeds of domesticated animals have sometimes been developed in the same way. The molecular and cellular techniQ of biotechnology have already begun to speed this process immensely.

But what about the multitude of wild species- the vast majority of both the plant and animal kingdoms-that have no domesticated or commercially valuable relatives? At least two general classes of economic arguments have been advanced for the preservation of these "unexploited" species. First, some of these species, in themselves, may prove to be of direct commodity value or productive use value in the human enterprise, or alternatively, may be valued for their potential commercial usefulness at some future time (an aspect of option value). The second class of economic valuations rests on attempts to estimate the non-commodity (or non-market or amenity) value of species, or of biodiversity itself, as measured by the degree to which people consider the economic value of places, services, or experiences to be increased by the presence or existence of species or by biodiversity.

Few would base the argument for the commodity value of currently unexploited species on the prospect that important, totally new food plants are likely to be discovered among wild species- although many known food plant species with

excellent nutritional value and promising ecological characteristics are under-utilized. Prospects for the discovery of novel biochemical compounds, however, have motivated several well-funded, intensive commercial surveys of pharmacologically or biologically active natural plant and animal products for possible use as drugs, biocides, and industrial biochemicals. Some of these efforts focus on plants used in the practice of folk medicine in traditional cultures, whereas others are simply broad surveys of plant material collected more or less at random, especially in tropical forests. There are concerns, however, that the advent of computer-designed molecules and the techniQ of genetic engineering may displace these efforts in the pharmaceutical industry.

Q.10 What do you understand by wildlife? Write down the values of wildlife conservation.

Ans.: Wildlife is defined as "the uncultivated flora and the undomesticated fauna amongst the plants and animals". According to Dr. Mahajan, wildlife is any form existing in natural surrounding.

Throughout history wildlife has suffered because of human beings and their activities. The invention of increasingly efficient weapons, such as the bow and arrow and, later, the rifle and shotgun, enabled people to kill game with growing ease. With the help of these advances, hunters have killed off some kinds of animals. People have also cleared forests, drained swamps, and dammed rivers to clear the way for agriculture and industry. These activities have seriously harmed or destroyed many habitats for wild plants and animals. In addition, human pollution of the environment has affected a number of wild species.

Various species had become extinct even before people appeared on the earth. In the past, however, other species developed and replaced those that died off, and the total variety of life did not diminish. Today, human activities kill of species with no hope for their replacement, and so the variety of life decreases.

Since about 1600, many kinds of wildlife have become extinct. For example, the dodo (Mauritius) became extinct in 1680, the yellow-headed macaw (Jamaica) in 1765, Stellar's sea cow (Bering Sea) in 1767, and the great auk (North Atlantic) in 1844. Many Australian animals became extinct in the 1800's. They include big-eared hopping mice, broad-faced rat kangaroos, brown hare wallabies, Darling Downs hopping mice, Tasmanian emus, and white-tipped stick-nest rats. Species that probably became extinct in the early 1900's include paradise parrots, pig-footed bandicoots and toolache wallabies. The Tasmanian tiger has not been sighted since 1933.

Beginning in the late 1800's, growing concern for the world's vanishing wildlife has led to increased conservation action. The governments of many nations have

passed protective laws and set aside national parks and other reserves for wildlife. Such efforts have saved the American bison, the pronghorn antelope, and many of the rare plants found on such islands as the Hawaiian and Galapagos islands.

However, several hundred species of animals and thousands of species of plants still face the danger of extinction. Such animals include the Asiatic lion, the Bengal tiger, the blue whale, the orangutan, the mountain gorilla, the whooping crane, the California condor, the ivory –billed woodpecker, and all the Asian **Rhinoceroses.** Plants that are facing extinction include the big leaf palm (Madagascar), the Chiapas slipper orchid (Mexico) and the green pitcher plant (Southern United States).

Values of Wildlife Conservation : If people ignore the need for wildlife conservation, today's endangered species will soon become extinct. Many other species will also face extinction. If this happens, human beings will lose much of great value that cannot be replaced. Wildlife is important to people for four main reasons: (1) beauty, (2) economic value, (3) scientific value and (4) survival value.

Beauty : Every kind of animal and plant differs from every other kind and thus contributes in a special way to the beauty of nature. Most people feel that such beauty enriches their life. It also heightens the enjoyment of camping and other forms of outdoor recreation.

Economic value : Wild species of animals and plants provide many valuable substances, such as wood and other plant products, fibres, meat and other foods, and skins and furs. The financial value of wild species is important to the economics of many nations. In industrialized nations, the recreational viewing of animals at zoos and wildlife refuges is also a sources of revenue.

Scientific Value : The study of wildlife provides valuable knowledge about various life processes. Such study has helped scientists understand bow the human body functions and why people behave as they do. Scientists have also gained medical knowledge and discovered important medical products by studying wildlife. In addition, by observing the effect of environmental pollution on wild animals, scientists have learned how pollution affects human life.

Survival Value : Every species of wildlife plays a role in helping, maintain the balanced, living systems of the earth. These systems must continue to function if life is to survive. Thus, the loss of any species can threaten the survival of all life, including human beings.

Classifications of Scarce Wildlife : Wildlife biologists use three main classifications for animals and plants that face possible extinction: (1) endangered, (2) threatened and (3) rare.

Endangered species face the most serious threat of extinction. They require direct human protection for survival. The California condor is endangered because only about 50 birds of this species still exist, most of them in captivity. In 1987, wildlife biologists captured what was then the last remaining wild California condor. Since then, more than 25 California condors have been born and raised in captivity, and scientists have released some of these birds into the wild.

Threatened species are generally abundant in some areas, but still face serious dangers. These dangers may result from unfavourable changes in the environment. They may be also due to extensive hunting, fishing, or trapping, or even to collecting by enthusiasts. The grey wolf, a threatened species, is plentiful in some places, But its overall numbers worldwide are being steadily reduced by hunting, trapping and poisoning.

Rare species have small populations. They live in protected environments, and their numbers are not decreasing. The torrey pine tree is classified as rare. It grows only I two small areas of southern California, but human actions do not threaten or endanger its survival.

Methods of Wildlife Conservation : The method used to protect wildlife depends on the danger to the threatened species. In many cases, wildlife can be helped by ensuring that their environment provides enough food, water and shelter. This method called habitat management, involves soil conservation, good forestry practices and water management.

Many species of wildlife have been threatened by human destruction of their habitat. For example, some swamps and marshes have been drained and converted into farmland. Poor farming practices may also destroy land, or the spread of cities and industries may pave over former wildlife habitats. Pollution may poison the air, water, plants and animals. To save wildlife habitats, people must control pollution and set aside areas in which wild animals and plants can survive.

An animal threatened by too much hunting can be protected by laws that forbid or regulate such killing. These laws may specify when a certain species may be hunted or how many of the species may be killed. Laws can also protect plants endangered by over-collection. If an entire habitat requires protection, the area may be made a national park or wildlife refuge. In some cases , predatory animals that kill an endangered species must be controlled until the endangered animal has increased in numbers. On the other hand, a species may become too numerous. When this happens, the animal may threaten its own survival-or the survival of other species –by eating too much of the food supply. This problem has occurred with elk and hippopotamuses in national parks. The numbers of such a species must then be reduced, either by controlled hunting or by restoring its natural enemies where they have become scarce.

If a species can no longer survive in its natural environment, it may be raised in captivity and then released into a protected area. This method saved the Hawaiian goose. Likewise, conservationists hope to save the black-booted ferret. This small mammal once lived throughout the Great Plains of North America, but its population declined sharply during the 1900's. Scientists captured all known ferrets in to the wild, these animals have established new breeding populations.

A species threatened by disease may be helped by sanitation measures in its habitat. Rare plants can be maintained in botanical gardens, or their seeds can be saved in seed banks for future planting.

The success of wildlife conservation depends on a knowledge of the **ecology** of a species. In other words, it requires an understanding of the way in which a species lives, and how it relates to everything, both living and nonliving, in its environment.

International cooperation in wildlife conservation began on a worldwide scale after the birth of the United Nations (UN) in 1945. The FAO and UNESCO set up wildlife conservation. Union of Nature and Natural Resources (IUCN), now better known as the World Conservation Union, to support worldwide conservation. As part of the international programme, the IUCN started to gather information on the endangered species of the world. It publishes this data in its Red Data Book. In 1961, IUCN helped to set up the World Wildlife Fund (now the Worldwide Fund for Nature).

Wildlife Conservation Today : There are more than 1,200 national parks, wildlife reserves and similar protected areas throughout the world. In addition most countries have laws that protect wildlife.

An international treaty designed to protect wildlife from being threatened by international trade was set up in 1975. It is known as the Convention on International Trade in Endangered Species of Wildlife, Fauna and Flora or CITES. The trade of moving live plants and animals and their products in the world has been responsible for large declines in the number of plants and animal species. CITES is designed to control and try to prevent this trade.

Wildlife Conservation in India : The Indian Wildlife possesses a rich and diverse fauna and is unique in having immense natural beauty in its different ecosystems. The fauna includes about 123 families of terrestrial vertebrates. An estimate puts the number at 400 mammals, 1200 species of birds, 350 species of reptiles and more than 29,70,000 species of insects.

The animals that make up the Indian fauna are Elephant, Rhinoceros, Musk deer (Kastura), Barking deer (Kotra), Spotted deer (Cheetal), Hog deer (Hoghiram), Mouse deer (Indian chevrotain), Swamp deer (Bara singha), Dancing deer (Sambur) Thamin, Kashmir stag, Four-horned antelope (Chausingha), Indian

Gazelle (Chinkra), Blue bull (Nilgari), Bison, Wild buffalo, Himalayan ibex or wild goat (Capra siberica), Wild boar, Wild ass, Nilgiri tahr, Lion, Tiger, Leopard, Striped hyaena, Nilgiri langur (Ceropithecus johni), Lion tailed macaque (Macaca silenus) Rhesus monkey (Macaca mulatto), Hanuman monkey (Semnopithecus cristatus), Indian giant squirrel (Ratufa indica), Porcupine, Pangolin, Peafowl (Pavo cristatus), Jungle fowl, Patridge, Quail, Great Indian bustard (Choriotes nigriceps), Duck pigeon, Sand grouse, Storks and Egrets, Pelicans, Eagle, Crane, Owl, Hornbill, Crocodiles, Gharials, Lizards (Uromastic) and about 216 species of snakes.

Q.11: Write down the status of endangered species , Natural parks and sanctuaries in India.

Ans.: A 1986 list contained the following species that were threatened with extinction.

These species face the most serious threat of extinction and require direct human protection for survival.

In India, several laws have been passed and sanctuaries and national parks have been established for the protection of the dwindling wildlife. India was probably the first county to enact a Wildlife Protection Act. The Wild Birds and Animals Protection Act was passed in 1887 and repealed in 1912. For game protection in the states, in 1927, the Forest Act XVI was enacted. Indian Board for Wildlife was established in 1952 and this was followed by setting up of Wild Life Boards in different States in India. In 1972, a new Wildlife Protection Act was passed. Under this Act, possession, trapping, shooting of wild animals alive or dead; serving their meat in eating houses; their transport and export are all controlled and watched by special staff (Chief Wildlife Warden and authorized officers). This act prevents hunting of females and young ones. Under this Act, the threatened species are absolutely protected and the rest afforded graded protection according to their state of population size.

In India, nearly 200 sanctuaries and national parks have been established for wildlife management. Sanctuaries are places where the killing and capturing of any animal is prohibited except under orders of the authorities concerned. National Parks are set up for preserving flora, fauna, landscapes and historic objects of an area. Some well known wildlife sanctuaries and national parks of India are :

Kaziranga Wildlife Sanctuary : It was established in 1926 in the district of Sibsagar, Subdivision Jorhat (Assam) on the southern bank of the Brahmaputra river. It covers an area of 430 sq. kms of forest grasslands and swamps and supports a fauna of 700 Rhinoceros, besides elephant, wild buffalo, bison, tiger,

leopard, sloth bear, sambhar, swamp deer, hog deer, barking deer, wild boar, gibbon and birds like pelican, stork and ring-tailed fishing eagles.

Manas Wildlife Sanctuary and Tiger Reserve : It is located in the district of Kamrup in Assam, covering an area of 540 sq. kms. and is situated at an altitude of 80 metres. The River Manas runs through this sanctuary. It contains the following wild animals : tiger, panther, wild dog, wild bear, Rhinoceros, gaur, wild buffalo, sambhar, swamp deep and golden langur.

Jaldapara Wildlife Sanctuary : It is situated in the Jalpaiguri district of West Bengal and covers an area of 65 sq. kms. of grassland. Wildlife fauna includes animals like Rhinoceros, gaur, elephant, tiger, leopard, deer and a variety of birds and reptiles.

Palamau National Park : It is situated in the Daltongunj district of Bihar and has an area of 345 sq. km. The fauna of this include tiger, panther, sloth bear, elephant, chital, gaur, nilgai, chinkara, chowsingha and mouse deer. The flora is thick tropical forests.

Hazaribagh National Park : This national park was established in 1954 in Bihar. It has an area of 184 sq. kms of thick tropical forests. The typical fauna of this park includes wild boar, sambhar, nilgai, tiger, leopard, sloth bear, hyaena and gaur.

Simlipal National Park : It is situated in the district of Mayuri Bhanj in Orissa and has an area of 2750 sq.km. of thick tropical forests. The typical fauna of this park includes wild boar, sambhar, nilgai, tiger, leopard, sloth bear, hyaena and gaur.

Chilka Lake : This largest inland lake has an areqa of 1000 sq. kms. and is about 100 kms. from Bhubaneshwar (Orissa). Its fauna includes waterfowl, duck, cranes, ospreys, golden plover, sandpiper, stone curlews, flamingoes, etc.

Kolameru Bird Sanctuary : This is a small bird sanctuary near Tadepallegudam in Andhra state. It is a breeding place for pelicans and many marine birds visit this place.

Vedanthangal Bird Sanctuary : This small-sized but very old sanctuary extends over a lake of about 0.30 sq. km., 85 km from Chennai. Many migratory birds regularly visit this temporary lake. The regular visitors of this lake are birds like spoon bills, open billed storks, egrets, ibis, cormorant, darter, grey heron, pelicans, snipes and db chicks.

Guindy National Park : It is situated near Chennai city and has mainly chitals and black bucks. A few albinos of black buck are also found here.

Point Calimer Wildlife Sanctuary : This is situated at the southern tip of the Thanjavur district of Tamil Nadu abutting the Palk Strait. Its backwater and

lagoon is visited by flamingoes and pelicans. It is close to the Vedaranyam forests which has a fauna of numerous black bucks, chitals and wild boars.

Mundanthurai Sanctuary : It is situated in the Tirunelveli district of Tamil Nadu and was established in 1964. It covers an area of 520 sq. km. The Tamaraparani river flows through the evergreen forests of the sanctuary. Panther, tiger, sambhar and chital form the major fauna of this sanctuary.

Periyar Wildlife Sanctuary : Situated in the state of Kerala, this sanctuary covers an area of 777 sq. km. It was established in 1949 around the artificial lake which arose behind the dam built across the Periyar river in 1900. This sanctuary of great scenic beauty supports a fauna of wild elephants, gaurs, leopoards, sloth bear, sambhars, barking deer, wild dogs, wild boars, black Nilgiri langur and water birds like grey hornbills, egrets.

Mudumalai Wildlife Sanctuary : This wildlife sanctuary was established in 1940 in North Western part of Nilgiri in Tamil Nadu. It is known for its rich forests and diversity of fauna that includes wild elephants, gaur, sambhar, chital, barking deer, mouse deer, four-horned antelope, tiger, panther, bonnet monkey, langur, giant squirrel, flying squirrel, wild dog, jackal, wild cat, sloth bear, porcupine, pangolin flying-lizard, monitor lizard, rat snake, python and various birds.

Ranganthittu Bird Sanctuary : It covers an area of 166 sq. km. and includes a series of islands in the Cauvery river 15 kms of the Bangalore-Mysore road, near Shrirangapatnam. Its avaial fauna includes open bill stork, white ibis, egret, spoon bill, wild duck, peafowl, night heron etc.

Bandipur Wildlife Sanctuary : This sanctuary was established in 1941 by the then ruler of Mysore (Karnataka State). It is situated 80 km south of Mysore city enroute to Octacamund. It has an area of 874 sq. km. and is at an altitude of 1454.4 metres. Its forest is very thick and has plenty of rainfall. Its wildlife fauna includes plenty of gaurs and animals like elephant, leopard, sloth bear, wild dog, chital, panther, barking deer, porcupine and langur.

Cotigao Wildlife Sanctuary : It is located in South Goa and has an area of 105 sq. km. It has wet evergreen forest of Elve and Berla trees and supports rich fauna of the following animals : gaur, sambhar, chital, hog-deer, barking deer, wild boar, hyaena, panther, leopard, jackal, otter, porcupine, and birds like parakeet lorokeet, woodpecker, kingfisher, bulbul, jungle fowl, egret, etc.

Bhagwan Mahadev Wildlife Sanctuary : Its is located in North Goa and has an area of 240 sq. km. and supports fauna almost similar to Cotigao Wildlife Sanctuary.

Sesan Gir : This famous wildlife sanctuary for the Asiatic lion is situated in Gujarat state, 468 km from Ahmedabad and 43 km form Veraval. It has an area of 1295 sq. km. of semi-arid country with patches of thorn scrub and deciduous

trees. Its fauna includes Asiatic lion, spotted deer, blue bull (nilgai), four-horned antelope, chinkara, striped hyaena, wild boar, porcupine, langur, python, crocodiles and birds like green pigeon, partridge, rock-grouse, etc.

Kanha National Park : This national park was established in 1955 in former Banjar Valley Reserve (Madhya Pradesh). This park has an area of 939.94 sq. km. and includes hilly terrain and streams. It is 175 km away from Jabalpur and has forests of sal trees. Its typical fauna includes animals like tiger, chital, panther, sambher, black buck and barasingha.

Tandoba National Park : It is located in Chandrapur district (Maharashtra) and an area of 116 sq. km. Its fauna include tiger, sambhar, sloth bear, bison, chital, chinkara, barking deer, blue bull, four-horned deer, langur, peafowl and few crocodiles.

Sariska : This is one of the most beautiful sanctuaries situated in the state of Rajasthan near Alwar. It has an area of 800 sq. km. and has dense Dohokara and Solar forests. Its fauna include tiger, leopard, spotted deer, jungle cat, four-horned antelope, langur, porcupine, hedgehog, peafowl, etc.

Bharatpur Bird Sanctuary (Koeideo Ghana) : It is located in Bharatpur district in Rajasthan, has an area of 29 sq. km. and harbours all kinds of indigenous birds like nesting water birds, weateside birds and migratory birds. More than 328 varieties of birds including cormorants, spoonbills, white ibies, Indian darters, egrets, painted storks, open billed storks, great black necked stroks, etc. Many migratory birds like ducks, geese, Siberian cranes, etc. regularly visit this sanctuary. Drier parts of this marshy sanctuary have animals like spotted deer, black buck, sambhar, blue bull, wild boar and python.

Sultanpur Lake Bird Sanctuary : This small sized (2 sq. km.) bird sanctuary is located in Gurgaon district (Haryana) about 30 km from Delhi. Its typical avain fauna includes crane, sarus, spot-bill, rudyshell and drake.

Shikari Devi Wildlife Sanctuary : It is located in Mandi district in Himachal Pradesh. It has an area of 213 sq. km. and has the following animals : snow leopard, flying fox, black bear, barking deer, musk deer, chakor, partridge, etc.

Bir Motibagh Sanctuary : It is located near Patiala in Punjab. The fauna includes black buck, blue bull, hog deer, hare, jackal and birds like peafowl, partridge, sparrow, babbler, myna, parakeet, pigeon, dove, etc.

Dancing Wildlife Sanctuary : It was established in 1951 in Kashmir, 26 km. away from Srinagar. It has an area of 89 sq. km. and has two levels : Upper Dachigam at 3692.3 metres altitude and Lower Dachigam at 1846.2 metres altitude. It mainly preserves hangul of Kashmir stag, musk deer, leopoard, black buck, black bear, brown bear and baboon.

Corbett National Park : It is one of India's most famous wildlife sanctuaries and was constituted in 1935 as the first national park of India. It is situated between National and Gharwal districts in Uttar Pradesh. It has an area of 525 sq. km. and is located within west-south bend of the river Ramgana. It supports a rich and diverse fauna of the following : tiger, panther, sloth bear, hyaena, elephant, blue bull, swamp deer, barking deer, Indian antelope, porcupine, birds like bulbul, wood peckere, barbet, babbler, bee eater, and reptiles like crockodile, python, etc.

Shivpuri Sanctuary : It is located in Madya Pradesh and is an asylum for tigers.

Annamalai Sanctuary : This sanctuary was established in 1972 in the southern part of Coimbatore district in Tamil Nadu. It has an area of 958 sq. km. and supports rich fauna of animals like elephant, gaur, sambhar, spotted deer, barking deer, nilgai, Nilgiri langur, Nilgiri tahr, lion-tailed macaque, tiger, panther, sloth bear, porcupine and pangolin.

These are some of the major sanctuaries in India. There are several smaller sanctuaries and national parks that house some of the important species. A sanctuary or a national park may be large or small, but planning should be based on a scientific background. To provide the basic needs for the wildlife the following steps may be taken as far as possible for conservation purpose :

(i) The forest inside the sanctuary / national park should be left unexpected as far as possible. It would be an ideal environment for the wildlife to get the fullest measure of protection and in such preserved conditions of life they can multiply freely.

(ii) If total unexploitation is not possible, the cutting operations of the forest should be in small units, well-distributed over the forest. Frequent light cuts are generally better for wildlife than infrequent heavy cuts.

(iii) The forest should not be planted with or allowed to grow only a single species of plant. Further, fruit-bearing shrubs and trees should be encouraged wherever possible and the natural openings of the forests should be preserved.

(iv) Poaching needs to be ruthlessly prohibited in the sanctuaries in particular and generally in other areas outside them, where wildlife still exists. Mobile armed units should be attached to all sanctuaries to patrol regularly the entire sanctuary to stop illegal activities.

(v) The water holes and stream sides should be managed and guarded carefully for the benefit of wildlife. Such criteria areas may be of small size, but their importance is disproportionately great because they supply important elements in wildlife ecology for larger areas during hot months of the year.

(vi) Annual burning of the grassland in most of our sanctuaries has become an integral part of management, since not burning these might bring about a lack of suitable fodder during the hotter months. Controlled burning has been found to increase forage and to preserve organic material in the soil. Such burning may be done in blocks with unburned areas in between, so that areas are burnt in rotation. The burning is to be confirmed to definite blocks by means of five-breaks. Burning at night is favored unless it is likely to extend the fire beyond the desired limits.

(vii) Provision for dust bath for animals should also be made by leaving some exposed soil for their dusting. These spots may be prepared in the form of small mounds elevated a few inches from the forest floor to allow for drainage and to dry quickly in wet months.

(viii) Some artificial salt-licks are also to be provided in the sanctuaries since the wildlife need them at regular intervals for their normal health. Such salt-licks are necessary for animals especially in areas where natural salted clay is scanty.

(ix) Concentrated grazing by domestic live-stock is to be prevented as wildlife can never complete with domestic stock under ordinary circumstances and domestic animals may be responsible for transmitting diseases like foot-and-mouth diseases, rinderpest, surra (sleeping sickness), heamorrhagic septicemia, anthrax etc.

(x) Cultivation near the sanctuary should be avoided as a rule as it may have an indirect effect on the wildlife. The chemical control of certain pests is often desirable for better yield in agriculture, but these pesticides can present ecological hazards for wildlife.

(xi) Scientific studies of the sanctuary, wildlife particularly of threatened species, by qualified persons should be encouraged in order to improve the status of the animals even by breeding them in capacity to rehabilitate them in suitable habitats.

Most wildlife could be saved by sufficient rigid protection of their natural habitat, combined with controlled exploitation of species which are of economic importance.

Some wildlife may be driven away from their natural habitats so that their requirement are not in conflict with human interests. The only possible course for maintaining their viable number is in natural parks, sanctuaries, game reserves, where they could thrive unharmed.

In the case of the most endangered species which have reached a point of extinction in their favorable habitat, their survival may be ensured through the maintenance of breeding stock in zoological parks in suitable parts of the country.

In spite of the many conservation efforts, the future remains uncertain. The continued growth of the human population, the destruction of wildlife habitats, and the spread of environmental pollution pose an increasing threat to the survival of wild species.

Q.12 Write down about the Ex- situ conservation strategies.

Ans.: Recognition of the world's shrinking biological heritage has promoted numerous reactions, both at international and national levels, as well as within local communities. Several international agreements and technical measures are being promoted to conserve the biodiversity left in the world's forests, wetlands, coastal waters and in farmer's field.

The 1992, United Nations Conference on Environment and Development (UNCED) provided important guidelines and international legally-binding instruments for governments to tackle the more immediate and fundamental causes of a biodiversity loss. Agenda 21 is a comprehensive action plan for the 1990s and beyond, adopted at the Conference by the international community. It presents a set of integrated strategies and detailed programmes to halt and reverse the effects of environmental degradation. The Conference's Convention on Biological Diversity and the Climate Convention can also potentially help decision-makers to re-orientate national policies towards more environmental sound and sustainable development.

On the practical level, several complementary methods are being used to conserve biodiversity with different degrees of success. These methods can be divided into two broad categories: in situ conservation, which means conserving plants, animals and micro-organisms within their natural habitat; and ex situ conservation, which means maintaining living organisms out of their natural habitat, either as whole living organisms or as parts (cells, sperm, seeds, etc.).

Ex Situ Conservation : There are three main methods of ex situ conservation used for plants : genebanks, field gene banks and tissue culture. Zoos and cryopreservation are important means for ex situ conservation for animals.

Genebanks : Genebanks are vast refrigerators where seed samples are stored under controlled humidity and temperature conditions. Under the recommended storage conditions, some seeds can survive for up to a hundred years, but regular checking for viability and damage is necessary. Samples of crop varieties must be grown out before the seeds begin to deteriorate so that a fresh generation of seeds can be obtained for continued storage. Wild species are more difficult to handle during this regeneration process as the conditions required to germinate them are often unknown.

Some 3.9 million seed samples are held in genebanks around the world but, given the challenges of keeping seeds viable, not all are healthy. Seeds lose viability if they are not grown out regularly; cold storage can affect the genetic material in the seed; and simple mismanagement, like a power failure, can endanger the materials stored. A 1989 evaluation of the US central seed bank disclosed the alarming information that of all the stored seed samples, only 28% had been recently tested and found healthy. The rest of the collection had not been tested for at least five years, contained too few seeds to risk testing, or was already dead. In 1991, representatives of 13 national germplasm banks in Latin America announced that between 50% and 100% of the maize seed collected between 1940 and 1980 was longer viable.

The network of International Agricultural Research Centres (IARCs) is one of the most important ex situ repositories of agricultural biodiversity, with some four and a half billion seeds from around the world.

Filed Genebanks : Plant species that do not easily produce seeds, and those with seeds that cannot be dried without injuring them (such as mango, cocoa, avocado and nutmeg) are usually conserved in field genebanks. These include botanical gardens arboreta, plantations and other areas of land in which collection of bananas, plantains, coffee and oil palms were established long ago in field genebanks.

Tissue Culture : Plant tissue culture involves growing plants in tubes in nutrient-rich jelly, and is well suited for mass cloning of a single species or crop variety. Crops and wild relatives that reproduce veretatively (e.g. potatoes, cassava, sweet potatoes), or have seeds that cannot be dried without injuring them, can also be maintained this way.

Zoos : Zoos can contribute to the conservation of individual animals species, especially those that are critically endangered. Zoo collections sometimes include individuals of species which have entirely disappeared from the wild. These captive specimens therefore represent an important part of the remaining genepool which may be used in the future to supplement wild populations, or to build entirely new populations. Some well-known reintroduction projects involving zoo-born animals include the European bison in Poland, the Hawaiian goose in Hawaii, the golden lion tamarin in Brazil and the eagle owl in various European countries.

Perhaps the most important contribution zoos make to conservation is though their public education role. Zoos attract many more visitors than most natural history museums, botanical garden and other comparable nature-oriented institutions. Worldwide, the existing 1000 or so zoos annually receive 600 million visitors – over 10% of the world's entire population. Living animals exhibited in zoos clearly have an enormous power of attraction.

Genetic Engineering : Advances in gene manipulation techniQ mean that, for commercial and therapeutic reasons, genes in any form are now an important focus for conservation strategies. These developments signify a shift away from conserving individual cells and genes. Since genes can now be isolated and stored outside the organism they derive from, ex situ conservation is taken a step further away from the natural habitat. The Human Genome and Human Genone and Human Genome Diversity Projects have added yet another dimension to biodiversity conservation, and have put the spotlight on human genes as an important new resources.

Q.13 Write down about the In-situ conservation methods with the convention foe biodiversity.

Ans.: The in situ approach to conservation aims to preserve whole tracts of land and water so that ecosystems and diversity among species can thrive and continue to evolve. National Parks and other protected areas are the vehicles for this approach.

There are now close to 8500 major protected areas throughout the world. These are widely distributed across continents. Worldwide, the growth in national parks and protected areas has been relatively rapid over the last two decades. Protected areas now exist in 169 countries. Strictly protected areas (such as national parks and strict nature reserves) constitute 3% of the earth's surface. At least another 40,000 protected areas of various sorts have been established that do not meet internationally recognized criteria, but which contribute to biodiversity conservation. This brings the total protected land area up to almost 10%.

Accordingly to the Fourth World Congress on National Parks and Protected Areas held in Caracas in 1992, each country should now designate a minimum of 10% of each biome under its jurisdiction (e.g. oceans, forests, tundra, wetlands, grasslands, etc.) as a protected area. Many countries have already classified more than 10% of their territories as protected area. These include Cost Rica with 29%, Honduras with 22%, Bhutan with 22%, Botswana and Panama with 18%, Guatemala with 16%, Nicaraguna with 14%, Central African Republic with 12%, Malaysia, Benin and Tanzanie with 11.5%, Senegal with 10.8% and Rwanda with 10.4%.

Conventionally, the establishment of protected areas has involved the displacement of local people, but increasing moves are being made to involve local communities and to integrate their development needs into conservation strategies.

The Biodiversity Convention : On December 29, 1993, a legally binding Convention on Biological Diversity came into force. It was heralded as the most

important imitative ever taken to set the world on a course towards environmentally sustainable development.

The Convention is a global instrument committing signatory nations to work together towards conserving biodiversity, but it also recognizes national sovereignty and the right of countries to benefit from their biological resources. Further, it highlights the right countries to have access to technologies, including new biotechnologies, that could assist the conservation effort or that may use in the exploitation of biological resources.

The Convention was drawn up in preparation for the 1992 UN Conference on Environment and Development (UNCED). By October 1995, 128 countries and the EU had signed the treaty. Its negotiation has turned into a political battle between Northern and Southern countries. Southern states demand compensation for the use by other parties of biological resources that originate within their territories. One of the mechanisms proposed for achieving this is the provision of access to new biotechnologies to help in conservation or resource use. Some Northern states, however, see this as piracy and insist on intellectual property rights for their biotechnologies – without this recognition, they see innovation and research being stifled. It is largely concerned over this issue that has till date prevented the US from signing the agreement.

UNCED was only the start of the biodiversity convention process and the negotiations continue through annual meetings of the Conference of Parties. Progress is slow and tortuous, partly because like 'as far as possible' and 'as par as appropriate', leaving it open to interpretation. The issues of rights to, and ownership of, genetic resources are providing the most problematic for negotiators.

GATI and Biodiversity : The General Agreement on Tariff and Trade (GATI) is a set of rules and a dispute – solving mechanism for trade negotiations. It was drawn up in 1947in an attempt to try to avoid the kinds of trade conflicts that were partially responsible for the two World Wars. Then, as now, the conflict were over access to raw materials and access to markets. GATI was originally a side agreement tagged on to the more substantial rules laid out by the International Trade Organization (ITO), which was set up at the same time.

GATI has been renegotiated several times since 1947, and it has turned into a very different beast. The 'Uruguay Round' of GATI, so-called because the negotiations first took place in Uruguay, began in 1986 and culminated in Morocco in 1994 with the formation of the World Trade Organization (WTO). The WTO is a 'super-GATI' – a formal, permanent organization instead of an agreement. The WTO is much more powerful than GATI, and is set to impose tight controls over the new, stricter and more inflexible rulebook governing trade negotiations.

GATI and the WTO will have several impacts on biodiversity conservation and management. Firstly, GATI is bad news for the environment because unilateral stances taken by one country against another for environmental reasons can be seen as a violation of free trade. At present, countries can overrule GATI, but this will not be possible with the WTO unless all the other members except the country in Qtion agree to disregard the ruling. In theory, the WTO could be beneficial for the environment since it has the power to establish trade rules that penalize parties conducting activities that are detrimental to the environment. However, given that GATI is a trade agreement, not an environmental one, it is unlikely that these powers will be used effectively.

Secondly, intellectual property became a trade issue with the launch of the Uruguay Round, and the agreement encourages the global adoption of intellectual property rights, which will accelerate the process of co modification of biodiversity.

Q.14: What do you understand by cryopreservation. Write down in brief.

Ans.: Cryopreservation means storing the materials at very low temperatures. All biological functions cease at this temperature, hence growth and ageing are also suspended. The short or long-term conservation of sperms, egg cells and embryos in liquid nitrogen (at – 196˚C) – are used in combination with artificial reproduction techniQ in zoos. Eland antelopes and baboons have been produced by transplantations of frozen and thawed embryos. Frozen and subsequently thawed sperm have been used to fertilize deer, apes and wolves, with young successfully produced from these artificial reproductions. Different zoos and zoo-related research institutions have already accumulated extensive collections of deep-frozen germplasm from exotic animal species.

Plant tissues in general are more difficult to cryopreserve than animal cells. Several factors influence the ability of plant cells to survive freezing and thawing, the most important being (i) age, nature and density of the cells (ii) cryoprotective agent (iii) rate of freezing (iv) storage temperature (v) method of thawing and the culture conditions .Thus in order to get the highest survival of cells, the following guidelines are suggested.

(1) Nature of the Material : Young, small, highly cytoplasmic, non-vacuolated and thin-walled cells in small aggregates from periodically transferred and actively growing suspensions are able to withstand freezing much better than relatively old cultures containing large vacuolated and thick-walled single cells. For the maintenance of clones, especially those of the vegetatively propagated crops, meristerms should be used. Whole organs and plantlets need to be partially dehydrated before freezing.

(2) **Pre-culture of the Material :** Before freezing the cells and tissues may be precultured for a couple of days on a medium containing low concentrations of a cryoprotectant, and then healthy cultures should be selected for freezing. This results in higher survival.

(3) **Cryoprotective Agent :** It is advisable to use a mixture of two or three cryoprotectants at low concentration rather than a single cryoprotectant at a high concentration – as it could be toxic. Dimethyl sulphoxide is the ideal cryoprotectant.

(4) **Freezing :** One of the main causes of cell injury or death is the intracellular freezing, regulated rate of slow freezing, or quick freezing by sudden immersion in liquid nitrogen are used.

(5) **Storage Temperature :** An additional injury to the cultures may be caused if they are not stored at sufficiently low temperatures. The storage temperature should be such that it stops all metabolic activity and prevents bio-chemical injury.

(6) **Thawing :** Immediate thawing of the frozen cultures at 35 to 40˚C gives the best results.

Cryopreservation is best for unorganized systems like callus cultures as it ensures phenotypic and genotypic stability. The freeze preservation of pollen has considerable potential in the breeding programmes. The preservation of meristems serves a dual purpose of the conservation of germplasm as well as the storage of disease-free stocks. Cryopreservation has a special significance for the storage of vegetatively propagated crops, because at present no belonging to plantation crops and fruit seeds, such as oil palm, coconut, walnut, mango, cocoa and avocado, the embryo is short-lived and aborts. In such cases, the germplasm could possibly be conserved through cryopreservation of embryos or their segments. Freeze preservation of embryos has a number of other potential uses – the somatic embryos are looked upon as "seeds" in plants which do not set seeds – when hybrid embryos abort, the immature embryos can be excised, cryopreserved and cultured when the need arises.

Q.**15** ***Write the difference between Insitu conservation and Existu conservation.***

Ans.: Recognition of the world's shrinking biological heritage has prompted numerous reactions both at International and national levels as well as with in local communities. Several International agreements & technical measures are being promoted to conserve the biodiversity left in the world's forest, wet lands, coastal waters and in farmer's fields.

On the practical level, several complementary methods are being used to conserve biodiversity with different degrees of success. These methods can be divided into two broad categories.

Insitu Conservation : Which means conserving plants, animals and micro-organisms with in their natural habitat; and

Exsitu Conservation : Which means maintaining living organisms out of their natural habitat, either as whole living organism or as part (Cells, sperms, seeds, etc.)

Q.17 Write an essay on biodiversity.

Ans.: Biodiversity is the property of living systems of being distinct, that is different, unlike. Life comes in an almost infinite variety of forms. Species are in turn, formed by different kinds of populations, these by different kinds of individuals, and these by different types of organs, tissues, cells and genes. Biodiversity is not an entity, but a property, a characteristic of nature. Species, populations, certain kinds of tissues are resources but not their diversity as such. But diversity is a defining characteristic of life. Without diversity, life is not conceivable.

Types of Biodiversity :

Genetic diversity is the amount of genetic variability among individuals of a single species as also between species.

Species diversity refers to the variety of living organisms on earth and has been variously estimated to be between 5 and 50 million or more, though , only about 1.4 million have actually been described.

Ecosystem diversity relates to the variety of habitats, biotic communities and ecological processes in the biosphere as well as the tremendous diversity within ecosystems in terms of habitat difference and variety of ecological processes.

Some other categories of biodiversity are also known. They are named with reference to a specific ecosystem, species, etc.

Agrobiodiversity is the component of biodiversity that is directly related to agriculture. It includes crop plants and their wild relatives, livestock and beneficial organisms such as pollinators, decomposers and predators which are normally associated with cultivated areas.

Endemic biodiversity refers to those forms of life that are exclusive to the given geographical area or ecosystem. For the sake of convenience, endemic biodiversity is often assessed within political boundaries. Islands for example are rich in endemic biodiversity.

Introduced biodiversity refers to diversity of micro-organisms, plants and animals that have been accidentally or deliberately transported by humans to landscapes, countries, regions or continents where they never occurred naturally. Disease causing organisms, weeds, insects, pests and rats are examples of introduced biodiversity.

Microbial diversity refers to the variety in micro-organisms such as virus, bacteria, yeast, amoeba and certain fungi.

There is so much diversity that one wonders where all this diversity came from. Fundamentally it derives from the properties of a variety of macromolecules, most notably DNA and proteins. Their characteristics made biodiversity possible.

All the tremendous and marvelous diversity of life emanates from the DNA molecule-the absence of a rule regarding the order in which the nitrogenous base pairs must occur along the chain. Since the order of the A - T and G – C does not matter from the physico-chemical point of view, one base pair can be substituted for another without affecting the thermodynamic stability of the molecule (mutation). But a shift in the order of the bases will affect the genetic code. Such a change can affect the characteristics of the protein that the modified gene makes. A change in the order of the amino acids can be (i) **Neutral,** (ii) **Lethal or semi-lethal** or (iii) **improved** (resulting protein is more efficient). The first type of mutation can accumulate and create diversity that apparently does not affect function. The second kind of mutations are eliminated by natural selection. The last type of mutation is the material that ultimately gives rise to all biological diversity. Arising from this variation at the DNA level, are the diversity of populations, geographical races, species, and higher categories – genera, families, orders and classes.

This enormous diversity is disappearing at an alarming and accelerating rate: whilst it is estimated that early this century the earth may have lost one species a year, we are currently losing between one and 50 species a day. Industrialized countries, in particular, have suffered huge losses in the genetic diversity of their crops and domesticated animals. For example, since the turn of the century 97% of the varieties of 75 vegetable species in the U.S. have become extinct. Some scientists predict that if we continue current practices, the world will lose a quarter of all our biological wealth by the middle of the next century.

Q18 Write a short note of continental drift.

Ans.: The hypothesis of continental drift based on the concept of plate tectonics. The hypothesis of continental drift was first proposed by Sinder in 1858 but developed by Taylor in America & Wegener in Germany.

Alfred Wegener in 1912 offered a theory that all land masses originally formed one large super continent, Pangaea before the Mesozoic. Later by continental drift, they reached present position for many years the theory has scant support, but recent evidence is more conclusive and it bears importantly on distribution and evolution of life. Two land masses have been envisioned. Gondwanaland in the Southern hemisphere and Laurasia in the northern, separated by the Tethys sea. The southern may have been in the south polar area during the Paleozoic according to data from iron bearing rocks and glaciations. Gondwanaland yielded South America, Africa, India, Australia and Antarctica. Laurasia gave rise to Eurasia, Greenland and North America.

Evidence for former connections includes :

(1) Geometric fit of continental contours below sea level on the continental shelf.

(2) Age structure and presumed movements of rocks.

(3) Palemagnetism records.

(4) Data on convection currents in the earth's mantle.

(5) Wide spread deposits of a continental glacier in late Paleozoic of Africa, South America, India and Australia;

(6) past and present distribution of life.

Time for break up of Gondwanaland in thought to have been from Permian to Cretaceous (by different authorities), with much rifting in late Jurassic and lower Cretaceous and dispersal of the continents continuing into the tertiary. Resulting shifts in latitude probably organism to major climatic changes.

1. Where in India asciatic lion inhabits?
   A.)Gujrat B.)Punjab C.)Madhya Pradesh D.)Maharashtra (A)

2. What is the main reason of biodiyersity?
   A.)Changes B.)Complexicity C.)Both D.)none of these
   (C)

5. Kaziranga national Park is located in:
   A.)Hazaribagh(Bihar) B.)Jorhat(Assam)
   C.)bhavnagar (Gujrat) D.)None of these (B)

6. Who is the president of bhartiya vanya jeevan board:
   A.)Prime minister B.)President
   C.)judge D.)none of these (A)

7. Dudhwa National park is located in:
   A.)Nanital B.)Chamoli
   C.)Varanasi D.)Lakhimpuri khiri

8. What is the total no. of national park in our country?
   A.)84 B.)85
   C.)86 D.)87 (C)

Section B

Detailed Classification of non-chordates & Chordates

Q.1 Give classification, habit and habitat of following -

(1) Obelia

(2) Seypha (Sycon)

(3) Petromyzon

(4) Great Indian Busturel

Ans.: (1) Obeilia :

Systematic Position :

Phylum	Coelenterata
Class	Hydrozoa
Order	Hydroida
Suborder	Lepto medusae
Family	Eucopidae
Genus	Obelia

Habits and Habitat : Obelia is typical sedentary marine and colonial hydroid having cosmopolitan distribution. It is abundant in both Athlantic and pacific coastral waters and found up to a depth of 80 meters. It occurs in asexual and sexual forms. The asexual form is branched hydroid colony found attached to rocks, stones, shells of animals etc. The sexual form is an inconspicuous bell or an umbrellas like free swimming stage called medusa.

(2) Sycon :

Systematic Position :

Phylum	Porifena
Class	Calcarea
Order	Heterocoela
Family	Syuttidae

Genus	Scypha / Sycon

Habits and Habitat : Scypha (Gr. Skyphos, cup) is a marine sponge which is widely distributed, but is best known from North Athlantic shores. It may be solitary or forms a colony by budding. Sessile conies of cylindrical individuals are found permanently attached to submerged rocks or other solid substrata in shallow sea water along the coasts. They thrine well where action is not too strong and at low tide mark.

(3) Petromyzon :

Systematic Positions :

Phylum	Chordata
Sub-phylum	Vertebrata
Division	Agnatha
Class	Cydostomata
Order	Petro myzotia

Habits and Habitat : Petromyzon is predator and feeds on the blood of fishes i.e. saguivorous in habit. It is often found attached to the host when the latter is caught. It swims actively in the water by the lateral undulations of its highly muscular body. It bruds only once in its whole life. During breeding season, the marine petromyzon migrates to the fresh water for reproduction and laying off of eggs.

(4) Great Indian Busturd :

Systematic Position :

Phylum	Chordata
Sub-Phylum	Vertebrata
Super class	Gnathostomata
Series	Tetrapoda
Class	Aves
Subclass	Neornithes
Super order	Neognathae
Order	Grviformes
Genus	Choriotis

Habits and Habitat : It is ground dweller but is also capable of flight. It runs on the ground before taking off. It is solitary in habbit and its chief food consists of straw and seeds and small animals, worms, insects, centi pedes, lizards etc.

Q.2 Give classification, habit and habitat of following-

(1) Chinkara

(2) Crocodile

(3) Naza

(4) Taenia

(5) Balangolossus

Ans.: (1) Chinkara :

Systematic Position :

Phylum	Chordata
Subphylum	Vertebrata
Superclass	Gnathostmata
Series	Tetrapoda
Class	Mummalia
Subclass	Theria
Infraclass	Eutheria
Order	Artiodactyla
Genus	Gazello

Habit and Habitat : It is even toed unqulate and inhabits from dense forests to deserts and socfy outcrps and feeds on green leaves of bushes, grass, bugs and fruits. During bruding season 5 – 7 fermals live with one male. This is called as Horem.

(2) Crocodile :

Systematic Position :

Phylum	Chordata
Sub Phylum	Vertebrata
Super class	Gnathostomata
Series	Tetrapoda
Class	Reptilia
Order	Crocodilia
Genus	Crocodilus

Habit & Habitat : It is amphibious in nature found in or near tropical fresh water livers and lakes. It makes a long (10-13 meters) tunnel below the level of water. Well adapted for aquatic existence. Nostril, eyes and ear openings remain exposed even when the whole animal is immersed in water as a result breathing, seeing and hearing remain uninterrupted. Crocodiles are oviparous.

(3) Teania

Systematic Position :

Phylum	Platy helminthes
Class	Cestoda
Subclass	Evcestoda
Order	Taenioidea
Family	Taenidae
Genus	Taenia

Habits and Habitats : It completes its life cycles in two hosts. The adult dwells as internal parasite in the small intestive of may (primary or final host) where it is anchored to the intestinal mucosa by its scolex. It has no mouth or digestive cavity but absorbs the host's digested food through its body wall. The larval stage occurs in the tissues of a secondary or intermediate host which is usually pig and sometimes dog and sheep. A number of other animals such as goat, cattle, horse, bear and monkeys have also been mentioned as intermediate hosts.

It is found in all those parts of the globe, where pig in domesticated and consumed as food. Its distribution, thus is cosmopolitan.

(4) Balanoglossus :

Systematic Position :

Phylum	Chordata
Supphylum	Hemichordata
Class	Enteropneusta
Genus	Balanoglossus

Habits and Habitat : It usually lives in burrowing condition but some times it may be seen under stones, rocks etc. It has a world wide distribution. It is marine and chiefly found in shallow, intertidal water along the warm and temperate oceans. These animals burrow in the sandy mud and secrete the integumentary mucous to cement the sand grains. The

burrow is usually 'U' shaped. It has two openings, the anterior opening is large and funnel shaped while the posterior openings is small and circular and concealed below the spirally coiled faucal matter of the animal. The faucal coil resembles the astings of earthworms. The anterior opening may give out side branches.

Balanoglossus feeds on plankton and organic debris. It is a sluggish and inactive creature and moves about slowly with the aid of cilia which are present on the greater part of the body. Sexes are seperte and the development is through larval shape known as tornaria larva. Asexual reproduction is absent but power of regeneration is well marked.

(5) Naza :

Systematic position :

Phylum	Chordata
Subphylum	Vetibrata
Superclass	Gnathostomata
Series	Tetrapoda
Class	Reptilia
Order	Sqnamata
Suborder	Serpentes
Genus	Naja

Habit and Habitat : Naja or Cobra is diurnal animal and lives in burrows under stones, in mud walls and in thick vegetation. It is deadly poisonous snake of India. Carnivorous and feeds on small birds, frogs, rats, lizards etc. It can dialate its neck into a hood supported by ribs and bean spectacle mark dorsally. They rise then hood when alarmed and the hood swings back & forth for striking Cabra is oviparous.

Q.3 Write an essay on economic importance of molluscs.

Ans.: The mollusca are bilaterally symmetrical, unsegmented soft bodies animals. The name is derived from latin word " mollis" meaning soft, referring to the soft body within a hard calcareous shell. The body is divided into the visural hump and the head mantle and foot. Mollusca in the second largets phylum after arthropoda and there are about 1,10,000 living species of Molluscs.

Fresh water nuscle found widely distributed in streams, rivers and lakes containing calcium carbonate dissolved in water, which enables them to produce their shells. The common species found in India is lamelledens marginalis. It lives

partly buried in the need or sand. Its body in enclosed with in a bivalved shell showing lines of growth, running parallel to the margin.

Oyster : The oysters are marine bivalves. Their body structure is very similar to that of fresh water – mussel but they are sedentary in habit and do not have a foot. The left side of the shell remains permanently attached to some solid object from the early larval stages. Whenever some sand particle or a small parasite gets in between the mantle and the shell, a mother of pearl (nacre) is secreted around it by the mantle. Additional layers of mother of pearl secreted around this for several years and formed in the large pearl oysters of west and south pacific.

Mikimoto a Japanese, discovered a method of artificially introducing foreign bodies between the mantle and the shell of the pearl oysters, thus stimulating pearl formation. The artificially treated oysters are lowered on the sea water in perforated cages for several years till the pearls of commercial value are produced and collected.

Molluscs are of major interest to man as about 10,000 species are of economic importance. Mostly they are beneficial to man although there are some mollusks which are indirectly harmful.

Beneficial Molluscs :

(1) **As Food :** Chitons formed the main food or Red Indians. The gastropods are consumed by numerous predators chiefly fish, birds and mammals. The large land snail Helix pom atia, large foot of Haliotis and apple snail (Pila) form common food in New York, California and South India, respectively. Oysters, scallops marine mussels and clams have been often used for food. Romans cultivate oysters to meet their great demand for countries like USA. Oystres are served fried, the hard shell marine clam, Venus mercenaria as whole on half shelled or cooked in chowder, Mya arenaria, a soft shelled clam, is steamed in shells and served with butter mytilus edulis is used in chowder, and adductor muscle of Pecten are served in flour and fried. Pelecypods also furnish food for star fish, boring sponges, drilling snails, some marine leeches, fish and shore birds.

Squids, cuttle fish and devil fish are popular as food articles in Oriental and mediterramian contries. Sepia is used as food either cooked or dried in open air in European contries. Loligo are split, sun dried ad preserved for later use. Octopus, the devil fish is used in Canada and Alaska on many occasions. Nautilus pompillus is much prized as food by Pacific islanders. Cephalopods also form food for other animals like marine mammals are large fish.

(2) **As Bait :** Many gastropods are very useful to man, as bait for catching fish,. Squids make an excellent bait for marine fishes especially cod in United States. Mall Octopus are used as bait by the line fishermen of Palk bay.

(3) **Money :** Red Indian tribes of America used the common Dentallium indianorum as sawampum or money. Value of shells varied lengthwise. Gastropodan shells were source of money for various native races, including Vampum of American Indians. Shell of gastropods made media or barter in Africa and their countries. American Oyster, Crassotria viginica, is commercially cujtivated and harvested and provides millions of dollars to the industry. Squids, cuttle fish and deveils fish earn money as they are sold in market for food in China, Japan, India and Italy,

(4) **Ornamentation :** Scaphopod, Dentallium indiaorum, tooth shells are valued as ornaments. Tools, utcensils and objects of delight have been formed from gastropodan shells. Some marine snails of South pacific (turban shells) have a calcarious operculum so rounded and coloured as to resemble a vertebrate eye. These opercula known as "cat's eye", are sought as curios. Nautilus shell is much used for decoration, art and for many other useful purpose.

(5) **Useful Dyes and Ink :** Some gastropods like Nucella (Purpura) and Murex, are sources of Tyrian purple from their juices. Dye for royal a gland of the snail, Murex truncuttus. Secretion is colorless but becomes a beautiful purple by exposure to the air. Contents of ink-sac of cuttle-fish provide a rich brown pigment called "sepia", used by the artists. Originally Indian ink was obtained from the ink of a cuttle-fish, Sepia cubrata. Now –a-days a certain brown finish of photograph is termed as sepia finish.

(6) **Buttons and Pearls :** Gastropodan shells are used to manufacture buttons and other articles. Shells of certain bivalves have been used for mother –of-pearl layer also for buttons, knife handles etc. Buttons are made by hand by cutting shells of freshwater bivalves and some marine clams. Pearls are made by clam and pearl oysters themselves and are among the most beautiful and valuable of our jewels.

(7) **In art and Medicine :** Shell cameos are made mostly from snails notably that of cypraea tigris and cases tuberose. Nautilus shell is commonly used in art. It is a pretty object thrown ashore during monsoon storms on the Indian costs.

A rather odd and unexpected use for fossil cephalopods is found among the Red Indians of Montana and Wyoming. Their medicine men collect specimens of beautifully preserved fossil ammonids from Cretaceous

Strata and keep them as 'medicine'. The internal calcarious shell of Sepia, the "cuttle'bone" is used as medicine as well as for other purposes.

(8) **In Literature :** There are stories about giant squids and octopuses cited to play exaggerated role in popular literature. One such story, pictures a huge squid dragged a small ship beneath the wavs and grabbed the helpless sailors in its cruel, snake-like arms and crushed them ot death. Large squids and octopuses are feared more rightly for their dangerously powerful beaks and ability to size men from boats or grip persons under water by their deadly tentacles.

(9) **Animal Inventions :** Cephalopods get credit for two animal inventions. One of hem is the principle of "jet propulsion" only recently discovered by man but used by squids and octopuses for millions of years. The second novel invention is the use of a "smoke screen", in both offence and defence, is another novel invention by cephalopods. A smoke screen is formed by ejecting a brownish ink into the water. This diffuses into a large area and allows cephalopod to stalk stealthily through the "smoke" searching for its prey, or to escape in cloudy water if persued by an enemy. Man could use such a device in warfare not earlier than first World War.

Q.4 What is the significance of classification? Write in brief.

Ans.: The classification is the ordering of animals relationships, that is of associations by contiguity, similarity of both (Simpson, 1961). Or it is the arrangement of the individuals into groups (taxa) and the groups into system in which the data about the kinds determine their position in the system and thereafter are reflected by the position (Blackwelder, 1967).

Significance of Classification :

(1) **Convenience of Study :** Out of million of lypus of organisms it is difficult to study each of them. The study of selected animals of a particular group giver an idea about the remaining animals of that group, for example study of rabbit gives the knowledge about all animals of class mammalia.

(2) **Knowledge of Affinities :** The knowledge about relationships of different animals with other animal species comes from classification.

(3) **Knowledge of Sequence of Evolution :** Classification gives the sequence of evolution of animals like evolution of sponges from single celled protozoa and that of arthropoda from annelida, could only be known through classification.

(4) **Knowledge of Connecting Links :** The transitory stage between two groups of animals is known as connecting link. It gives the sequence of evolution of animals. With the help of classification definite position of connecting links can be made clear.

(5) **Knowledge of Adaptation :** By classification we come to know about such characters of animals with which they adopt to an environment.

(6) **Knowledge of Phylogeny :** Animals of one group are evolved from a common ancestor, is known through classification because this is based on phylogency. We know that all animals of class mammalian have evolved from one common ancestor.

General Principals of Taxonomy

Q.5 Write an essay on general principles of Taxonomy.

Ans.: The word taxonomy is derived from Greek word (taxis = arrangement) and (nomos = law). It was first coined by A.P. do candolle.

Taxonomy is actually the study of the principles and practices of classification and as such it is only a part of systematics.

In simple terms, actually there are two parts of systematics. The first part taxonomy is connected with describing and naming the many kinds of organisms that exist today, those that have been extinct. The second part of systematices, evolution is concerned with understanding just how all of these kinds of animals arose in the first place and what process are at work today to maintain or change them.

Stages of taxonomy : Taxonomy of a given group passes through several stages. These stage are following :

(1) **Alpha Taxonomy :** is the level at which the species are characterized and named.

(2) **Beta Taxonomy :** It refers to the arrangement of the species into a natural system of lower and higher categories.

(3) **Gamma Taxonomy :** It is the analysis of intra-specific variation and evolutionary studies i.e. study of speciation.

Classification is simply the grouping together of individual organisms on the basis of relationships or associations among them. These groups have to be delimited and arranged in a orderly manner.

In the natural system of classification on the animals are placed into as many groups and subgroups as are the similarities and dissimilarities for eg. vertebrate includes mammals (with hair and mammary glands) along with other groups like birds, reptiles, amphibians and fishes with their own specific natural characteristics. The mammals are again subdivided into respectively smaller groups on the basis of various natural characterstics.

The various major hierarchical groups which are thus created are called taxa.

According to Simpson, "A taxon is a group of real organisms recognized as a formal unit at any level of hierarchic classification.

The sort of arrangement of taxa into an ascending series of over increasing inclusiveness is called "Hierarchic system of classification". A hierarchy is thus a systematic frame work for zoological classification on with a sequence of classes at different levels in which each class except the lowest includes one or more subordinate classes (Simpson, 1961). These disjoint classes at each level are called taxa and the ordinal levels are called ranks. The taxa of a given rank constitute a category.

Linnaean Hierarchy : Linnaeus recognized five hierarchic levels with in the animal kingdom. These were classis (class), Ordo (order), genus, species and variety. Later, two additional categories – family (by Butschili in 1790) and phytum (by Haeken in 1886) were added. The six categories – phylum, class, order, family, genus and species form the basic taxonomic hierarchy of animals and any given animal must belong to these discarded categories. The term variety was eventually have become widely used. These are tribe between genus and family and cohort between order and class.

This resulted in splitting of original basic categories and also additions of some among them. With the result these are as many as 33 categories presently in use in the hierarchic classification. Of these 33, only 18 (marked with asterisk below) are generally followed –

Kingdom*

Subkingdom

Infra kingdom

Super phylum

Phylum*

Subphylum*

Infra phylum
Super class
Class*
Subclass*
Infraclass
Super cohort
Cohort*
Sub Cohort
Super order
Order*
Sub order*
Infra order
Super family* (-oidea)
Family* (inae)
Sub family* (-inae)
Infra family
Super tribe
Tribe* (-ine)
Sub tribe
Infra tribe
Super genus
Genus*
Sub genus*
Super species
Species*
Sub species*

Q.6 Write down the three necessary conditions for zoological nomenclature.

Ans.: The International Code of Zoological Nomenclature (ICZN) consists of three main parts – the Code proper, Appendice and Glossary. The Code proper includes

"Preamble" followed by 88 consecutively numbered. "Articles" grouped in 18 chapters.

The three most important conditions of scientific nomenclature are – uniqueness, universality and stability.

(1) **Uniqueness :** Every name has to be unique because it is the key to entire knowledge related to particular species or taxon.

(2) **Universality :** Each animal has a diversity in the names in different languages. To avoid this confusion zoologists have adopted by international agreement a single language and a single set of names for each taxonomic category to be used internationally.

(3) **Stability :** The names of taxa once assigned msut remain unchanged, that is remain stable because if names of objects are frequently changed. They would create great confussion.

Q.7 What is the importance of taxonomy.

Ans.: The contribution of taxonomy to biology are both direct and indirect. It plays it roles in both the areas "theoretical and applied biology".

In theoretical biology –

- It is responsible in making conceptual contributions like population thinking.
- It is also responsible in solving the problems of multiplication of species.
- It helps in understanding of the structure of species and of the evolutionary role of peripheral population.
- Mimicry and other evolutionary areas have also been clearly understood through taxonomy.
- It also plays useful role in the development of behavioral science.
- It is a key to the study of ecology.

In applied biology - Taxonomy played quite a wonder role in the important fields of applied biology. Some of their roles are as follows –

(1) **Agriculture and Forestry :** Presently we are faced with the aute problem of saving our crops & trus from the attack of various kinds of pests. It is essential to know the correct manes of such pests before their proper control and eradication. All the essential information can be easily obtained by screening the literature if the identity of the pest is known.

(2) **Biological Control :** As the use of insecticides is declining and replaced by specific methods of biological control, the use of accurate identification of the pest and its natural enemies is becoming increasingly important.

The taxonomy presently greatly involved in designing and implementing the biological control programmes of pest & diseases most effectively.

(3) **Public Health :** Taxonomy plays a great role in public health programmes. A good example of such a case in the occurrence of malaria in epidemic for in Europe. The mosquito, a maculipennis meigen, a supposed vector of malaria, was found prevalent throughout Europe. Large sums of money were wasted in controlling this mosquito, although malaria was not prevented all over Europe in spite of the presence of this mosquito. The taxonomists Hackett (1937) and Bates (1940) were consulted and they reached to the conclusion that maculipennis complex comprising several sibling species of which few were responsible for transmitting malaria. The control measures were that applied only to the target species.

(4) **Quarantine :** Many new pest and diseases of plants, animals and human beings have already entered many countries and still others are following suit. Taxonomists play a vital role here in providing correct and prompt identification of the pest a disease.

(5) **Wildlife Management :** Presently great attention in being paid to conserve and propagate wild life. Taxonomy helps the taxonomist in the environmental protection by identifying all such animals which are endangered by any reason.

(6) **Soil Fertility :** Many animals plays an important role in increasing the fertility of the soil. It is necessary to know such animals, identify them for, their proper management in agriculture.

(7) **In Commerce :** Products like honey, silk, lac and dyes are provided by insects. Taxonomists can play an important role in increasing and improving the quality of these products by manipulating the useful species. The introduction of any useful species is possible only through correct identification.

The Italian honey-bee, Apis mallifera and the fish, European corp, Cyprinus Carpio are two well known examples of successful introduction in India, which was possible only through correct identification.

Q.8 Define Taxonomy and write a short note on Binomial nomenclature

Ans.: **Taxonomy** is the practice and science of classification. The word comes from the Greek *τάξις, taxis*, 'order' + *νόμος, nomos*, 'law' or 'science'. Taxonomies, or

taxonomic schemes, are composed of ***taxonomic units*** known as ***taxa*** (singular ***taxon***), or kinds of things that are arranged frequently in a hierarchical structure, typically related by subtype-supertype relationships, also called parent-child relationships.

In biology, **binomial nomenclature** is the formal system of naming species. The system is also called **binominal nomenclature** (particularly in zoological circles), **binary nomenclature** (particularly in botanical circles), or the **binomial classification system**.

Significance of Binomial Nomenclature : The value of the binomial nomenclature system derives primarily from its economy, its widespread use, and the stability of names it generally favors :

- Every species can be unambiguously identified with just two words.
- The same name can be used all over the world, in all languages, avoiding difficulties of translation.

Although such stability as exists is far from absolute, the procedures associated with establishing binomial nomenclature tend to favor stability. For example, when species are transferred between genera (as not uncommonly happens as a result of new knowledge), if possible the species descriptor is kept the same. Similarly if what were previously thought to be distinct species are demoted from species to a lower rank, former species names may be retained as infraspecific descriptors.

Levels of Organisation

Q9 Write a short note on grades of organization.

Ans.: Protoplasmic Grade : It is found is protozoa as all the activities at this level are confined with in the limits of single plasma membrane (plasma lemma).

Cellular Grade : The structural organization of unicellular animals referred to the cellular grade organization. Animals of this organization comes into subkingdom Protozoa. This subkingdom includes only a single phylum Protozoa.

Cell-tissue Grade Organization : It is seen in coelenterates as their alls are not only specialized for different functions but also certain similar alls gather to form tissue as well. A noteworthy examples is the nerve net formed by nerve cells and their processes.

Tissue organ Grade : It appears in flat worms with the arrangement of tissues to for organs.

Organ–system Grade : here organs join together in a system to perform some function in typical of all higher invertebrate forms.

Multiple Choice Question

1. Who is the writer of "Systema naturae"?
   A.)John Ray B.)Linnaeus
   C.)Aristotle D.)Lamarck (B)

2. The body of octopus is:
   A.)Bilaterally symmetrical B.)radial
   C.)Asymmetrical D.)None of these (A)

3. Order of platyhelminthes which lacks scolex:
   A.)Spathebothoridea B.)Cyclophyllidea
   C.)Nippotaenoidea D.)Caryophyllidea (D)

4. Scorpion belongs to:
   A.)Merostomata B.)Crustacea
   C.)Insecta D.)None of these (D)

5. Connecting link between animals & plants:
   A.)Amoeba B.)Paramecium
   C.)Virus D.)Euglena (D)

6. Euglena is:
   A.)Autotroph B.)Heterotroph
   C.)Parasite D.)Both A & B (D)

7. larval phase of taenia solium is called as:
   A.)Trocophore B.)Cisticircus
   C.)Miricidium D.)Radia (B)

8. Dichondylic cranium present:
   A.)In pises & amphibia B.)In reptelia & aves
   C.)In amphibian & mammalia D.)In amphibian & reptelia (C)

9. Bones of vertebrates are made by:

A.)Calcium carbonate B.)Sodium chloride
C.)Calcium phosphate D.)calcium magnesium phosphate(C)

10. Amnion membrane is absent in:
A.)Cyclostomes B.)Fishes
C.)Amphibians D.)All of the above (D)

11. Python that found in India is:
A.)*Python reticulates* B.)*Python molurus*
C.)Both D.)none of these (C)

12. Labeo is:
A.)Cartilage fish B.)Bony fish
C.)Mammal D.)None of these (B)

13. Order of Icthyophis is:
A.)Apoda B.)Anura
C.)Squamata D.)None (A)

14. Tailed amphibian is:
A.)Gymnophiona B.)Urodela
C.)Anura D.)All of the above (B)

15. State animal of rajasthan:
A.)Columba livia B.)Lepus migricollis
C.)Gajela gajela D.)camelus dormedarus (C)

16. member of anura:
A.)Salamender B.)Naja
C.)Rana D.)Icthiophys (B)

17. Example of apoda:
A.)Salamender B.)Naja
C.)Rana D.)Icthiophys (A)

18. Sub class of hemidactylus:
A.)Anapisida B.)Diaphsida
C.)Parapsida D.)Synapsida (B)

19. Non poisonous snake is:
A.)Python B.)Krait

C.)Viper D.)Naja (C)

20. Thecodont are found in:
A.)Crocodila & Amphiians B.)Crocodilia & mammals
C.)crocodilia & Aves D.)Only crocodilia (B)

21. Poisonous lizard is:
A.)Draco B.)Hemidactylus
C.)Heloderma D.)Euromastica (C)

22. In which lizard's lung air sac are present?
A.)Hemidactylus B.)Chamaleon
C.)Lacertilia D.)chelonia (B)

23. Thecodont teeth & 4 chambered heart is specificity of :
A.)Viper B.)Crocodilia
C.)Chelonia D.)Lacetilia (B)

24. Blind snake is:
A.)Typhlops B.)Python
C.)Viper D.)Zamenis (A)

25. Smallest unit of classification is:
A.)Phylum B.)Genus
C.)Family D.)Species (D)

Section C

Evolution

Q.1 Explain the Lamarckian theory of evolution.

Ans.: The French biologist Lamarck proposed in 1809, a hypothesis to account for the mechanism of evolution based on two conditions. The use and disuse of parts, and the inheritance of acquired characteristics.

Changes in the environment may lead to changed patterns of behavior which can necessitate new or increased use (or disuse) of certain organs or structures. Extensive use would lead to increase size and / or efficiency whilst disuse would lead to degeneracy and atrophy. These traits acquired during the life time of the individual were believed to be heritable and thus transmitted to offspring.

According to Lamarckism, as the theory came to be known, the long neck and legs of the modern giraffe were the result of generations of short necked and short legged ancestors feeding on leaves at progressively higher levels of trees.

The slightly longer necks and legs produced in each generation were passed on to the subsequent generation, until the size of the present day giraffe was reached. The webbed feet of aquatic birds and the shape of flat fish could be explained similarly. In aquatic birds the constant spreading of the toe bones and the skin between them in order to swim to find food and escape predators adaptations resulting from fish lying on their sides in shallow water were proposed to explain the shape of flat fish. Whilst Lamarck[s theory helped prepare the way for acceptance of the concept of evolution his views on the mechanism of change were never widely accepted.

However Lamarck's emphasis on the role of the environment in producing phenotypic changes in the individual was correct. For example, body – building exercises will increase the size of muscles, but these acquired traits, whilst affecting the phenotype are nongenetic and having no influence on the genotype cannot be inherited.

To demonstrate this, Weismann cut off the tails of mice over many successive enforced disuse of tails should have lid to progeny with smaller trails. This was not the case. Weismann postulated that somatic (body) – acquired characteristics (resulting in phenotypic changes) did not directly affect the germ (gamete) cells which are the means by which characteristics are passed on to the next generation.

Q.2 What do you understand by adaptive radiation? Explain in detail.

Ans.: The living organisms exhibit plasticity in their organization. The animals of unrelated groups which occupy the same habitat exhibit features in common or look alike (convergence). On the other hand animals of the same group or closely related groups exhibit great divergence in their morphology (i.e, they appear very different) when they are found in different habitats (Divergence).

"Each isolated region if large and sufficiently varied in its topography, soil, climate and vegetation, will give rise to a diverse fauna. The large the region and more diverse the conditions, the greater will be the varieties of animals found".

Mammalian limbs are modifications of the pentadactyle limb. Primitive, ancestral mammals are believed to have been short-legged, five-fingered creatures living on the ground but the limbs were not modified for any special type of locomotion. Modern insectivorous mammals such as shrews form the modern representative of these terrestrial animals. One line radiated from these led of arboreal or tree-dwellers, with limbs adapted for tree life (e.g., squirrels sloths, monkeys). Another line led to aerial Somewhere along the line we can place gliding forms which are wrongly called the flying individuals e.g., the "flying" squirrel. Careful studies of these two adaptations would reveal that the life on trees preceded flight.

Next comes the Cursorial forms which includes mammals like horses, antelopes, etc., and that had limbs adapted for rapid running though less swift animals like wolves, foxes, hyenas and lions are also included.

Fossorial or burrowing mammals like moles have their forelimbs modified into powerful digging organs as otherwise they are poorly adapted for locomotion on the surface of the ground.

Aquatic mammals like whales and porpoises with strongly developed limbs for aquatic life only which would be useless if these animals think of moving on the land, though some aquatic mammals like seals, sea lions and walruses have some ability to move about on land. Others like otters and polar bears are at home both in water and in land.

Studying all these examples and the way they have diversified, it can be said that adaptive radiation in evolution is in several directions starting from a common ancestral type.

The same study can be made starting from the ground finches with heavy beaks. Various forms like the cactus ground finches, vegetarian tree finches, insectivorous tree finches, woodpecker finches and warbler finches have adapted in such a way that their particular beak type is made full use of. Each type of beak

was efficiently used depending on the food the individual relied upon for its survival.

Yet another example of adaptive radiation is seen in drapanids or sicklebills or honeycreepers.

Like this in every group of animals, one can cite examples of adaptive radiation.

Q.3 Write a note on genetic basis of evolution.

Ans.: An essential key to the development of the modern theory of evolution limes in the discoveries emanating from the experiments carried out by Mendel in the 1860s. When Mendel's basic ideas were rediscovered in 1900, they produced a revolution in biological thought comparable to the impact of Darwin's theory of natural selection or, in our time, to the effect of the concepts of molecular biology. Rediscovery of Mendel's principles led to the repaid, explosive growth of the field of genetics and established the basis for unraveling the secret of biological reproduction and heredity. A leading figure in developing our current knowledge of the patterns and mechanisms of biological inheritance was Thomas Hunt Morgan a great many assoc rates worked first at Columbia University and then at the California Institute of Technology. By the early 1940s,these researchers and a host of other geneticists had establishment a sound basis for explaining the concepts of independent segregation, random assortment, the genetic factor (gene), the chromosomal theory of heredity, chromosomal regulation of sex determination, linkage, crossing over, multiple gene control of development, and mutation.*

Almost from the outset of genetic study, scientists began to speculate about the chemical nature and manner of action of genetic material. No real progress was, made in this search until 1944, when O.T. Avery, C.M. Mac Leod, and M.McCarty Demonstrated that deoxyribonucleic acid (DNA), long know to be localized in the chromosomes, is the genetic material. Subsequently, in 1953, James D.Watson, F.H.C. Crick, and M.H.F. Wilkins discovered the structure of the DNA molecule (see Fig. 1-1). Since that time extensive studies on the nature of DNA action and its control of living system at the biochemical level have led to new levels of understanding of the molecular basis of genetics, development and metabolism. The establishment of the nature, structure, and action of DNA has led to a revolution in biological thought unequaled in the present century, leading to new directions of thought about all aspects of biology.

Both the Mendelian and molecular views of biological heredity contribute to evolutionary theory by explaining reproductions. Our present understanding of reproductive processes may be summarized as follows:

(1) Development of individual organisms is controlled by a series of hereditary regulators called genes. Each gene is equivalent to a portion of a DNA molecule and regulated the production of a single polypeptide chain through production of RNA (see Fig. 1-3). In all living systems, the proteins, including those serving as major structural components, and the enzymes responsible for controlling activities are composed of a single polypeptide chain or a series of polypeptide chains formed individually in this fashion and subsequently aggregated. Essentially one gene forms one polypeptide chain.

(2) Genes, in almost all organisms, are found in large units called chromosomes; are usually included in the cell nucleus. The central axis of the chromosome appears to consist of a single, very long DNA molecule comprising hundreds of genes. Around the DNA skeleton are other complex macromolecules: proteins called histones, residual protein, and RNA manufactured by the DNA (see Fig. 1-2) ; the number and type of chromosomes are usually constant for each species, as is the amount of DNA for each somatic cell. Some organisms, particularly bacteria and blue-green algae, lack a nucleus but apparently have a single chromosome composed of a DNA double strand, located in the cell material, Viruses are made up of single protein –coated strand or a double helix of hereditary material and correspond to several free-living genes ; in some viruses the hereditary material consists of ribonucleic acid (RNA) rather than DNA.

(3) DNA is cable of coordinated and exact replication of itself (see Fig. 2.5) giving rise to exact duplicates of the original genes. This process is the key to biological heredity, and explains the continuity of common features in all living systems and the conservative nature of biological reproduction.

The majority of organisms are cellular and contain a nucleus and discrete chromosomes; subsequent discussions will refer only to examples of this type.

All organisms that contain chromosomes are of two general types. In most species the chromosomes within most cells occur in pairs, so that each cell contains two sets of "homologous" (corresponding chromosomes, each with homologous DNA double strands, and each therefore, containing paired homologous genes. This kind of cell is called diploid because it contains twice (2N) the basic number (N) of chromosomes, For example, all cells but the reproductive cells of the human body contain 46 chromosomes or 23 pairs, the usual diploid number for man. The total number of chromosomes is 2N-that is (2 X 23) or 46. In some organisms and in the reproductive cells (gametes) of higher plants and animals, the chromosomes are unpaired. This kind of cell contains one chromosome from each homologous pair or is haploid (N). The haploid cells of man, for example, contain 23 or N chromosomes. In most cases in diploid organisms with haploid gametes, exactly one-half of the chromosomes, namely one from each pair of man is used

as an example, each sperm (male gamete) or egg (female gamete) contains N, or 23 chromosomes, one from each pair found in the diploid cells. It is also interesting to note that the amount of DNA present in a diploid cell of a particular species is twice that found in a haploid cell.

Cellular Reproduction : In organism other than viruses, reproduction is based upon the origin of new cell by growth and division of other cells. In all multicellular organisms, whether they are haploid or diploid, new cells are being produced constantly by cell divisions to replace worn or injured cells and to provide for growth. The new cells contains exactly the same number and kinds of chromosomes present in the original cells. In addition, new individuals may be produced by this same type of cell division in organisms with asexual reproduction. In this mode of reproduction a cell or group of cells divides from the parent and becomes and independent individual begins as a single cell, but by cell division it grows into an organism composed of thousands of cells. In many one-celled organisms, new individuals are produced simply by the growth and division of the parent (cell) in to two new individuals (cells) containing the identical chromosomal complement of the parent cell. The numbers and kinds of chromosomes in individuals produced by asexual reproduction are exactly the same as those in the parent.

The process of cell division that produces new cells or individuals with replicas of the chromosomes of the parent is called mitosis. The significant features of mitosis are presented in Fig. (In the example, mitosis is followed in a diploid organism with two sets of chromosomes; that is 2N= 4.) During the period between divisions, the cells is spoken of as being at the resting stage. As the cell begins to prepare for division, toward the end of the resting stage, the chromosomes duplicate essentially exact replicas of themselves. The process of mitosis begins when the chromosomes condense into compact bodies. Each kind of chromosome is represented at this stage by a pair of duplicates attached by a small body called a centromere. In the accompanying diagram, the homologous chromosomes of each of the two sets are of the same size, but of different shades, and replica chromosomes are of the same size and shade. Shortly after the condensed chromosomes appear, the nuclear membrane breaks down, the spindle apparatus appears, and the chromosome line up along the equatorial plane. The centromeres now divide and the daughter chromosomes move to opposite poles, apparently assisted by the spindle apparatus. The process is completed by the division of the cell and the formation of new nuclear membranes, producing two new cells each with a nucleus containing 2N chromosomes identical to those in the parental cell. The process is summarized in Fig. 203.

A second kind of specialized division of cells is characteristic of some stages in the life history of all organisms with sexual reproduction. This process is called

meiosis (Fig. 2.2) and provides for reduction of the parental diploid chromosome number (2V) to the haploid number (N). Meiosis may occur in unicellular organisms, but in multicellular forms it takes place only in the reproductive organs (gonads), all other cellular divisions in the body being mitotic. Thus, in human beings cells are produced by mitosis throughout all of the body, except in the gonads (male; testis; female; ovary) where meiosis produced the reproductive cells or gametes (male: sperms; female: ova or eggs).

The significant features of meiosis are indicated in fig. 2.2 for an organism with a diploid number (2N) of four chromosomes: the number and arrangement follows that in the example for mitosis (Fig. 2.1). Two cell divisions occur during meiosis. After the chromosomes are replicated during interphase, division begins with condensation, just as in mitosis. About the time the spindle apparatus appears and the nuclear membrane breaks down, the homologous chromosomes come to lie on opposites sides of the equatorial plane. The replicas are still attached to one another by the centrmere, but unlike the situation in mitosis at this stage, the centromeres are not on the equatorial plane and do not divide. Subsequently the homologous units (two replicate chromosomes of each homologous pair) move toward the poles of the spindle apparatus. Nuclear membranes appear and cell division is completed from each homologous pair. This process constitutes the first meiotic division.

The second meiotic division begins with recondensation of the chromosomes and the breakdown of the nuclear membrane. No further replication of chromosomes occurs between the first and second divisions. The chromosomes now line up on the equatorial plane as in mitosis, the centromers divide, and one replica of each chromosome moves to each pole. Nuclear membranes appear and the second meiotic division is completed, producing four cells each containing a haploid number of chromosomes (N). The manner of division is random; that is, a replica of either chromosome of a given homologous pair may go to either shows the formation of chaismata) and is responsible for the genetic phenomenon of crossing over. Crossing over is an important source of genetic variability and will be discussed later in some detail. Figure 2-4 shows the formation of chiasmata and their effects on gametes.

If one chiasma occurs between different chromosomes, twice as many gamete types may be formed as when no chiasmata are present. (How many kinds of gametes are possible when one chiasma has occurred during meiosis in an organism with 2N = 4 such as in Fig.2-4?

In sexual reproduction, new individuals are produced by the coming together of two gametes (usually a male and a female gamete) to form a diploid cell, or zygote. The zygote then develops into the new organism. In most sexually produced diploid organisms one-half of their chromosomal and genetic material comes from each gamete, or one-half from each parent. Meiosis is responsible for

this situation and insures that half of the heredity of the individual is carried by each gamete.

The Molecular Basis of Reproduction : From the molecular point of view, the fundamental features of any living system are determined by a series of specific enzymes that regulate metabolism, development, and growth. It is because of the specific nature of enzymes, and their interactions and effects on other kinds of molecules, that each kind of organism exhibits a peculiar complement of physiologic, morphologic, and ecologic features that distinguishes if from other organisms. Oak trees differ from lions and lions differ from tigers for this reason. As discussed in the preceding chapter, protein and enzyme synthesis is regulated by DNA. The differences between oaks and lions ultimately involve differences both in the DNA molecules and in their arrangement through protein and enzyme synthesis. Since DNA controls the specific features of each kind of living organism, it follows that the key to understanding biological reproduction is in the mechanism by which a specific DNA structure is reproduced and passed on to new cells or individuals, which will resemble their parents in all essentials. The general process of DNA replication is now well established. During the resting stage, described in cellular reproduction above, the DNA double helix strands become separated through the breaking of the weak chemical bond between complementary base pairs (Fig.2-5). Each strand acts to form a complementary stand by pulling complementary bases out of the surrounding cellular material. By the time cellular division is intimated, each strand has completely reduplicated itself, so that there are now two replicas of the original double stranded helix of DNA. By this means, each daughter cell receives a duplicate of the DNA of the parent cell. This process frequently is called the semi conservative replication of DNA, since each new double helix contains one new strand and one from the original cell. As the order of the bases on the double strands of DNA determines the kinds of proteins and enzymes produced by the cell, it is apparent that cells produced by mitosis will contain essentially identical DNA complements and genes, and will produce essentially identical proteins and enzymes.

In meiosis the four haploid cells produced from one chromosomal replication (and one DNA replication) will each contain DNA double strands produced by exactly the same kind of semi conservative replication discussed above. The zygote or new individual produced by the fusion of two haploid gametes receives half of its DNA complement from each parent., in the form of one homologous DNA double-stranded helix from each gamete. In some cases the amount of DNA present in diploid cells is not obtained equally from parental gametes. In many insects, fishes and other vertebrates, males and females differ in the chromosomes (and amount of DNA) present. In human beings, for example, females usually have 23 similar pairs of chromosomes, one pair called the X-chromosome; males

have 22 similar pairs and two other chromosomes (XY) that differ from one another in size and shape, but that pair up at cell division. Consequently female gametes usually contain 23 chromosomes one of which is an X chromosome, but half of the male gametes contain 23 chromosome, but half of the male gametes contain 23 chromosomes corresponding in the group in the female gametes (including an X), and the other half 22 plus the short Y chromosome. Strictly speaking, all normal human gametes contain 23 chromosomes, but the amount and kind of DNA and corresponding genes are less in those gametes containing a Y chromosome. New human beings arise from zygotes that are XX or XY, depending upon the chromosome complement of the father's gamete. The former (XX) are female, the latter (XY) male.

In some groups one sex is characterized by an unpaired chromosome (XO), while the other has the same chromosome paired (XX); cases one sex produces two kinds of gametes in terms of chromosome numbers and total DNA, the other only one kind.

These patterns from interesting deviations from the usual. In most sexually reproducing organisms, exactly one-half the chromosome complement, one-half of the genes, and one-half of the DNA comes from each parent through the haploid gametes. Gametes produced by the diploid parents of these organisms receive exactly one-half the parental chromosomes and genetic material. Meiosis operates through the process of gamete formation to insure this result. For the development of concepts of evolution subsequently presented in the book, all examples will refer to population where one-half of the chromosomes, genes, and DNA present in the diploid adults comes from each parent through the haploid gametes.

Genes and Alleles : In previous sections it has been shown how chromosomes and DNA are replicated and inherited. Most genetic studies are concentrated upon the individual segments of the DNA molecule, the genes, each capable of directing the formation of a particular polypeptide chain. The gene and its polypeptide produce are apparently collinear, and the genes are arranges in a linear sequence on the chromosome. On paired homologous chromosomes – are present in each diploid cell. Very frequently a particular gene location is represented on different chromosomes by several slightly different base sequence that produce different polypeptides. These differences in polypeptides may be reflected in enzyme formation or in the visible expression of some characteristic. The different base sequences, or expressions of them, are called alleles of the gene. In tomatoes, for example, the gene for stem color may produce one or the other of two enzymes that control the presence of a purple pigment. One allele (base sequence) if present produces a purple stem, the other a green stem. The gene is called the stem-color gene (although it does not produce stem-color by itself) and its tow expressions, the purple and green stem alleles. Each diploid tomato plant

cell contains two stem-color genes, one on each of a homologous pair of chromosomes. Tomato plant gametes always contain only one stem-color gene, since they contain only one chromosome from each homologous pair.

In any particular individual organism, any combination of alleles for a particular gene may be present. A tomato plant may have two purple-stem alleles or two green-stem alleles, or one of each. For simplification, we can symbolize these alleles as follows:

a_1 = purple stem, a_2 = green stem

The possible combinations are

a_1a_1 a_2a_2 a_1a_2

When dealing with gene combinations the appearance of the organism is called its phenotype; thus the phenotype of a_1a_1 is a purple stem. The actual combination of genetic materials is called a genotype; thus the genotype of tomatoes with a green stem is a_2a_2. In many instances, when two different alleles for a particular gene are present, the phenotype appears identical to that of an individual having two identical alleles. The other allele is present and is passed on to the gametes is masked out by what may be called the dominant allele. The hidden gene is called a recessive allele. In tomatoes, individuals with the genotype a_1a_2 have a purple stem (phenotype), indicating that a_1 (purple) is a dominant allele and a_2 (green) is recessive.

Of course, of utmost importance in considering heredity and the probabilities of gene combination is the production of gametes. Individuals of the genotype a_1a_1 and a_2a_2 each produce only one kind of gamete, all a_1 and all a_2, respectively, and are called homozygous. Organisms with a genotype of a_1a_2 produce equal numbers of each type of gamete and are called heterozygous.

Probability and Genetus : Because of the constant and exact manner in which chromosomes and genes are replicated in reproduction, the theory of probability may be applied to the analysis of genetic and evolutionary events. In mitosis no range of possibility exists, for each daughter cell is an exact genetic duplicate of the parental cell. Probability theory is of great significance in understanding the genetics of sexual reproduction, however, since new individuals produced by this means receive, in the form of discrete units, exactly one-half of their heredity from each parent.

Most of you are familiar with probability theory as applied to the loss of a coin : What is the probability of obtaining a head on any particular loss? Or in playing cards : What is the probability of cutting the deck to a kind or to the ace of spades? A better example for our discussion is to reconsider the case of meiosis developed above (Fig. 2-2). For the sake of example, let us regard the products of two lineages (1 and 2) as representing the gametes of two individuals, one (1) a

male, the other (2) a female. Further, we will concern ourselves only with the single pair of large chromosomes, which can be either dark or light. If it is assumed that 1,000 male gametes are present, it is obvious from the nature of meiosis that 500 will contain a dark chromosome and 500 will contain a light chromosome. Let us first consider the probability under these circumstances of sampling the gametes and obtaining one with a dark chromosome. It is clear that the chance of drawing a gamete with a light chromosome is just as likely as drawing a dark one; the events are equally probable. How do we express these probabilities?

The general formula for the probability, R, of a single event is

$$R = \frac{f}{f + u}$$

where is the number of ways in which the selected or favorable event may transpire, and u the number of ways in which some other outcome or unfavorable event may occur. R is usually is given as a fraction or decimal; f + u is always equal to the total number of events. To return to the example, the number of favorable events is 500 dark chromosomes and the total number of events possible is 500 dark chromosomes plus 500 light chromosomes :

$$R = \frac{500}{1,000}$$

$$R = \frac{5}{10}$$

$$R = 0.5$$

The probability of obtaining a gamete with a dark chromosome on any one draw is 0.5. (What is the probability of obtaining a gamete with a light chromosome?)

The probabilities for any single event range from 0 to 1.0, a probability of 1.0 representing certainly. The probability of drawing a indicated in the diagram is 1.0. A probability of 0 means that the event is impossible. The probability of obtaining a gamete with 7 chromosomes from the indicated individuals is 0. In any given situation, the sum of the probabilities of all possible events always equals 1.0. (With these facts in mind, what is the probability of drawing a gamete containing one large dark chromosome and one small light chromosome from the mixed gametes of individuals 1 and 2, if the total number of gametes present is 1,000?)

Thus far, we have considered only the probability laws relating to single events; those principles applicable to the probabilities of two or more independent events happening simultaneously are more meaningful for problems of sexual

reproduction. Again if we consider only the larger chromosomes in the gametes (1,000 male gametes and 1,000 female gametes), what is the probability of a zygote being formed by the coming together of any two gametes (one male and one female)? To answer this Qtion, let us assume that fertilization has occurred at random to produce 1,000 zygotes. What is the probability that a zygote will contain two lights chromosomes? The probability of two or more independent events happening jointly is the product of the probability of one event times the probability of the other:

$$R = \frac{f_1}{f_1 + u_1} X \frac{f_2}{f_2 + u_2}$$

$$R = R_1 X R_2$$

The probability of obtaining, in this example, a male gamete with a large light chromosome is $0.5(R_1)$, and the probability of a female gamete with a large light chromosome is $0.5(R_2)$. The probability of any zygote in the sample having two large light chromosome is

$$R = 0.5 X 0.5$$

$$R = 0.25$$

The probability of obtaining a zygote from a male gamete with a large dark chromosome and a female gamete with a large dark chromosome is similarly 0.25. Again, the probability of drawing a zygote with a large light and a large dark chromosome formed a male gamete with a light and a female gamete with a dark chromosome is 0.25; the probability of the reverse situation, a zygote formed from a male gamete with a dark and a female gamete with a light chromosome, is also 0.25. In drawing zygotes from the pool of 1,000 there are only these four possibilities, each with a probability of 0.25. The sum of the four probabilities equals 1.

In the example above, it is seen that while there is only one possible way to produce a zygote with two light or two dark chromosomes; however, a zygote containing one light and one dark chromosome may be formed in two ways. If we are concerned only with the probability of getting a zygote of this latter type, a third principle is applicable. When a particular independent event may occur in more than one way, its probability is the sum of the probabilities for each manner in which the event takes place:

$$R = R_1 + R_2$$

In the discussed example the probability for each of the two ways of obtaining a zygote with one light and one dark chromosome is 0.25. The probability of drawing such a zygote, without reference to the manner of origin, is

R = 0.25 + 0.25

R = 0.5

Although the manner of determining probabilities to explain the three principles has been detailed above, it is not necessary for out purposes to work out probabilities by listing all of the possible arrangements in every case. A simple formula will serve to provide us with all of the required information. Since a zygote is always formed by the joint occurrence of two independent events (the two gametes), the expansion of the binomial $(p + q)^2$ provides the probabilities directly :

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

p = the frequency or probability that a zygote contains a light chromosome $(p = 1 - q)$

q = the frequency or probability that a zygote contains a dark chromosome $(q = 1 - p)$

the exponent 2 indicates that two independent events involving p and q are happening simultaneously; $p + q = 1$, $(p + q)^2 = 1$.

In the expansion, each term indicates the probability of a particular combination of the two events :

P^2 = the frequency or probability that a zygote with two light chromosome (p x p)

q^2 = the frequency or probability that a zygote with two light chromosome (q x q)

2pq = the frequency of probability of a zygote with one light and one dark chromosome (2 indicating that there are two ways to obtain this result).

This general formula may be applied to any situation involving zygote formation. For example, if the large chromosomes are ignored (Fig.2-3), what are the probabilities of drawing zygotes (produced by crossing 1 and 2) containing two small light chromosomes and two small dark chromosomes or a small light and a small dark chromosome.

The previous section of this discussion indicates how the hereditary carriers, the chromosomes, are inherited. The actual regulators of heredity, the genus, are located in a linear sequence on the chromosomes. On the basis of the above and your background in genetics (see Levine, Genetics in this series), solve the following problems.

Problems :

(1) A plant breeder carried out the following experiment involving garden peas. He crossed a stain homozygous for smooth coated peas (in the pod) with another homozygous for wrinkled peas. All of the offspring had pods full or smooth-coated peas. Since garden peas are usually self-fertilizing, he prevented self-fertilization and made random crosses among these individuals. What are the probabilities of finding each of the following in the next generation : phenotypes for wrinkled and smooth; genotypes for homozygous recessive, homozygous dominant, and heterozygous?

(2) A plant breeder crossed homozygous red-flowered primrose with a homozygous white-flowered primrose. All of the offspring were pink flowered. One of the pink-flowered individuals was crossed back to the original red-flowered plant. What are the probabilities for each of the following in the next generation: phenotypes for red, white, and pink; homozygous and heterozygous genotypes?

(3) In many animals more than two alleles may be found for any particular gene. In rabbits; four alleles for the coat-color gene are present. On allele when homozygous produces a dark gray coat; the second a light grey coat; the third a Himalayan coat, white and black ears, nose, feet, and tail; and finally albino. The alleles show dominance, decreasing in the order given above. A Himalayan individual is crossed with an albino. If it is assumed that all genotypes are equally represented, what is the probability that the offspring will be albino? The same Himalayan is crossed with an individual with a dark grey coat; what is the probability that the offspring is albino?

Q.4 Write an essay on Divergent evolution.

Ans.: Divergent evolution can be seen in some higher-level characters of structure and function that are readily observable in organisms. For example, the vertebrate limb is one example of divergent evolution. The limb in many different species has a common origin, but has diverged somewhat in overall structure and function.

Alternatively, "divergent evolution" can be applied to molecular biology characteristics. This could apply to a pathway in two or more organisms or cell types, for example. This can apply to genes and proteins, such as nucleotide sequences or protein sequences that derive from two or more homologous genes. Both orthologous genes (resulting from a speciation event) and paralogous genes (resulting from gene duplication within a population) can be said to display

divergent evolution. Because of the latter, it is possible for divergent evolution to occur between two genes within a species.

In the case of divergent evolution, similarity is due to the common origin, such as divergence from a common ancestral structure or function has not yet completely obscured the underlying similarity. In contrast, convergent evolution arises when there are some sort of ecological or physical drivers toward a similar solution, even though the structure or function has arisen independently, such as the different characters converge on a common, similar solution from different points of origin. In other words divergent evolution is where animals closely related evolve different structures.

"Divergent evolution" is most commonly meant when someone invokes evolutionary relationships and "convergent evolution" is applied when similarity is created by evolution independently creating similar structures and functions. The term parallel evolution is also sometimes used to describe the appearance of a similar structure in closely related species, whereas convergent evolution is used primarily to refer to similar structures in much more distantly related clades. For example, some might call the modification of the vertebrate limb to become a wing in bats and birds to be an example of parallel evolution. Vertebrate forelimbs have a common origin and thus, in general, show divergent evolution. However, the modification to the specific structure and function of a wing evolved independently and in parallel within several different vertebrate clades. Also, it has much to do with humans and the way they function from day to day.

In complex structures, there may be other cases where some aspects of the structures are due to divergence and some aspects that might be due to convergence or parallelism. In the case of the eye, it was initially thought that different clades had different origins of the eye, but this is no longer thought by some researchers. It is possible that induction of the light-sensing eye during development might be diverging from a common ancestor across many clades, but the details of how the eye is constructed--and in particular the structures that focus light in cephalapods and vertebrates, for example--might have some convergent or parallel aspects to it, as well. (See Gehring reference below and other researchers cited in that research field).

A good example of divergent evolution is the Darwin's finches, which has now over 80 varieties which all diverged from one original species of finch. (John Barnes)

Q.5 What do you understand by micro evolution? Write a note in brief.

Ans.: **Microevolution :** Individuals Don't Evolve, Populations Do

People change throughout their lifetime, growing taller and sometimes wider, curling and cutting their hair. However, each individual's genetic make-up stays the same. That means that these changes are not evolution. Evolution on a small scale, called microevolution, happens as changes happen to the genetic make-up of a group of organisms of the same species over many generations.

All of the versions of all of the genes in a population of a species are called a gene pool. A gene pool changes over many generations. Small changes in the amount of each type of gene can happen for a number of reasons.

- Gene mutation: An error during cell division can create a new type of gene. That new gene is a small part of the gene pool. It can be passed on to the next generation. If the new gene is useful, it might become a common part of the gene pool.
- Gene flow: If new individuals of the species move into or out of the region, it can affect the gene pool. For instance, the only people in North America were once Native Americans. Immigration from other parts of the world over the last several hundred years has changed the gene pool of the origional people a lot.
- Genetic drift: The amount of each gene in a gene pool can change over time because of chance events. For instance, if a few individuals leave a population and establish a new one, by chance their gene pool may not have the same frequency of genes as in the population they left, but those genes become the gene pool of the new population.
- Natural selection: Some genetic differences will improve the chances of survival for individuals that have them. For instance, hawks with large talons may be more likely to survive than hawks with small talons. Since the surviving ones make the next generation, the genes for large talons are more likely to be passed on. Eventually, the gene pool shifts towards large talons.

Natural Selection

Q.6 Write an essay on the role of natural selection in the evolution.

Ans.: The natural selection is the directive facto in evolution is now generally accepted. Darwin and Wallace proposed that natural selection in the mechanism by which new species arise from pre-existing species.

This hypothesis / theory is based on the observations and two deductions which may be summarized as follows :

Observation 1 : Individual with in a population produce on average more offspring than are needed to replace themselves.

Observation 2 : The numbers of individuals in a population remains approximately constant.

Deduction 1 : Many individuals fail to survive or reproduce. There is a "struggle for existence" with in a population.

Observation 3 : Variation exists with in all populations.

Deduction 2 : In the "struggle for existence" those individuals showing variations best adopted to their environment have a "reproductive advantage" and produce more offspring than less well – adopted organisms.

Deduction 2 offers a hypothesis called natural selection which provides a mechanism accounting for evolution.

Variation

Q.7 Write a note on somatogenic or somatic variations.

Ans.: The difference shown by the organisms even when the environment is same are called as variations.

These variations are due to the direct influence of the environment upon the soma or body.

These variations are neither inherited from the parents nor are transmitted to the progeny but they are acquire by the individuals during its own life time and are lost with its death. Therefore these are also called as acquired variations. These are not generally transmitted by heredity because they do not affect the germ cells. These are many examples of acquired characters. For example, sun-burnt complexion of emopeans in tropics. Better development of muscles of an athlete, the loss of a tail or a digit through accident, the boring of the lobe of the external ears etc.

Effects of Environment : Tower and Agar performed various experiments about effects of environment on somatic variations in rats and mice; rising or lowering of the temperature effects the growth by certain modifications. In majority of the cases, mice reared in a warm room, about 21˚C, were found to differ considerably

form those reared in a cold room having about 5˚C temperature. Cunningham experimentally proved that in a normal flat fish, Soleo, the lower surface, which is originally white, also becomes pigmented in response to light.

The nature of the medium in which individuals live has a definite influence on their farm and behavior. When the eggs of a fish called fundulus are exposed to the influence of magnesium chloride, they hatch into peculiar fish having a single median eye instead of two normal lateral eyes. Shape of the larvae of sea-urchins and frogs can also be modified by the addition of lithium salts to the water in which they live. The nature of food has marked effect on the metabolism of an individual. When tadpoles of frog are fed on thyroid of mammals, they pass through all the shapes of metamorphosis very rapidly, although at the end they are still of very small size. Those tadpoles, which are fed on ordinary diet, grow to normal size of a tadpole but take much longer time of complete metamorphosis.

The use and disuse of organs also produe variations. The continuous use of an organ result in better development. Whilst the constant disuse of an organ reduces it.

For example an athlete who uses his muscle daily in exercise, acquires a stronger and more muscular physique than the one who does not do any exercise. Other example are true of other animals. An animal kept in captivity in a zoo weaker than the one living in natural haunts.

Somatic variations are produced by conscious efforts of human beings. The examples are : achieving slender waists by using light garments and belts by European women receiving education, learning an art and formic habits and so on.

Adaptations

Q.8 Write about Natural Selection and Adaptation.

Ans.: That natural selection is the directive factor in evolution is now generally accepted. Since natural selection rests upon a complex web of phenomena, no one definition of selection satisfies everyone. A definition acceptable to many is as follows: natural selection is the consistent differential survival and reproduction of two or more classes of entities.

Any change in gene frequency requires that one allele be replicated more than another. Selection occurs when individuals of one genotype survive and reproduce better on the average than those of a different genotype. But if an average superiority is to be expressed, there must exist at least several copies of

each gene. In other words, there must exist classes of genes or genotypes. Thus, selection requires the presence of multiple copies of each gene and the hereditary transmission of that gene. The stronger its degree of heredity, the more effective and long lasting will be the results of selection.

Selection of whole genotypes in a sexually reproducing species occurs only rarely because whole genotypes are not precisely reproduced. Similarly, selection of whole chromosomes barely exists because a "superior" chromosome lasts only a few generations before it is broken up by crossing-over. Selection is most effective and has its most enduring effects when it acts on single genes, which are faithfully replicated and strongly inherited.

The gene is undoubtedly the major unit of selection. Other biological entities – chromosomes, genotypes, populations also function as units of selection, albeit less efficiently. At the level of populations, interdemic or group, selection can occur when population of one kind emerge or die out at a different rate from populations of another kind. Species selection occurs when the species is the unit of selection. In this case, a given species with a given feature more rapidly leads to other species (or less often becomes extinct) than species with another feature.

Fitness is an important aspect of natural selection. Fitness is a consequence of the relationship between an organism's phenotype and the environment in which it lives. The same genotype could have different degrees of fitness in different environments. The more fit an individual, the greater its genetic contribution to subsequent generations.

Clearly, an individual can influence the frequencies of the alleles it carries in future populations. It can do this in two ways.

- By producing its own offspring – that is, by individual selection.
- By promoting the survival of relatives with the same alleles because they have descended from a common ancestor – a mechanism called kin selection.

Combinations of individual and kin selection establish the inclusive fitness of an individual. In general species that are solitary or that reproduce in pairs tends towards individual selection, while highly social species, such as primates and social insects, give prominence to kin selection.

Changing Concept of Natural Selection : To many of Darwin's contemporaries, natural selection seemed a brutal struggle for survival in a carnage. Such phrases as "struggle for existence" and "survival of the fittest" were used by Darwin, but in a metaphorical sense.

From such concepts there developed a doctrine called social Darwinism, which interestingly was not supported by Darwin himself. Natural selection was supposed to warrant as "right" all kinds of cutthroat competition, including wars

between classes and nations, on the ground that in this way only the "fittest" would survive. The belief was unwarranted for several reasons. Natural selection is not an ethical principle that indicates what is right in human behavior. It may be natural for populations to have a high infant mortality, or for human beings or animals to be infested with parasites, but that does not mean we should happily embrace the situation.

Animals do sometimes fight and drive the weaker to the wall. Plants do complete for space, water, and sunlight. However, the competition has no bearing on populations and their genetic and evolutionary changes, unless it leads to differential reproduction. That, and not the winning or losing of a struggle by individuals, is the point of natural selection.

Creative Selection : Some nineteenth-century critics argued that the effects of natural selection could not be creative. They conceded that natural selection could account for the elimination of the unfit, but denied that it could explain the origin of the fit, a more important problem.

It is easy now to see that natural selection is indeed creative. For one thing, the selective elimination of an allele from a population does not occur unless there is an alternative allele that, under existing conditions, is superior in promoting reproduction.

Natural selection is creative in a second way that is more complex, subtle, and important. An organism's many traits are, in reality, not determined separately and independently by individual genes. Usually each gene affects many traits and each trait is affected by many genes. Genes also interact, so that a given allele may have different effects depending on neighboring alleles. As noted above, natural selection acts not only on each allele but on the genetic system as a whole. It tends to produce gene associations and integrated genetic systems that would have little or no chance of arising and spreading through populations by any random process.

Form of Selection : Natural selection produces evolutionary change by acting on the variability within a population that is under genetic control. Evolutionists have described three forms of selection.

- Stabilizing selection occurs when those phenotypes in the middle of a range of phenotypes are favored. An early student of natural selection found after a storm that killed many birds that mortality had been highest among the largest and smallest birds and lowest among those of average size. Stabilizing selection works against individuals with traits at the extreme ends of the distribution of polygenic traits, slowing their spread in populations and thereby maintaining a steadily high ratio of "better" alleles at a given locus. This type of selection generally favors reproduction of the well-adapted individuals near the average, at the expense of

deviants at the extremes. In a more subtle way, stabilizing selection seems to favor systems that tend to produce normal organisms despite varying environmental influences during development. This is how natural selection acts on most populations most of the time.

- Directional selection occurs when one phenotype – large size, for example – is favored over another phenotype, say small size. Its result is to shift the mean size in the direction of largeness in subsequent generations. Obviously, this can continue only as long as underlying genotypic differences remain in the population for a given trait. Eventually, when the population becomes genotypically homogenous with respect to that trait, selection can no longer alter the population mean for the trait.

Fig.1: Three forms of selection. The effect of different types of selection on a polygenic trait such as weight. (A) The population before selection has a normal weight distribution. (B) The individuals eliminated by selection appear in color. Stabilizing selection removes very heavy or very light individuals, producing with less weight variation. Directional selection eliminates lighter individuals, producing a population with a higher mean weight (dashed line) than in (A). Disruptive selection removes medium-weight individuals, producing two populations with different median weights (dashed lines)>

Disruptive Selection, seeming less common that the other two types of selection, occur when both the extremes of a phenotype's distribution range are favored over the middle – indeed over any intermediate type. Disruptive selection, we believe, determined the sizes and shapes of the bills of the famous ground finches of the Galapagos Islands. During dry spells the only food types available were far more accessible to finches with extreme bill sizes an shapes than to birds with bills nearer the center of the size-shape range. By splitting it population into two or more types, disruptive selection also has a potential for promotion balanced polymorphism, to be described later in the chaper.

Limitation of Selection : Even though natural selection often impels populations towards improved responses to environmental challenges, there are limits to what it can do. For one thing, it can operate only on genetic variations that are actually present in a population. Over a limited span of time, selection within a population can produce only slight modifications of what was already there. Mutations with really large effects are almost always so poorly integrated with the rest of the evolving organism that they yield "monstrosities" that are promptly eliminated by stabilizing selection. Of course, drastic changes do result from natural selection, but we believe that these occur only by the slow accumulation of lesser changes over many generations in the course of millions of years.

Possible future changes can arise only from past mutations, which are often nonadaptive. Surely, the likelihood is small that a chance mutation will improve something as intricate as an enzyme or a receptor. Quite the contrary, and this is undoubtedly why elaborate mechanisms have evolved for repairing altered DNA.

In other words, natural selection has to work with what is available. Also – and this deserves emphasis – it acts on phenotypes, and these can be many steps removed from the genotypes whose changes guide the course of evolution. As a result, we find many examples of "jerry-rigged" contraptions in nature, the human propensity to low-back pain and difficult childbirth, both of which can be blamed on a less than flawless transition of quadrupendal (four-footed) locomotion to the bipedal (two-footed) variety).

Adaptive characters may actually be produced by an allele that has other effects-including nonadaptive ones. The outcome may be a compromise in design rather than a crowning perfection. Consider, for example, the male peacock's large and brilliantly colored tail. On the one hand, the tail enhance its possessor's mating success. On the other hand, it jeopardizes his ability to avoid predators. Natural selection strikes some sort of balance between the two selective forces and have given way to peacocks with tails that are "just right."

The limitations of natural selection have had a remarkable result in the history of life: the great majority of species have failed to remain adapted during environmental changes. Failure of adaptation is the usual cause of **extinction**, and it is interesting to note that most of the countless millions of species that have ever lived did in time become extinct.

Natural selection is a limited and blind process that cannot always produce adequate adaptation. The whole world of life attests nonetheless to its overall success.

Frequency-dependent (or apostatic) selection occurs when the less frequent of two alleles is favored by natural selection. This is common in nature. For example, when a female Drosophila is offered a choice of males of two genotypes, she prefers to mate with the rarer male. In contrast, most vertebrate predators seek the most common form of prey and tend to ignore rare phenotypes. (Figure 1).

Fig. 1: Frequency –dependent selection in vertebrates. Predation by a fish on three color morphs of the corixid bug, Sigara distincta. Each morph suffers proportionately higher predation when it is common than it is rare.

At least two circumstances bring about frequency dependence. One is diversity of environments. For example a predator may attack a disproportionate number of individuals belonging to the more common type and repeatedly shift its preferences. Or, some environments may favour carriers of one allele while other environments favour the competing genotype. Another circumstance involves

interactions of carriers of different genotypes. For example, there may be a pattern of mating in which individuals preferentially select others with a different allele. This is called **disassortative mating**. As a result, the rare genotypes can reproduce at a higher rate and increase their abundance until they attain the frequency at which they are no longer scarce enough to gain any advantage.

Disruptive selection, a rarer phenomenon, was described above. Polymorphism-or at least bimodality in continuously varying traits-can result if sufficiently strong selection is directed in a sustained manner against intermediate types. The resulting two peaks thus become tow subpopulations within a larger population. In extreme cases, the two subpopulations may even esplit up into two or more species. This has been demonstrated in laboratory experiments but not yet in nature. It could occur in nature if individuals showed strong mating preference for those of similar phenotype. This is called **assortative mating.**

Q.9 Write a short note on Parasitism.

Ans.: **Parasitism** is a type of symbiotic relationship between organisms of different species in which one, the parasite, benefits from a prolonged, close association with the other, the host, which is harmed. In general, parasites are much smaller than their hosts, show a high degree of specialization for their mode of life and reproduce more quickly and in greater numbers than their hosts. Classic examples of parasitism include the interactions between vertebrate hosts and such diverse animals as the tapeworms, flukes, *Plasmodium* species and fleas.

The harm and benefit in parasitic interactions concern the biological fitness of the organisms involved. Parasites reduce host fitness in many ways, ranging from general or specialized pathology (such as castration), impairment of secondary sex characteristics, to the modification of host behaviour. Parasites increase their fitness by exploiting hosts for food, habitat and dispersal.

Although the concept of parasitism applies unambiguously to many cases in nature, it is best considered part of a continuum of types of interactions between species, rather than an exclusive category. Particular interactions between species may satisfy some but not all parts of the definition. In many cases, it is difficult to demonstrate the host is harmed. In others, there may be no apparent specialization on the part of the parasite, or the interaction between the organisms may be short-lived. For example, because of the episodic nature of its feeding habits, the mosquito is not considered parasitic. In medicine, only eukaryotic organisms are considered parasites, to the exclusion of bacteria and viruses. Some branches of biology, however, do regard members of these groups to be parasitic.

Q.10 Write an essay on Parasitism.

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Types of Parasitism:

Parasites are classified based on a variety of aspects of their interactions with their hosts and on their life cycles.

Those that live inside the host are called **endoparasites** (e.g., hookworms) and such kind of parasitism is called as endoparasitism

Those that live on its surface are called **ectoparasites** (e.g., some mites). This type of parasitism is called as ectoparasitism.

An **epiparasite** is one that feeds on another parasite. This relationship is also sometimes referred to as "hyperparasitism".

Parasitoids are organisms that cause the host to die as a result of parasitism. Thus, the interaction between the parasitoid and the host is fundamentally different than true parasites and their host, and shares some characteristics with predation

Social parasites take advantage of interactions between members of social organisms such as ants or termites. In kleptoparasitism, parasites appropriate

food gathered by the host. An example is the brood parasitism practiced by many species of cuckoo. Many cuckoos use other bird species as "babysitters", depositing their eggs in the nest of the host species, which raise the cuckoo young as one of their own.

Parasitism can take the form of isolated **cheating** or **exploitation** among more generalized mutualistic interactions. For example, broad classes of plants and fungi exchange carbon and nutrients in common mutualistic mycorrhizal relationships; however, a few plants species (known as myco-heterotrophs) "cheat" by taking carbon from a fungus rather than donating it.

For **parasitic conjoined twins**, see Parasitic twin.

Evolutionary Aspects : Biotrophic parasitism is an extremely common mode of life that has arisen independently many times in the course of evolution. Depending on the definition used, as many as half of all animals have at least one parasitic phase in their life cycles,[1] and it is also frequent in plants and fungi. Moreover, almost all free-living animals are host to one or more parasite taxa.

Parasites evolve in response to defense mechanisms of their hosts. Examples of host defenses include the toxins produced by plants to deter parasitic fungi and bacteria, the complex vertebrate immune system, which can target parasites through contact with bodily fluids, and behavioural defenses. An example of the latter is the avoidance by sheep of open pastures during spring, when roundworm eggs accumulated over the previous year hatch en masse. As a result of these and other host defenses, some parasites evolve adaptations that are specific to a particular host taxon and specialize to the point where they infect only a single species. Such narrow **host specificity** can be costly over evolutionary time, however, if the host species becomes extinct. Thus, many parasites are capable of infecting a variety of host species that are more or less closely related, with varying success.

Host defenses also evolve in response to attacks by parasites. Theoretically, parasites may have an advantage in this evolutionary arms race because of their more rapid generation time. Hosts reproduce less quickly than parasites, and therefore have fewer chances to adapt than their parasites do over a given span of time.

In some cases, a parasite species may coevolve with its host taxa. In theory, long-term coevolution should lead to a relatively stable relationship tending to commensalism or mutualism, in that it is in the evolutionary interest of the parasite that its host thrives. For example, although animals infected with parasitic worms are often clearly harmed, and therefore parasitized, such infections may also reduce the prevalence and effects of autoimmune disorders in animal hosts, including humans.

The presumption of a shared evolutionary history between parasites and hosts can sometimes elucidate how host taxa are related. For instance, there has been dispute about whether flamingos are more closely related to the storks and their allies or to ducks, geese and their relatives. The fact that flamingos share parasites with ducks and geese is evidence these groups may be more closely related to each other than either is to storks.

Parasitism is part of one explanation for the evolution of secondary sex characteristics seen in breeding males throughout the animal world, such as the plumage of male peacocks and manes of male lions. According to this theory, female hosts select males for breeding based on such characteristics because they indicate resistance to parasites and other disease.

Q.11 What do you understand by the term mimicry? Write in detail.

Ans.: Use of the word mimicry dates back to 1637. It is derived from the Greek term *mimetikos*, "imitative," in turn from *mimetos*, the verbal adjective of *mimeisthai*, "to imitate." Originally used to describe people, it was only applied to other forms of life after 1851.

Classification : Many types of mimicry have been described. An overview of each follows, highlighting the similarities and differences between the various forms. Classification is often based on function with respect to the mimic (e.g. avoiding harm), though other parameters can also be used, and multidimensional classifications are required to understand the full picture. For this reason, some cases may belong to more than one class, e.g. automimicry and aggressive mimicry are not mutually exclusive, as one describes the species relationship between model and mimic, while the other describes the function for the mimic (obtaining food).

Defensive : Defensive or protective mimicry takes place when organisms are able to avoid an encounter that would be harmful to them by deceiving an enemy into treating them as something else. Four such cases are discussed here, the first three of which entail mimicry of an aposematic, harmful organism: Batesian mimicry, where a harmless mimic poses as harmful; Müllerian mimicry, where two harmful species share similar perceived characteristics; and Mertensian mimicry, where a deadly mimic resembles a less harmful but lesson-teaching model. Finally, Vavilovian mimicry, where weeds resemble crops, is discussed.

Batesian : Several species, including several hoverflies, mimic stinging species of wasp.

In Batesian mimicry the mimic shares signals similar to the model, but does not have the attribute that makes it unprofitable to predators (e.g. unpalatability). In other words, a Batesian mimic is a sheep in wolf's clothing. It is named after Henry Walter Bates, an English naturalist whose work on butterflies in the Amazon rainforest (including *The Naturalist on the River Amazons*) was pioneering in this field of study.[10][11] Mimics are less likely to be found out when in low proportion to their model, a phenomenon known as negative frequency dependent selection which applies in most other forms of mimicry as well. This is not the case in Müllerian mimicry however, which is described next.

Examples :

- **Lepidoptera**
  - The Ash Borer (*Podosesia syringae*), a moth of the Clearwing family (Sesiidae), is a Batesian mimic of the Common wasp because it resembles the wasp, but is not capable of stinging. A predator that has learned to avoid the wasp would similarly avoid the Ash Borer.
  - Plain Tiger (*Danaus chrysippus*) - an unpalatable model with a number of mimics.
  - Common Crow (*Euploea core*) - an unpalatable model with a number of mimics. See also under *Müllerian mimicry* below.
  - *Consul fabius* and *Eresia eunice* imitate unpalatable *Heliconius* butterflies such as *H. ismenius*.
  - Several palatable butterflies resemble different species from the highly noxious papilionine genus *Battus*.
  - Several palatable moths produce ultrasonic click calls to mimic the unpalatable tiger moths.
- The False Cobra (*Malpolon moilensis*) is a mildly venomous but harmless colubrid snake which mimics the characteristic "hood" of an Indian cobra's threat display. The Eastern Hognose Snake (*Heterodon platirhinos*) similarly mimics the threat display of venomous snakes.
- Octopuses of the genus *Thaumoctopus* (the Mimic Octopus and the "wunderpus") are able to intentionally alter their body shape and color so that they resemble dangerous sea snakes or lionfish.[14]

Müllerian : The Heliconius butterflies from the tropics of the Western Hemisphere are the classical model for Müllerian mimicry.[15]

Müllerian mimicry describes a situation where two or more species have very similar warning or aposematic signals and both share genuine anti-predation attributes (e.g. being unpalatable). At first Bates could not explain why this should be so; if both were harmful why did one need to mimic another? The German naturalist Fritz Müller put forward the first explanation for this phenomenon: If two species were confused with one another by a common predator, individuals in both would be more likely to survive.[16][17] This type of mimicry is unique in several respects. Firstly, both the mimic and the model benefit from the interaction, which could thus be classified as mutualism in this respect. The signal receiver is also advantaged by this system, despite being deceived regarding species identity, as it avoids potentially harmful encounters. The usually clear identity of mimic and model are also blurred. In cases where one species is scarce and another abundant, the rare species can be said to be the mimic. When both are present in similar numbers however it is more realistic to speak of each as *comimics* than of a distinct 'mimic' and 'model' species, as their warning signals tend to converge toward something intermediate between the two.[18] Another theoretical problem comes up when one considers that the two species may exist on a continuum from the harmless to the highly noxious, raising the Qtion of where Batesian mimicry ends and Müllerian convergence begins.

Examples :

- **Lepidoptera**
  - The Monarch Butterfly (*Danaus plexippus*) is a member of a Müllerian complex with the Viceroy butterfly (*Limenitis archippus*) in shared coloration patterns and display behavior. The Viceroy has subspecies with somewhat different coloration, each one very closely matching the local *Danaus* species. E.g., in Florida, the pairing is of the Viceroy and the Queen Butterfly, and in Mexico, the Viceroy resembles the Soldier Butterfly. Therefore, the Viceroy is a single species involved in three different Müllerian pairs.[21] This example was long believed to be a case of Batesian mimicry, with the Viceroy being the mimic and the Monarch the model, but it was more recently determined that the Viceroy is actually the *more* unpalatable species, though there is considerable individual

variation.[22] While *L. archippus* is really bad-tasting, *Danaus* species tend to be toxic rather than just repugnant, due to their different food plants.

- Unpalatable *Euploea* species look very similar. See also under *Batesian mimicry* above.
- The genus *Morpho* is palatable but are very strong fliers; birds - even species which are specialized for catching butterflies on the wing - find it very hard to catch them. The conspicuous blue coloration shared by most *Morpho* species seems to be a case of Müllerian mimicry.[12]
- The "orange complex" of species, including the heliconiines *Agraulis vanillae*, *Dryadula phaetusa*, and *Dryas iulia* which all taste bad.[12]
- Many different tiger moths make ultrasonic clicking calls to warn bats that they are unpalatable. Presumably a bat may learn to avoid *any* signalling moths, which would make this an example of Müllerian mimicry.[13]

- Various bees and numerous vespid and sphecoid wasps: These animals are examples of Müllerian mimics because they have the aposematic yellow and black stripes (sometimes black and red, or black and white). Females of most of these species are potentially harmful to predators, fulfilling the second requirement of Müllerian mimicry. However, in essentially all such species, the males are harmless, and can thus be considered automimics of their conspecific females (see below). There are also many genera in these groups where the females are not capable of stinging, and yet still possess aposematic coloration (e.g., the wasp genus *Cerceris*), so they are considered Batesian mimics.

Emsleyan/Mertensian : Texas Coral Snake, *Micrurus tener*

Emsleyan or *Mertensian mimicry* describes unusual cases where deadly prey mimic a less dangerous species. It was first proposed by Emsley as a possible answer for the problem of Coral Snake mimicry in the New World. It was elaborated on by the German biologist Wolfgang Wickler in a chapter of *Mimicry in Plants and Animals*, who named it after the German herpetologist Robert Mertens. This scenario is a little more difficult to understand, as it is usually the most harmful species that is the model. If a predator dies, it cannot learn to recognize a warning signal, e.g. bright colors in a certain pattern. In other words, there is no advantage

in being aposematic if an organism will kill any predators it succeeds in poisoning. It would then be better off camouflaged instead, so as to avoid encounters altogether. If, however, there is another species that is harmful but not deadly, the predator may learn to avoid it. Provided it results in less encounters than camouflage, the deadly species can then profit by mimicking this aposematic organism.

The exception here, ignoring any chance of animals learning by watching a conspecific die, is the possibility of not having to learn that it is harmful in the first place: instinctive genetic programming to be wary of certain signals. In this case, other organisms could benefit from this programming, and Batesian or Müllerian mimics of it could potentially evolve. In fact, it has been shown that some species do have an innate recognition of certain aposematic warnings. Hand-reared Turquoise-browed Motmots (*Eumomota superciliosa*), avian predators, instinctively avoid snakes with red and yellow rings. Other colors with the same pattern, and even red and yellow *stripes* with the same width as rings, were tolerated. However, models with red and yellow rings were feared, with the birds flying away and giving alarm calls in some cases. This provides one alternative explanation to Mertensian mimicry. See Greene and McDiarmid for a review of the subject.

Examples :

- Some Milk Snake (*Lampropeltis triangulum*) subspecies (harmless), the moderately toxic False Coral Snakes (genus *Erythrolamprus*), and the deadly Coral Snakes all have a red background color with black and white/yellow stripes. In this system, both the milk snakes and the deadly coral snakes are mimics, whereas the false coral snakes are the model.

Wasmannian : Wasmannian mimicry refers to cases where the mimic resembles a model along with which it lives (inquiline) in a nest or colony. Most of the models here are social insects such as ants, termites, bees and wasps.[29]

Aggressive - Aggressive mimicry : Aggressive mimicry describes predators (or parasites) which share the same characteristics as a harmless species, allowing them to avoid detection by their prey (or host). It is less often known as *Peckhamian mimicry* after George and Elizabeth Peckham.[36][37] The mimic may resemble the prey or host itself, or another organism which is either neutral or beneficial to the signal receiver. In this class of mimicry the model may be affected negatively, positively or not at all. Just as parasites can be treated as a

form of predator,[38] host-parasite mimicry is treated here as a subclass of aggressive mimicry.

The mimic may have a particular significance for duped prey. One such case is spiders, amongst which aggressive mimicry is quite common in both in luring prey and stealthily approaching predators. One case is the Golden Orb Weaver (*Nephila clavipes*), which spins a conspicuous golden colored web in well-lit areas. Experiments show that bees are able to associate the webs with danger when the yellow pigment is not present, as occurs in less well-lit areas where the web is much harder to see. Other colors were also learned and avoided, but bees seemed least able to effectively associate yellow pigmented webs with danger. Yellow is the color of many nectar bearing flowers, however, so perhaps avoiding yellow is not worth while. Another form of mimicry is based not on color but pattern. Species such as *Argiope argentata* employ prominent patterns in the middle of their webs, such as zigzags. These may reflect ultraviolet light, and mimic the pattern seen in many flowers known as nectar guides. Spiders change their web day to day, which can be explained by bee's ability to remember web patterns. Bees are able to associate a certain pattern with a spatial location, meaning the spider must spin a new pattern regularly or suffer diminishing prey capture. Another case is where males are lured towards what would seem to be a sexually receptive female; the model in this situation being the same species as the dupe. Beginning in the 1960s, James E. Lloyd's investigation of female fireflies of the genus *Photuris* revealed they emit the same light signals that females of the genus *Photinus* use as a mating signal. Further research showed male fireflies from several different genera are attracted to these "femmes fatales", and are subsequently captured and eaten. Female signals are based on that received from the male, each female having a repertoire of signals matching the delay and duration of the female of the corresponding species. This mimicry may have evolved from non-mating signals that have become modified for predation.

Automimicry : Automimicry or intraspecific mimicry occurs within a single species, one case being where one part of an organism's body resembles another part. Examples include snakes in which the tail resembles the head and show behavior such as moving backwards to confuse predators and insects and fishes with eyespots on their hind ends to resemble the head. The term is also used when the mimic imitates other morphs within the same species. When males mimic females or *vice versa* this may be referred to as sexual mimicry.

Examples :

- Many insects have filamentous "tails" at the ends of their wings which are combined with patterns of markings on the wings themselves to create a "false head" which misdirects predators (e.g., hairstreak butterflies).
- Several pygmy owls bear "false eyes" on the back of their head to fool predators into believing the owl is alert to their presence.
- The yellow throated males of the Common Side-blotched Lizard use a 'sneaking' strategy in mating. They look and behave like unreceptive females. This strategy is effective against 'usurper' males with orange throats, but ineffective against blue throated 'guarder' males, which will chase them away.
- Female hyenas have pseudo-penises which make them look like males.

Other :

Some hawk-cuckoos resemble hawks like the Shikra.

Some forms of mimicry do not fit easily within the classification given above.

Owl butterflies (genus *Caligo*) bear eye-spots on the underside of their wings; if turned upside-down, their undersides resemble the face of an owl (such as the Short-eared Owl or the Tropical Screech Owl) for which in turn the butterfly predators - small lizards and birds - would be fooled.[61] Thus it has been supposed that the eye-spots are a form of Batesian mimicry. However, the pose in which the butterfly resembles an owl's head is not normally adopted in life. Recently zoologists have shown experimentally that eye-spots are not a form of mimicry and do not deter predators because they look like eyes, rather patterns on moth wings deter predators due to conspicuousness. [62]

Another case is floral mimicry induced by the discomycete fungus *Monilinia vaccinii-corymbosi*.[63] In this unusual case, a fungal plant pathogen infects leaves of blueberries, causing them to secrete sugary substances including glucose and fructose, in effect mimicking the nectar of flowers. To the naked eye the leaves do not look like flowers, yet strangely they still attract pollinating insects like bees. As it turns out, the sweet secretions are not the only cues—the leaves also reflect ultraviolet, which is normally absorbed by the plant's leaves. Ultraviolet light is also employed by the host's flowers as a signal to insects, which have visual systems quite capable of picking up this low wavelength (300-400nm) radiation. The fungus is then transferred to the ovaries of the flower where it produces mummified, inedible berries, which overwinter before infecting new plants. This case is unusual in that the fungus benefits from the deception, but it is the leaves which act as mimics, being harmed in the process. It bears similarity to host-parasite mimicry, but the host does not receive the signal. It also has a little in

common with automimicry, but the plant does not benefit from the mimicry, and the action of the pathogen is required to produce it.

Study of Extinct Form

Q. 12 Write an essay on Archaeopteryx.

Ans.:

Cast of the Berlin specimen of Archaeopteryx lithographica*, from the collections of UCMP. Original at Humboldt University, Berlin.*

Introduction : *Archaeopteryx lithographica* ("ancient wing from the printing stone").

Named after the limestone in which it was discovered. The stone is a smooth, fine grained limestone which was used in printing. Quarried from in and around the Solnhofen area of Germany. Formed on the bottom of a hypersaline lagoon in the Late Jurassic, about 150 million years ago.

***Archaeopteryx* Specimens :** There have been 8 specimens of *Archaeopteryx* found (7 actual specimens and one feather). These finds are documented chronologically (by description) below.

(1) The Feather : Found in 1860 near Solnhofen and a revelation when it was described by H. v Meyer in 1861.

(2) **The London Specimen :** Found in 1861, near Langenaltheim. Probably the best known (together with the Berlin specimen). Its discovery was announced by H. v Meyer in 1861 and the specimen was subsequently bought by the British Museum of Natural History in London (under the instruction of Richard Owen).

(3) **The Berlin Specimen :** Found in 1877 near Blumenberg. This was a better specimen than the London specimen.

(4) **The Maxburg Specimen :** Found in 1958 near Langenaltheim (same as London Specimen). This specimen is of the torso only and is the only specimen to still be in private hands.

(5) **The Haarlem or Teyler Specimen :** This specimen was actually found near Reidenburg in 1855, 5 years **before** the feather! It lay in a museum after being classified as *Pterodactylus crassipes* by H. v Meyer in 1875.

(6) **The Eichstatt Specimen :** Found near Workerszell in 1951, it was described by P. Wellnhofer in 1974. This is the smallest of all the specimens, being some 2/3 the size of the others.

(7) **The Solnhofen Specimen :** Found in the 1960's near Eichstatt by a Turkish worker.

(8) **The Solnhofen-Aktien-Verein Specimen :** A new specimen was described by Wellnhofer (1993), but the description is in German and so information is limited.

Archaeopteryx's Avian Features :

(1) **Feathers :** Feathers are **the** diagnostic feature of modern birds. This is one of the main criterion for classifying Archae as a bird, as no other modern animal has feathers. The possession of feathers is a characteristic of birds, so strike one up for the birds. **However**, in late 1996, a discovery in China may change this view. A small theropod dinosaur *Sinosauropteryx* by Chen et al. 1998 was found with what appear to be feathers preserved along the back. The identification of the sturctures is equivocal however, e.g. Unwin 1998, with some doubting that the structures are feathers.

Feathered Dinosaurs Found (Extinct forms of Reptiles with Feathers) : Two species of dinosaur have recently been found in northeast China which possess feathers by Qiang et al. 1998. *Protoarchaeopteryx robusta* and *Caudipteryx zoui* show regiges, rectrices and plumulaceous feather inpressions. Further, they are not birds, lacking a reverted (backwards facing) big toe and a quadrratojugal squamosal contact, having a quadrojugal joined to the quatrate by a ligament and a reduced or absent process of the ishium. These and other characters group *Protoarchaeopteryx* and *Caudipteryx* with maniraptoran coelurosaurs rather than birds.

It appears that feathers can no longer be used as a unique feature of birds.

(2) **Opposable Hallux (big toe) :** This also is a character of birds and not of dinosaurs. Although opposable big toes are found in other groups, they are not found in dinosaurs. A reversed big toe is found in some dinosaurs however, and the condition is approached in some theropod dinosaurs.

(3) **Furcula (Wishbone) formed of two clavicles fused together in the midline.** Now we start getting on shaky ground. It used to be thought that the possession of a furcula distinguished birds from dinosaurs. Indeed, up until recently even clavicles were few and far between in even theropod and they have been found in several species, e.g., *Segisaurus, Velociraptor, Euparkeria, Ornithosuchus, Saltoposuchus, Ticinosuchus.*

It has been found that the clavicles are often small and poorly ossified. This is no surprise, since they are of little evolutionary advantage to your average theropod dinosaur. However, birds too show this variation in ossification, especially amongst the carniates and some parrots, clavicles are reduced or even missing. Therefore the apparent absence of clavicles in some theropod dinosaurs may well be due to poor ossification rather than true absence.

(4) **Pubis elongate and directed backward.** This is a feature of birds, but it is also a feature of some theropod dinosaurs so is not diagnostic of birds - another neutral character. However, the pubic shafts of *Archaeopteryx* and dromaeosaurs (a group of theropod dinosaurs which are thought to be closely linked to birds) share a plate-like, slightly angled transverse cross-section which not found in any other archosaurs.

Archaeopteryx's Reptile Features :

(5) **Premaxilla and Maxilla are not horn-covered.** This is posh talk for "does not have a bill." The premaxilla does not have a keratinized covering, so *Archaeopteryx* has no bill. The bill is produced via the process of 'cornification' which involves the mucus layer of the epidermis and thus its formation is independant of jaw bone formation.

(6) **Trunk region vertebra are free.** In birds the trunk vertebrae are always fused.

(7) **Bones are pneumatic.** I.e. they appear to have air-sacs, as they do in birds and in some dinosaurs (It should be pointed out that previous claims suggesting the bones of Archae were not pneumatic was based on negative evidence, i.e. that the bones do not exhibit pneumatic pores (through which the air sacs enter the bones) and the bones show none of the

plumpness and bulges which characterise the pneumatic bones of modern birds. Britt et al. found evidence for the presence of pnematic bones in *Archaeopteryx*:

(8) **Pubic Shafts with a plate-like, and slightly angled transverse cross-section.** A Character shared with dromaeosaurs but not with other dinosaurs or birds

(9) **Cerebral hemispheres elongate, slender and cerebellum is situated behind the mid-brain and doesn't overlap it from behind or press down on it.** This again is a reptilian feature. In birds the cerebral hemispheres are stout, cerebellum is so much enlarged that it spreads forwards over the mid-brain and compresses it downwards. Thus the shape of the brain is not like that of modern birds, but rather an intermediate stage between dinosaurs and birds.

10) **Neck attaches to skull from the rear as in dinosaurs not from below as in modern birds.** The site of neck attachement (from below) is characteristic in birds, _Archaeopteryx_ does not have this character, but is the same as theropod dinosaurs:

Skull and brain of Archae is basically reptilian and is not "totally birdlike"

(11) **Center of cervical vertebrae have simple concave articular facets.** This is the same as the archosaur pattern. In birds the vertebrae are different, they have a saddle-shaped surface:

"The most striking feature of the vertebrae is the simple disk-like facets of their centra, without any sign of the saddle-shaped articulations found in other birds" (de Beer 1954, p. 17).

(12) **Long bony tail with many free vertebrae up to tip (no pygostyle).** Birds have a short tail and the caudal vertebrae are fused to give the pygostyle.

(13) **Premaxilla and maxilla bones bear teeth.** No modern bird possess teeth (e.g. Romanoff 1960; Orr 1966, p. 113). Bird embryos form tooth buds, but do not actually produce teeth. Some birds subsequently produce ridges in the bill, but there is no connection between them and the embryonic tooth buds, since the ridges also form in other areas of the bill where no tooth buds have previouslu formed. Some birds produce hook-like structures which are papillae, and appear to be related to the process of keratinization of the beak (Romanoff 1960), and have nothing to do with teeth. They do not possess blood vessel or nerve connections, nor do they produce dentine.

The expression of tooth buds in the bird embryo has a simple evolutionary explanation, since it suggests that the ancestors of modern birds possessed teeth and that this character has been supressed in modern birds. The

presence of tooth buds in the embryos of organisms which do not possess teeth in the adult is a difficulty for anti-evolutionists, since why should a character be expressed that is never used in the organism? Some fossil birds exhibit a reduction in the number of bones which have teeth. Both *Hesperornis* and *Baptornis* lack teeth on the premaxilla (*Archaeopteryx* and theropod dinosaurs have teeth on both the maxilla and premaxilla). Not only that, *Hesperornis* has a beak, but on the upper jaw only (Gingerich 1975). It therefore has **half** a beak **and** teeth. A good example of a morphologicaly intermediate structure between toothed birds which lack a beak, and beaked, toothless birds.

(14) **Ribs slender, without joints or uncinate processes and do not articulate with the sternum.** Birds have stout ribs with uncinate processes (braces between them) and articulate with the sternum.

(15) **Pelvic girdle and femur joint is archosaurian rather than avian (except for the backward pointing pubis as mentioned above).** Here Archae really shows its transitional nature. Whilst the pelvic girdle as a whole is basically free and similar to archosaur girdles, the pubis points backward - a character shared with birds and some other bird-like theropod dinosaurs.

What **is** interesting is that with the bird pelvis:

"The ischium lies beneath the posterior part of the ilium and beneath this again is the pubis, which is directed backwards (i.e. like this: =). Embryological studies show that the peculiar position of these bones is the result of secondary rotation and that the pectineal process, in front of the ascetabulum, is not the true pubis as some workers have maintained." (Bellairs & Jenkin 1960, p. 258).

In other words, the embyonic pelvis of the bird, when first formed, looks, in shape and angle between the ilium and the pubis (45 degrees), very similar to the "A"-frame pelvis of *Archaeopteryx* (i.e. like this: <) (e.g. Romanoff 1960). The fully formed pelvis with all bones lying parallel is the result of secondary rotation of the pubis from "<" to "=". This supports the view that birds had an ancester with a saurischian pelvis such as the type possessed by *Archaeopteryx* and other theropod dinosaurs. (see also A tale of two pelvises below)

(16) **The Sacrum (the vertebrae developed for the attachment of pelvic girdle) occupies 6 vertebra.** This is the same as in reptiles and especially ornithipod dinosaurs. The bird sacrum covers between 11-23 vertebrae! So, while the variation seen in modern birds is large, it is nowhere near the number found in *Archaeopteryx*

(17) **Metacarpals (hand) free (except 3rd metacarpal), wrist hand joint flexible.** This is as in reptiles. In birds the metacarpals are fused together

with the distal carpals in the carpo-metacarpus, wrist /hand fused. All modern birds have a carpo-metacarpus, all fossil birds have a carpo-metacarpus - except one (guess!) :). However, the carpals of several coelurosaur dinosaur groups show a trend towards fusion, and in the Late Cretaceous form *Avimimus*, a true carpo- metacarpus is formed.

It has been suggested that the ostrich and/or other Ratites also possess unfused wrist/hand bones. This is not correct:

"The ostrich, emus, rheas, cassowaries and kiwis are often referred to together as the Ratites, though they may not be closely related to each other. They have tiny wings and cannot fly, but the bones of their hands are fused together in the same peculiar way as in flying birds, which suggest that they evolved from flying birds." (Alexander 1990, p. 435).

Some similarity between the hand of the ostrich and some of the more derived theropod dinosaurs was once used to suggest that the Ratites were 'primitive' and evolved before the advent of flight in birds. However Tucker (1938b) showed that such similarities are entirely superficial.

"He has directed attention to the bird-like characters of the hand of the dinosaur *Ornitholestes* as evidence that a bird-like hand can be developed independantly of flight, but the writer has pointed out in the communication mentioned above [Tucker 1938b] that the resemblance is utterly superficial and that the peculiar bowing and terminal fusion of metacarpals 2 and 3 which charcaterise both the Carnate and the Ratite hand are in no wise [sic?] reproduced in the dinosaur." (Tucker 1938a, p. 334).

"Reverting now to the reasons on which have sought to base the view that the Ratites were primitive birds whose ancesters had never flown, one: the similarity between the hand of the ostrich and that of the dinosaur, has been dismissed as invalid. Tucker (1938b) has shown that such resemblances as there are between them are only superficial and without significance." (de Beer 1956, p. 65).

(18) **Nasal opening far forward, separated from the eye by a large preorbital fenestra (hole).** This is typical of reptiles, but not of birds. Where a fenestra is present in birds, it is always greatly reduced, and is involved in prokinesis (movement of the beak)

(19) **Deltoid ridge of the humerus faces anteriorly as do the radial and ulnar condyles.** Typical of reptiles but not found in birds

(20) **Claws on 3 unfused digits.** No modern adult bird has 3 claws, nor do they have unfused digits. The juvenile hoatzin and Touracos do have 2 claws but loose them as they grow, the ostrich appears to retain its 2 claws into

adulthood, due to the early termination of development (see section on Ratites). In the case of the hoatzin it is thought that these claws allow the juvenile to climb. It had been claimed that since these birds do have claws, even in the juvenile stage, then the presence of claws cannot be used as a reptilian character. This is not so, however. In fact almost all birds exhibit claws, but in the embryonic stage and they are lost by the time the bird leaves the egg. In the case of the few which do retain claws into the juvenile stage, this is merely the extension of the condition into the post-embryonic stage. As McGowan (1984, p 123) says:

"In retaining a primitive reptilian feature which other birds lose just before leaving the egg [the hoatzin] is showing us its reptilian pedigree. Far from being evidence to the contrary, the hoatzin is additional evidence for the reptilian ancestry of birds."

(21) **The fibula is equal in length to the tibia in the leg.** This again is a typical character of reptiles. In birds the fibula is shortened and reduced.

(22) **Metatarsals (foot bones) free.** In birds these are fused to form the tarsometatarsus. However, in modern bird embryos, the foot bones are initially separate as in the adult *Archaeopteryx* and is another character supporting a reptilian ancestry for birds. After all, why bother producing separate bones in the embryo and then fuse them? Why not produce a fused mass to start with? No adult modern bird has separate metatarsals, but they are separated, initially, in the embryo. This can be explained in terms of evolution - birds evolved from a group which had unfused metatarsals.

Ceratosaurians, *Avimimus*, and Elmisauridae all show true tarso-metatarsi. Archae itself only shows the beginning of this structure.

(23) **Gastralia present.** Gastralia are "ventral ribs," elements of dermal bone in the ventral wall of the abdomen. Typical of reptiles, they are absent in birds, e.g.:

"In addition to the true ribs the British Museum specimen shows a large number of so-called ventral ribs or gastralia, elements of dermal bone lying in the ventral wall of the abdomen." (de Beer 1954, p. 18)

It can be seen that Archae possesses many more characters which are present in dinosaurs and **not** in birds, than it does characters which are present in birds but not in dinosaurs. This is why Archae is a true transitional species, because it shares some characters which are diagnostic of one group whilst still retaining characters diagnostic of its ancestral group. Anyone who claims that Archae is 100% bird is wrong. Anyone

who claims that Archae's skeleton is even predominantly bird- like is wrong. Anyone who claims Archae has a "totally birdlike" skull is wrong.

This latter point is made in reference to the claim by Dr. Duane Gish that the skull of Archae is "totally birdlike" (R. Trott pers. comm. 1994). This claim is false. To show this we need to consider the skull of Archae further.

Cranial Features of Archaeopteryx : As stated above, Dr Gish claims that the skull of Archae is "totally birdlike." This is false. Romer (1950 p. 261) describes Archae thus: "The skull, as far as can be seen, was rather birdlike. . . ". However, not only is this a far cry from "totally birdlike," but Romer was using the detailed reconstruction of the Berlin Specimen, by Heilmann (1926). Ostrom (1976 p. 131) has this to say on the Heilmann reconstruction:

"Despite the details shown there [Heilmann's reconstruction of the skull -cn], the actual specimen does not permit such detailed and precise conclusions. It [the Berlin specimen's skull - cn] is badly crushed and the bones are extensively fracture, chipped and distorted - to the extent that very few cranial or mandibular sutures are unmistakably identifiable. Heilmann's reconstructions have been republished by many authors and subsequent interpretations and hypotheses based on it. Quite probably, some authors have been unaware of the inadequate basis of Heilmann's reconstruction, and understandably so unless they have had the opportunity to examine the specimen itself."

***Archaeopteryx* + modern birds, just variation within kind?**

It has been suggested that the differences between *Archaeopteryx* and modern birds represents simple within-group variation. However, this is not correct. Modern birds show a large number of derived morphological characters not possessed by *Archaeopteryx*. Morphologically, *Archaeopteryx* clearly appears more closely related to theropod dinosaurs that any other group and is grouped with birds over theropod dinosaurs due to the possession of only two main characters, presence of feathers, and presence of a fully reverted hallux (toe).

As can be seen, the variation within birds shows a distinct trend. The more "reptile"-like morphologies occur in the earliest birds, with the typical 'modern' bird morphology restricted to later birds. If, as suggested, morphological variation is simply variation within birds, we would expect to see the various morphological groups (fossil birds, modern birds) evenly spread throughout the relevant time interval. If, however, birds evolved from theropod dinosaurs, then we would expect to see the first birds to posses more "reptile"-like characters and the more derived, modern birds to have less "reptile"-like characters. This, in fact, is what we see. Thus the distribution of characters within birds supports their derivation from theropod dinosaur ancesters and does not support the claim that variation is simply 'within kind'.

To Fly or not to Fly : Flying is a tricky business. However, flying confers such a strong evolutionary advantage that it is not surprising that the ability has evolved several times. The success of birds provide ample evidence for the positive benefits of flight. If it did fly, Archae must have utilized much the same method as do birds today, therefore a discussion on the possibility of flight in Archae must consider those structures most relevant to flight in birds. These are the feathers, the flexibility of the wing, muscle bulk and the presence of a keeled sternum.

Feathers : Feathers are composed of a long, tapering, central rachis, which bears closely spaced side branches called barbs. The barbs on either side of the rachis constitute a surface called the vane. The two vanes on the feather may be symmetrical (i.e. the same width) or asymmetrical, in which case the rachis appears closer to one edge of the feather than the other. The flight feathers of modern birds are typically asymmetrical, whilst body contour and semiplume feathers are symmetrical.

In modern birds, remiges, or wing feathers, are highly modified for power flight (e.g. McFarland et al. 1985), primarily in that the rachis is shifted towards the leading edge of the feather (i.e. the leading vane is thinner than the trailing vane), resulting in an asymmetric feather. The thinner or leading vane of the feather overlaps the wider or trailing vane of the feather in front of it (Fig. 2). The trailing vane contains zones of friction barbules which grip the overlapping feather and stop the feathers from slipping too far apart.

Conclusions : *Archaeopteryx* is a bird because it had feathers. However, it retained many dinosaurian characters which are not found in modern birds, whilst having certain characters found in birds but not in dinosaurs. By virtue of this fact *Archaeopteryx* represents an example of a group in transition - a representative which, although on the sidelines in the dinosaur to bird transition, an echo of the actual event, still allows a brief glimpse into the possible mechanism which brought about the evolution of the birds and by its very existence shows that such a transition is possible

Isolation

Q.13 Describe the prezygotic barriers of isolation.

Ans.: Geographic Isolation : It is most striking when comparing the floras of equal climatic zones on different continents, like those of North America and Europe.

Introduction of foreign species into an area has shown, that this type of reproductive barrier is often rather feeble and collapses easily. Hybridizations with endemic species are therefore common unless prevented by other barriers. *Spartina townsendii* is a good example.

The same phenomenon is met when analyzing the vegetation of islands. **Endemic species** (plants and animals), i.e. species occurring exclusively in a certain, often clearly demarcated area, are very common on islands. Both C. DARWIN and A. WALLACE based their selection theories on this observation. The DARWIN-finches, each species of which occurs only on certain islands of the Galapagos Archipelago, became famous. The Galapagos Archipelago – of volcanic origin and geologically rather young - does also house plant groups, certain species of which live only on single islands. The occurrence and dispersal of *Scalesia*, a genus of the Compositae, is of special interest. The roughly 20 species are easiest distinguished by the shape of their leaves. Moreover, they are woody, some are even large trees. This is atypical for Compositae, a plant families harbouring one of the largest number of species, since most Compositae are annual herbs or perennial non-wooden plants. Composite trees do not only live on the Galapagos Archipelago, but also on other Pacific islands, like the San Fernandez-Islands close to the coastline of Chile and in a few continental habitats.

The following model experiment shows, that the collapse of a reproductive barrier may even lead to the extinction of a species.

Biotope Isolation : Just like geographic isolation, biotope isolation is no absolutely safe method for preventing the hybridization of related (sympatric) species. A. KERNER von MARILAUN showed already in the 19th century, that hybrid populations do often occur along the border of the habitats of (two) neighbouring vicarious species. These hybrids are rarely stable, and the development of new species is even rarer. The primula hybrids described by MARILAUN are a good example. *Primula auricula* flowers yellow and occurs in the Alps on limestone, *Primula hirsuta* and several similar species have two-coloured flowers (yellow and red-lilac) and are common on primeval rock (silicate, granite). Mostly unstable hybrids can be found, wherever these two types of rock occur simultaneously. These hybrids are the origin of *Primula pubescens*, the garden auricle.

Seasonal or Timely Isolation : Seasons do hardly occur in the tropics. The sympatric *Miconia*-species (family: Melastomataceae) from the primary forest of the Amazon area at Manaus provide an example of a timely isolation. These species are all visited by the same pollinators, among them bees of the genus *Melipona* and Halictides (S. RENNER, 1984). The temporally staggered flowering periods of the *Miconia*-species do largely prevent interspecific pollination. At the same time, a competition for pollinators is diminished.

Ethological and Mechanical Isolation : These two mechanisms take often place simultaneously, because, on one hand, the influence of the pollinator on the development and selection of species has to be considered, on the other hand, the flower structure allowing pollen nectar, and stigma access to only certain pollinators is of importance. *Aquilegia formosa*, a North American colombine species, has simple, nutant, yellow and red flowers with a short, 1 – 2 cm long spur. The flowers contain nectar and are pollinated by humming birds with beaks slightly longer than the flower's spur. *Aquilegia chrysantha, Aquilegia longissima*, and *Aquilegia pubescens* have all pale yellow, erect flowers with long spurs. These species are usually pollinated by butterflies of the Sphingidae-group. Respective measurements show, that the lengths of the spurs and the lengths of the butterflies' proboscides tally extremely well. Humming birds have no chance to reach the nectar of *Aquilegia chrysantha* and *Aquilegia longissima*, and they do not even try. They are , nevertheless, sometimes successful in the case of *Aquilegia pubescens*. The last three species can without difficulties be crossed experimentally. The hybrids produce fertile progeny. In nature, the demarcation is kept by different geographical distributions and different pollinators.

In contrast, *Aquilegia pubescens* and *Aquilegia formosa* have overlapping distributions. Since humming birds may act as pollinators of both species, hybridization and thus also gene exchange occurs (V. GRANT, Rancho Santa Ana Botanical Garden, Clairemont/ Cal., 1952). Hybridization cancels an otherwise effective mechanism of isolation and leads thus to a reduction of the species' fitness.

The importance of reproductive isolation and how fatal a collapse of a reproductive barrier can be is illustrated by the fact, that several independent barriers do often exist in parallel. A pair of species (a and b) from the genus *Gilia* provide a good example:

(a) *Gilia capitata chamissoni*

(b) *Gilia millefoliata*

Both sympatric species are isolated ecologically. (a) occurs on sand dunes, (b) on meadows. The two species are seasonally isolated due to different flowering periods, (b) flowers earlier than (a). Finally, an ethological and mechanical isolation exists: (a) has large flowers and is pollinated by bees, while (b) has small flowers and is autogamous (V. GRANT, 1952, 1963).

Sterility Barriers - Extern and Genetic Influences : The mechanisms of isolation mentioned so far seem mostly to be maintained by extern influences. This is only partly true, since genetic factors decide whether a species flourishes on limestone or primeval rock or whether the flowers open in the morning or in the evening. The genome of the plant determines, too, how the flower looks like and whether

it is attractive and viable for the pollinator. The behaviour and occurrence of the pollinator, on the other hand, is what we would call an extern influence.

Sterility barriers are almost exclusively founded on endogenous, i.e. genetically determined factors. Pollen, for example, may happen to reach a wrong style. It does consequently develop no pollen tube, or the developed pollen tube degenerates or cannot reach the egg cell. This barrier is called pollen incompatibility or pollen sterility. Pollen incompatibility is, beside other mechanisms, one of the causes for the existence of obligatory allogamous species.

Multiple Choice Questions

1. Writer of "Phylosphy Zoologic" is:
   A.)Darwim B.)Mendal
   C.)Lamarck D.)De vries (C)

2. Hugo de vries did his experient on:
   A.)Drosophilla B.)Evening primorse
   C.)Garden pea D.)None of these (B)

3. White & Black molluscs shows:
   A.)Stablizing selection B.)Directional selection
   C.)Discriptive selection D.)All of the above (C)

4. Age of fossils is determined by:
   A.)Carbon B.)Urenium lead
   C.)Pottasium Ar method D.)All of the above (D)

5. Era of reptile is:
   A.)Mesozoic era B.)Coenozoic era
   C.)Proterozoic era D.)Palaeozoic era (A)

6. Characterstics of Archeopteryx were:
   A.)Similar to reptiles B.)Similar to aves
   C.)Both (A) & (B) D.)None of these (C)

7. When no. of genes decrease in chromosome is called as:
   A.)Haploidy B.)Hyperploidy
   C.)Hypoploidy D.)Deletion (D)

8. Exchange of genes between heterologus chromosome is called as:
   A.)Crossing over B.)Teanslocation
   C.)Transversion D.)None of these (A)

9. Species originated by geographical barriers are called as:
   A.)Allopatric B.)Sympatric
   C.)Sibling D.)All of the above (A)

10. Group of individuals of a species is known as:
    A.)Community B.)Ecosystem

C.)Population D.)biosphere (C)

11. Sickel cell aneamia is example of:
A.)Natural selection B.)Polyploidy
C.)Pliotrophy gene D.)All of the above (D)

12. Example of hybrid sterlity:
A.)Horse B.)Donkey
C.)Mule D.)Sheep (C)

13. In which period placental mammal were originate?
A.)Triasic period B.)Jurassic period
C.)Permian period D.)Creastaceous period (D)

14. Archeopteryx originated in:
A.)Community B.)Ecosystem
C.)Population D.)biosphere (C)

15. Kiwi are found in:
A.)America B.)Newziland
C.)Africa D.)India (B)

16. What is the total no. of carpals in the wrist of archeopteryx?
A.)2 B.)3
C.)4 D.)5 (B)

17. What is the main reason for struggle in animals?
A.)Place B.)Food
C.)Reproduction D.)all of the above (D)

Keywords

Adaption: A character that has been modified and is or was maintained as a result of selection for increased fitness.

Aerial: Living or occurring in air.

Afferent: Any structure leading toward a centre.

Allele: One of the alternative forms of a single gene

Allopatric: Species or populations whosw geographical distribution do not contact each other.

Allopolyploid: An organism or species that has more than two sets of chromosomes which drive from two or more different ancestral groups.

Ammocoetes: The larval stage of lamprey.

Anagenesis: The evolution of new species that takes place progressively over time with in a single lineage.

Arboreal: Pertaining to trees.

Brood parasite:A creature.such as a cuckoo,which induces other species to hatch,feed and protect its young.

Cladogenesis: "branching" evolution involving the splitting and divergence of a lineage into two or more lineages.

Coevolution: Evolutionary changes in one or more species in response to changes in other species in the same community.

Deletion: An aberration in which a section of DNA or chromosome has been lost.

Derived character: A character whose structure or form differs from that of the ancestral stock.

derived from a large population begin a new colony.

Duplication: Instances in which a particular section of DNA or visible chromosome segment occurs more than once.

Eon: A major division of the geological time scale

Era: A division of scale time that stands between the eon and the period

Extinction: The disappearance of a species or higher taxon

Fitness: Relative reproductive success

Fossils: The geological remains,impression,or traces of organisms that existed in the past.

Founder effect: The effect caused by a sampling accident in which only a few founders

Frequency: Dependent selection

Gamete: A sex cell which normally has a haploid chromose set.

Gene: A unit of genetic material,composed of a sequence of nucleotide that provides a specific function to an organism.

Genotype: The genetic constitution of cells or individuals

Geographic isolation: the separation between population caused by geographic distance or geographic barriers.

Habitat: the natural environment which an animal lives.

Haploid: A term for the halved set of chromosome found in sex cells

Integument: Outermost covering of body.

Invagination: Impushing of a cellular layer into a cavity.

Monoecious: Having both male and female gonads in the same individual.

Nephron: Structural and functional unit of kidney.

Olfactory: Refers to the sense of smell.

Opthalamic: Pertaining to eye.

Optimum: the most favourable condition.

Order: A high level category in the classification of organism which is made up of groups of closely related families.

Organism: A single living creature.

Paleozoic: The first era of the phanerozoic eon.

Parasitism: An association between species in which individuals of one species obtain

Speciation: The splitting of one species into two or more new species or the transformation of one species into a new species over time.

their nutrients by living on or in the tissues of another species.

Uncinate: Hooked.

Zoogeographic: Branch of zoology dealing with geographic distribution of animals.

B.Sc. (Part I) Examination, 2011

(Faculty of Science)

[Also common with subsidiary Paper of B.Sc. (Hons.)Part I]

(Three – Year Scheme of 10+2+3 Pattern)

Zoology

First Paper

Diversity of Animals and Evolution

Time allowed : Three Hour **Maximum Marks : 33**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part - I

1. Answer the following question in maximum 25 words: 1 x 9 = 9

   (a) Name the type of fauna found in desert region.

   (b) Write some important characters of marine adaptation.

   (c) Name of the organizations for conservation in India.

   (d) Write down the important of Taxonomy.

   (e) Explain the three important characters of scientific nomenclature.

   (f) What is symmetry ? Name the teo phyla of radial symmetry

   (g) Classify the sycaon and peripataus with their characters.

   (h) Write down the three fundamental characters of phylum chordate

   (i) Describe the type of natural selection.

Part – II

Section-A

2. **Ex**plain the diversity if Indian region .

3. Write short on the following :

(a) Protective Adaptation

(b) Desert Adaptation

4. What are the natural resource? How can we conserve the animals from extinction?

Section-B

5. Describe the binomial nomenclature and its various rules.
6. Write in detail five kingdom concept of classification.
7. Write down the characters and classifications of phylum coelenterate up to class, with two example of each.

Section-C

8. Discuss the genetic basis of evolution.
9. Define isolation. Describe the reproductive isolation on detail with example?
10. Write short notes on any two of the following :-

(a) Genetic variation

(b) Process of fossilization and types of fossils

(c) Dinosaurs.

B.Sc. (Part I) Examination, 2010

Zoology

First Paper

Diversity of Animals and Evolution

Time allowed : Three Hour **Maximum Marks : 33**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part - I

1. Answer the following question in maximum 25 words: 1 x 9 = 9

   (a) What are the key characters?

   (b) On what basis can evolutionary relationship between blue-green algae and bacteria be proved?

   (c) Differentiate redial and bilateral symmetry.

   (d) Define segmentation. Name two phylum which exhibit his characters.

   (e) Write down the names of different levels of organization.

   (f) What are the organisms which emit light called? Give one example.

   (g) Phylum Mollusca is divided into how many classes? Names them.

   (h) What will happen if selection pressure continues for long time?

   (i) Define mutations.

Part – II

Section-A

2. What do you understand by adaptations? Give a brief account of structure adaptations in animals.
3. What is Zoogeography? Describe geographical limits, extent, climate and major fauna of Oriental region.
4. Write a note on Continental drift.

Section-B

5. Write short notes on any two:
   (i) Coelom (ii) Segmentation (iii) Symmetry
6. Analyze the system of classification of animals into Protozoa and Metazoa.
7. Describe the habit. Habitat and external features of any two with diagrams:
   (i) Fasciola (ii) Balanoglssus (iii) Hirudinaria

Section-C

8. Write short notes on the following:
   (i) Archeopteryx
   (ii) Imperfection of geological record.
9. What is speciation? Describe the process of speciation giving examples.
10. Define hardy-weinberg's law of genetic equilibrium and give its main salient features.

B.Sc. (Part I) Examination, 2009

Zoology

First Paper

Diversity of Animals and Evolution

Time allowed : Three Hour **Maximum Marks : 33**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer the following question in maximum 25 words: 1 x 9 = 9

   (a) Define Wallace's line.

   (b) What is mimicry? Give an example of Batesian mimicry.

   (c) What are hot spots of biodiversity?

   (d) Differentiate Protista and Fungi.

   (e) Group the different phyla of animals on the basis of types of coelom found in them.

   (f) Write down the names of different levels of organization of organization.

   (g) Define Hardy- Weinberg principle.

   (h) Give four reptilian characters of Archaeopteryx.

   (i) What is genetic drift?

Part – II

Section-A

2. What is Zoogeography? Describe geographical limits, extent, climate and major mammalian fauna of Ethiopian region.

3. What do you understand by biodiversity? Give an account of main causes of extinction and measures of conservation of biodiversity.

4. Give a brief account of biodiversity of Fauna of India.

Section-B

5. Describe general principles of Taxonomy.

6. Give characteristics of chordates and classify vererata upto classes giving suitable characters and examples of each class.

7. Describe the habit, habitat and external features of Obelia, Taenia and Asterias with diagrams.

Section-C

8. Describe various isolating mechanisms and their role in evolution.

9. Write an essay on theory of natural selection.

10. Write short notes on the following:

(i) Dinosaurs

(ii) Fossils

(iii) Lamarckism.

B.Sc. (Part I) Examination, 2008

Zoology

First Paper

Diversity of Animals and Evolution

Time allowed : Three Hour **Maximum Marks : 33**

Question No. 1 part-I is compulsory. Attempt four questions from Part-II selecting at least one question from each section. All questions in Part-II carry equal 6 marks.

Part – I

1. Answer the following question in maximum 25 words: 1 x 9 = 9

   (i) Write the names of any two lung fishes.

   (ii) Define protostomia

   (iii) What is natural selection?

   (iv) In which area of the world

   (v) Write the names of areas of the earth where (i) Penguins, (ii) Polar bears are found.

   (vi) Write two most important characters of Prototheria.

   (vii) Write two important characters of Kingdom Monera.

   (viii) Animals of which phylum contain Cnidoblast cells?

   (ix) Write the names of subclasses of class amphibian which do not include toads and forgs.

Part – II

Section-A

2. What are adaptations? Describe adaptations in deep sea animals.

3. Written an essay on continental drift.

4. Write the names of principal zoogeographical regions of the world. Describe ffuna of Indian Thar desert in details.

Section-B

5. Describe various kinds of symmetry and types of coelom found in the animals with the help of suitable diagrams and examples.
6. Write the habit, habitat and classification of Hirudinaria, Petromyzon, Salamander and Chinkara.
7. Write exernal features of Herdmania and Balanoglossus with diagrams. Write name of the phyla to which they belong.

Section-C

8. How is a new species formed in nature?
9. Differentiate between:
   (i) Lamarckism and Darwinism
   (ii) Continuous and discontinuous variations
   (iii) Commensalism and symbiosis.
10. What is basis of geological divisions of Earth's crust? Describe Cenozic Era, Its Epochs and life forms during this period.

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Notes

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