Manual on
Wild and Zoo Animal Health Care
and
Management / Fish Production

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**CONTENTS**

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Section Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Classification of Vertebrates</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Characteristic Features of Species of Importance in Wildlife</td>
<td>9</td>
</tr>
<tr>
<td>4.</td>
<td>Habitat</td>
<td>26</td>
</tr>
<tr>
<td>5.</td>
<td>Housing of Zoo Animals</td>
<td>28</td>
</tr>
<tr>
<td>6.</td>
<td>Sanitation</td>
<td>31</td>
</tr>
<tr>
<td>7.</td>
<td>Feeding of Wild Animals</td>
<td>32</td>
</tr>
<tr>
<td>8.</td>
<td>Public Health Problems Arising from Zoos</td>
<td>39</td>
</tr>
<tr>
<td>9.</td>
<td>Prevention and Control of Diseases in Zoos</td>
<td>41</td>
</tr>
<tr>
<td>10.</td>
<td>Physical Restraint</td>
<td>42</td>
</tr>
<tr>
<td>11.</td>
<td>Chemical Immobilization</td>
<td>46</td>
</tr>
<tr>
<td>12.</td>
<td>Transport of Wild Animals</td>
<td>51</td>
</tr>
<tr>
<td>13.</td>
<td>Handling and Physical Examination</td>
<td>54</td>
</tr>
<tr>
<td>14.</td>
<td>Nutritional and Metabolic Diseases in Zoo Animals</td>
<td>57</td>
</tr>
<tr>
<td>15.</td>
<td>Bacterial Diseases</td>
<td>59</td>
</tr>
<tr>
<td>16.</td>
<td>Viral Diseases</td>
<td>62</td>
</tr>
<tr>
<td>17.</td>
<td>Parasitic Diseases</td>
<td>64</td>
</tr>
<tr>
<td>18.</td>
<td>Fish Preservation</td>
<td>68</td>
</tr>
<tr>
<td>19.</td>
<td>Methods of Packing and Transport</td>
<td>76</td>
</tr>
</tbody>
</table>
INTRODUCTION

Wildlife is the term used for all wild animals and plants in their natural communities. In other words, it is defined as all living things (except human) which are undomesticated.

Zoological Park/ Garden is an organized non-profitable institute governed and managed by central / state government. It is authorized to keep maintain, and breed the wild mammals, reptiles and birds.

Wildlife management is the application of ecological knowledge to populations of vertebrate animals and their plant and animal associates in a manner that strikes a balance between the needs of those populations and the needs of the people.

Zoo

It is defined as a place for collection and breeding of wild animals and birds, under captivity.

Wildlife sanctuary

It is a large restricted area in which the wild fauna and flora are allowed to grow naturally and hunting of any species is prohibited but limited public entry is permitted.

National Park

A national park is a relatively bigger area where wild fauna and flora is conserved and protected and permission for visitor is allowed under special condition for education and research. A wildlife sanctuary may be upgraded to a National park.

Community is a group of co-existing individuals of different species.

Population is a group of co-existing individuals of same species.

Fauna is a combined term for all animal life in an area.

Flora is a combined term for all plants in an area.

Objectives and functions of zoo

- Education
- Recreation
- Captive breeding
- Basic and applied research
- Conservation
- Protection
- Display of local, regional and exotic fauna of rare species.
- Treatment and health care of the captured wild animals.
ROLE OF WILDLIFE VETERINARIAN IN FREE RANGING AREAS

1. To monitor diseases in wild animals.
2. To have vigilance on the occurrence of any infectious diseases esp. during episodes of outbreak of diseases in surrounding domestic animals.
3. To suggest prophylactic measures with regard to management of outbreak, if occurred.
4. To assist research aspects related with wildlife health & disease aspects.
5. To implement wildlife health management programmes.
6. To assist authorities in medico-legal issue related to wild animals of various species.
7. To assist in capturing the stray animal which has entered into areas outside the protected wildlife areas.
8. To establish basic laboratory in a protected wildlife area for diagnosis of diseases.
9. To perform post-mortem examination whenever needed

DUTIES OF ZOO VETERINARIANS

- Responsible for overall health condition of the animals.
- Diagnosis and treatment of sick animals.
- Periodical clinical examination of animals.
- To carry out prophylactic measures such as deworming, vaccination etc.,
- Supervision of the quarantine area for the newly arrived wild animals.
- Inspection of meat and other feeds for quality control.
- Breeding of animals in captivity and rearing the young ones.
- To impart training to animal keepers.
- To assist research activities related to wildlife health and disease management.
- To conduct post-mortem examination for confirmatory diagnosis of disease whenever needed.
CLASSIFICATION OF VERTEBRATES

Phylum: Chordata

Vertebrata

Craniata

Acraniata

Super Class: Pisces (Fish) Tetrapoda

Class: Amphibia Reptilia Aves (Birds) Mammalia

Order:

   2. Caudata / Urodela Eg: Salamanders 2. Casuariiformes Eg: Emus, Casuarius
     -3—Anura / Saientia Eg: Frogs and toads 2. Crocodylia Eg: Crocodiles 3. Sphenisciformes Eg: Penguin
     3. Chelonia Eg: Turtles, Tortoises, Terrapins 4. Pelecaniformes Eg: Pelican
<table>
<thead>
<tr>
<th></th>
<th>Order</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Galliformes</td>
<td>Jungle fowl, Peacocks, Quail, Grey Patridge, Pheasant.</td>
</tr>
<tr>
<td>8</td>
<td>Gruiformes</td>
<td>Crane</td>
</tr>
<tr>
<td>9</td>
<td>Columbiformes</td>
<td>Pigeons, Dove</td>
</tr>
<tr>
<td>10</td>
<td>Cuculiformes</td>
<td>Koel, Cuckoo</td>
</tr>
<tr>
<td>11</td>
<td>Psittaciformes</td>
<td>Parrots, Parakeet</td>
</tr>
<tr>
<td>12</td>
<td>Strigiformes</td>
<td>Owl</td>
</tr>
<tr>
<td>13</td>
<td>Apodiformes</td>
<td>Humming birds, Swifts</td>
</tr>
<tr>
<td>14</td>
<td>Coraciformes</td>
<td>King fisher</td>
</tr>
<tr>
<td>15</td>
<td>Piciformes</td>
<td>Wood pecker</td>
</tr>
<tr>
<td>16</td>
<td>Passeriformes</td>
<td>Crow, Sparrow, myna, Indian robins, Bulbul</td>
</tr>
</tbody>
</table>
Class: Mammalia

Sub Class:
- Prototheria
  (egg laying mammals)
  Eg: Spiny ant eater/ Echidna,
  Duck billed Platypus.
- Metatheria
  (pouched mammals)
  Eg: Kangaroos, Phalangers, Wallabies
- Eutheria
  (placental mammals)
  Eg: Lion, Tiger etc.,

Orders:
1. Insectivora: Insect eaters
2. Chiroptera: Bats
3. Dermoptera: Flying lemurs
4. Primates: Lemurs, Monkeys,
   Apes, man
5. Edentata: Sloths, Armadillos,
   Ant eaters
6. Pholidota: Pangolins
7. - Lagomorpha: Pikas,
   Rabbits, Hares
8. Rodentia: Rodents
9. Cetacea: Whales, Dolphins,
   Porpoises
10. Carnivora: Dogs, Weasels, Lions
11. Pinnipedia: Seals, Sea – lions,
    Walrus
12. Tubulidentata: Aardvark
13. Proboscidae: Elephants
14. Hyracoidea: Hyraxes
15. Sirenia  : Manatees, Dugong
17. Artiodactyla : Pigs, Camels, Deer, Giraffes, Antelopes

Order – Carnivora

Family : Felidae  Eg: Major Wildcat → Tiger, Lion, Snow leopard, Clouded Leopard, Golden cat, Desert cat, Cheetah.
Family : Viverridae  Eg: Civets
Family : Herpestidae  Eg: Mongoose
Family : Hyaenidae  Eg: Hyaena
Family : Canidae  Eg: Wolves, Jackals, Foxes and wild dogs.
Family : Ursidae  Eg: Sloth bear, Brown bear, Himalayan black bear.
Family : Ailuropodidae  Eg: Red Panda, Giant Panda
Family : Mustelidae  Eg: Otter, weasels, polecats, badgers, marten.
Ungulates

Order: Perissodactyls (odd toed)
   Eg: Asiatic wild ass, Tibetan Wild ass, Great one horned Indian Rhinoceros

   Artiodactyls (even toed)

   Family: Bovidae
      Eg: Gaur or Indian bison, yak, Wild buffalo, Wild sheep, wild goat – Nilgiri Tahr, Himalayan Tahr.
   Cervidae
      Eg: Swamp deer, Sambar, Spotted deer, Chital, hog deer, Musk deer, Mouse deer, Muntjak

   Suidae
      Eg: Indian Wild boar

Exotic Mammals:
1. African elephants
2. Bear
3. Giraffe
4. Hippopotamus
5. Rhinoceros
6. Zebra
Order – Rodentia

Eg: Porcupine, Common Giant Flying Squirrel, Large brown Flying Squirrel, Red flying Squirrel, Lesser Giant Squirrel.

Eg: Indian hare, Himalayan Mouse Hare.

Order – Lagomorpha

Sea Mammals

Order

Pinnipeds
Eg: Seals
Sea-lions
Walruses

Cetacea
Eg: Whales
Dolphins
Porpoises

Sirenia
Eg: Dugongs
Manatees
CHARACTERISTIC FEATURES OF SPECIES OF IMPORTANCE IN WILDLIFE

INDIAN PRIMATES

These are apes, monkeys and lemurs in India. Indian monkeys contain macaques and langurs. Macaques are sturdy, solid and squat and have cheek pouch. Langurs are slim and with long tail and have a pouch like stomach.

Rhesus Macaque

The most widespread monkey of northern India, living in close association with humans (commensal). The Rhesus is an aggressive primate that is found as multi - male groups dominated by a single male. It has a range of vocalizations, a short bark, a food call and grunt being most common.

- **Habitat**: Urban areas, deciduous and evergreen forests and scrub.
- **Best seen at**: Northern Indian towns.

Bonnet Macaque (Local name: Vella korangu)

A peculiar Cap of long hair, arranged in a whorl, gives the Bonnet Macaque its name. It is a medium-sized species with a tail that is longer than its body. This is the common commensal monkey of South India and can be seen around temples.

- **Habitat**: Urban and rural areas, deciduous forest and scrub.
- **Best seen at**: Periyar NP (Kerala), southern Indian towns.

Lion Tailed Macaque (Local name: Singhavai manthi)

Grey facial mane and much shorter, tufted tail that looks like a lion's tail. It is a medium to large sized macaque, which is very arboreal.

- **Habitat**: Dense evergreen and semi-evergreen forests.
- **Best seen at**: Silent valley NP (Kerala), kalakkad and Anamalai WLS (Tamilnadu)

Nilgiri Langur (Local name: Kari manthi)

Slim and black, common rainforest monkey of the southern Western Ghats. It has yellow tinted hair on its head. Also, the Nilgiri Langur's tail is longer. Females have a white patch on the inside of their thighs.

- **Habitat**: Primarily rainforests.
- **Best seen at**: Anamalai WLS (Tamilnadu), Periyar NP (Kerala)

Hanuman Langur (Local name: Vella manthi)

The most widespread langur in India, the common or Hanuman Langur is silver - grey with a black face. There are several races, differing in colour and size. It is known for its unique association in the forest with the Cheetal or Spotted deer, each warning the other of the approach of predators.

- **Habitat**: All habitats except high mountains and desert, and also found in human settlements.
- **Best seen at**: Sariska NP (Rajasthan) and Corbett NP (Uttaranchal). Also seen around temples.
EXOTIC APES

Chimpanzee

Is the native to equatorial Africa, and they are believed to be the closest living relatives to human beings. Height 1-1.7 m. Black coat, hair on head is parted or directed backwards, skin pale and dark with face and ears naked. They are territorial and feed on plants and insects. They produce single ones at birth, may live up to an age of 35 years.

Family:  

Himalayan Musk Deer

A dog-sized mountain ruminant, has a thick, bristly coat speckled with white on the flanks, white stocking legs and naked tail. The only deer with a gall bladder, a musk gland and no facial glands. The adult male has a gland or pod under the abdominal skin that secretes musk.

- Best seen at Kedarnath Wild Life Sanctuary (Uttaranchal)

Family:  

SAMBAR (Local name: Kadaa maan)

A typical forest deer with a shaggy, dark brown coat, large spreading antlers, and sambar is India's largest deer.

- Size: Height at shoulder: 150cm.
- Habitat: Mixed deciduous forest and grassland scrub
- Best seen at Sariska and Ranthambhor NPs (Rajasthan)

KASHMIR RED DEER

The Kashmir red deer or Hangul is a large, dingy brown animal with an orange - white rump patch. Its white lips and chin and large spreading antlers may identify the Hangul.

- Habitat: Broad-leaved and coniferous forests, and meadows between 1500 - 3600m
- Best seen at Dachigam NP (J&K)

BROW - ANTLERED DEER

The male deer has a dark brown winter coat which turns to fawn in summer, the female is fawn all year round.

- Habitat: Open flat grasslands and floating vegetation in marshes.
- Best seen at Keibul Lamjao NP (Manipur)

SWAMP DEER

The twelve tined antlers of stags give this deer the name Barasingha.

- Habitat: Grasslands, Swamps (N and NE India), and sal forests (C India)
- Best seen at Kanha NP (Madhya Pradesh) and Kaziranga NP (Assam)

MOUSE DEER (Local name: Saruhu maan)

India's smallest deer, the mouse deer or the Asian Chevrotain, is a unique species with a three chambered stomach. It also has large hooves and a wedge shaped body. Neither sex has antlers but both have long canines, narrow head and pointed muzzle.
• Habitat: Deciduous and evergreen forests.
• Best seen at Mudumalai (Tamilnadu) and Bandipur NP (Karnataka)

INDIAN MUNTJAC or BARKING DEER (Local name: Kelaïyadu)

It has a glossy brown coat with no under fur. Face has V shaped ridges, the arms of V continued as freely projecting columns. Its canine teeth are projecting but are not always visible. Also known as Rib Faced Deer.
• Habitat: Prefers hilly and moist areas in thick deciduous and evergreen forests.
• Best seen at Corbett NP (Uttarakhand)

HOG DEER

Hog deer is stouter, with shorter legs. Its stout rump and lowered stance gives it a pig-like appearance. The underside of the body and tail is white.
• Habitat: Tall grasslands and forest swamp.
• Best seen at Kaziranga NP (Assam) and Dudhwa NP (Uttarakhand)

SPOTTED DEER (Local name: Pulli maan)

This is India's most commonly sighted deer. Its coat varies geographically, becoming redder in southern India. The sexes are almost identical except for size and antlers in the male.
• Habitat: Deciduous forest, especially around fringes
• Best seen at Corbett NP (Uttarakhand), Bandipur NP (Karnataka) and Kancha NP (Madhya Pradesh)

Family: Bovidae

NILGAI

India's largest antelope, the Blue Bull or Nilgai is said to resemble a horse more than a bull. The shoulder slopes downwards to a low rump. Adult males are iron-blue, while females and calves are sandy brown.
• Habitat: Dry deciduous savanna country, open scrub, and agricultural land.
• Best seen at Ranthambhor and Sariska NPs (Rajasthan)

BLACKBUCK (Local name: Veli maan)

An antelope found exclusively in the Indian subcontinent. Adult males are dark brown to velvet black with white undersides. Females and young are fawn above and white below.
• Habitat: Arid grasslands, open scrub and semi-desert areas.
• Best seen at Velavadar NP (Gujarat)

FOUR HORNED ANTELOPE (Local name: Naal kombu maan)

A small, light brown antelope and is reddish when young, turning yellower with age. Males have two pairs of horns, the front pair being very short. Its horns are keeled and not ringed, as in most antelope.
• Habitat: Dry deciduous forest and scrub and animal prefers undulating terrain.
• Best seen at Mudumalai NP (Tamilnadu) and Bandipur NP (Karnataka)
INDIAN GAZELLE

The Indian Gazelle is light chestnut or biscuit-colored, with very glossy fur. Its horns are S-shaped in profile but appear straight from the front and are sometimes present in females.

- **Habitat:** Desert and arid regions.
- **Best seen at:** Desert NP (Rajasthan)

NILGIRI TAHR (Local name: Varai aadu)

The male Nilgiri Tahr looks like a short version of its close cousin, the male Himalayan Tahr, without the flowing mane and hair of its northern relative. The short, greyish-brown coat of the females and is blue black in adult males. The throat and abdomen are white. The horns of both male and female are parallel and curve backwards.

- **Habitat:** Desert and arid regions.
- **Best seen at:** Desert NP (Rajasthan)

GAUR OR INDIAN BISON (Local name: Kattu madu)

The largest bovine in the world. It has a massive head, deep chest, and muscular shoulder ridge. Adult males are glossy black, while the young and females are coffee-brown. Weight: 800-1200 kg. Adult males and females usually have horns. Have keenly developed sense of smell.

- **Habitat:** Mixed deciduous, scrub and evergreen hill forests, and grasslands.
- **Best seen at:** Mudumalai NP (Tamilnadu) and Bandipur NP (Karnataka)

Family: Suidae

WILD PIG (Local name: Kattu panni)

A large forest pig, with dark greyish-brown with a black mane, stout body, coarse hair, short tail and very long muscular snout.

- **Habitat:** Scrub, grassland, mixed deciduous and evergreen forests.
- **Best seen at:** Almost all Indian sanctuaries

Family: Elephantidae

ASIAN ELEPHANT (Local name: Yanai)

The largest land mammal in India. The Asian Elephant's grey wrinkled skin, long trunk and sail-like ears make it one of the most easily recognized animals. The Asian elephant is smaller than the African Savanna Elephant and differs from it anatomically in many ways. The Asian elephant has a rounded or humped back as opposed to the saddle-shaped one of the African elephant. Its trunk ends in one tip or "finger" as opposed to two, it has a two-domed forehead, and its ears are smaller in size. Only male Asian elephants have large tusks, while females have very small dental protuberances called "tushes". Males, called "makhnas", are tuskless and can be distinguished from adult females by the penis bulge below the tail.

- **Habitat:** Mixed deciduous and evergreen forests, scrub and grassland.

Family: Rhinocerotidae

GREATER ONE-HORNED RHINOCEROS

They are the second largest terrestrial mammals second only to elephants. Indian Rhinoceros are black and have a single central horn. The horns are not bony but formed by tough fibrous tissue. These are hoofed animals. Have short shifty legs with three toes. The skin is deeply folded behind
the shoulder and also thin. There are tubercles all over the body that may look like a reveted coat. It gives an armour-plated look. The enlarged nasal bone support the central single horn. Grasses are the major food.

Behavior: Rhinoceros regularly follows the same walking paths or “dandies” when foraging. It also uses the same spot to defecate, forming large “toilets”.

- Weight: 1,500 - 2,100 kg
- Best seen at Kaziranga National Park (Assam)

Family: Ursidae

SLOTH BEAR (Local name: Karadi)

The widespread Indian bear is a shaggy black animal with a long snout and lumbering gait and is dim-sighted and rears up on its hind legs.

- Behavior: This bear sucks up termites and ants through the gap caused by its missing front incisors. It's long claws are used to tear up termite mounds.
- Habitat: Deciduous forest, scrub and grassland.
- Best seen at Mudumalai Wildlife Sanctuary (Tamilnadu) and Melghat NP (Maharastra)

Family: Canidae

JACKAL (Local name: Naree)

The jackal's scraggy, buff-grey coat is neither as smooth as the fox's, nor as dense as the wolf's. The buff coat is interspersed with black hair while the underside, throat and the area around the eyes and lips are white.

- Behavior: It has an undeserved reputation as a scavenger.
- Habitat: Urban and semi urban areas, and forests.
- Best seen at Sariska and Ranthambhor NPs (Rajasthan)

WILD DOG (Local name: Chen nai) or Dhole

A uniquely Asian reddish-brown forest dog and the Dhole has shorter legs, a more bushy tail, and a thicker muzzle than both Wolf and the domestic dog.

- Behavior: Dholes hunt in packs of six or seven.
- Habitat: Open woodland interspersed with grassy meadows.
- Best seen at Bandipur and Nagarhole NPs (Kamataka)

INDIAN FOX (Local name: Kulla naree)

Easily distinguished by its black-tipped tail and greyish appearance. The ears are brown with a black fringe and there are small black patches of hair on the muzzle in front of the eyes.

- Habitat: Open rocky country, desert.
- Best seen at Velavadar National Park (Gujarat) and Rollapadu Wildlife Sanctuary (Andhra Pradesh)
Family: Hyaenidae

**STRIPED HYENA** (Local name: Kazhutha pulli)

- It has a sloping back, spindly legs, a buff body with black stripes on the flanks and legs, and coarse, long fur. The back has a dark crest and the throat and breast are black.
- **Behaviour:** Laughing call that ends in a cackle.
- **Habitat:** Scrub forests, and near human habitation.
- **Best seen at Gir National Park (Gujarat)**

Family: Felidae

**TIGER** (Local name: Vengai Puli)

- Tiger has an orange coat patterned with broad black stripes. It has black ears, each with a winging white spot on the back, powerful forepaws, and a long banded tail.
- **Size:** Total body length: 2.6 - 3m. Weight: 135-230 kg
- **Habitat:** Deciduous, thorn, and evergreen forests, mangroves and grassland.
- **Best seen at Ranthambhor National Park (Rajasthan) and Bandhavgarh National Park (Madhya Pradesh)**

**ASIATIC LION**

- An unpatterned body and a long naked tail with a tuft at the tip, the male Asiatic lion is known by its distinctive mane, which varies in colour from pale blonde to jet-black. Lionesses do not have a mane. Both sexes have a distinct fold of skin along the belly.
- **Habitat:** Dry deciduous teak, scrub jungle and dry savanna forests.
- **Only seen at Gir NP (Gujarat)**

**COMMON LEOPARD** (Local name: Chiruthai Puli)

- Leopard has a clear yellow coat marked with black rosettes. It has a small spotted head with powerful jaws, and a long tail, and its underside is white. The colour of the coat varies considerably in intensity from gold to tawny in commoner forms.
- **Habitat:** Deciduous and evergreen forests, scrub jungle, open country and fringes of human habitation.
- **Best seen at Sanjay Gandhi NP, Borivili NP (Maharashtra) and Gir NP (Gujarat)**

**SNOW LEOPARD**

- Snow leopard is adapted completely to live in snow-covered areas. It is marginally smaller than the Common leopard, with a more luxuriant coat. It has black spots on its limbs and face and its pale smoky-grey coat, with ghostly, dark grey rosettes, allows for excellent camouflage.
- **Best seen at Hemis National Park, Ladakh (J&K)**
**Family: Mustelidae**

**SMOOTH - COATED OTTER**

Most common otter in India easily identified by its well-groomed chocolate-brown coat. Its underside is lighter and its paws are dark brown but lighter than the body. Otter is active day by day.

- **Habitat:** Lakes and streams throughout India, except Gujarat and Rajasthan.
- **Best seen at:** Chambal WLS (Uttar Pradesh), Periyar NP (Kerala)

**Family: Viverridae**

**SMALL INDIAN CIVET (Local name: Punugu Poonay)**

A common ring-tailed civet; the small Indian civet is buff coloured with spotting all over its body. The coat can vary from brown to grey. The black and white ringed tail has 8-10 dark bands. It has black marks on white throat.

- **Behaviour:** Prefers thick grass and scrub.
- **Habitat:** All habitats except deserts and mountains.

**GREY MONGOOSE**

The common Indian Grey Mongoose has tawny grey fur which is much more grizzled and coarse. Individual hairs have ten alternate dark and light bands. Its legs are darker than its body, and its tail is as long as its head and body put together.

- **Behaviour:** Very bold and inquisitive

**Family: Manidae**

**INDIAN PANGOLIAN (Local name: Azhungu)**

The Indian Pangolian has a faint pinkish-white skin that is covered dorsally by a suit of dirty yellow scales. Skin is visible only on its lower body and face.

- **Habitat:** Scrub, urban cultivation and mixed deciduous forest.
- **Best seen at:** Mudumalai NP (Tamilnadu) and Bandipur NP (Karnataka)

**INDIAN PORCUPINE (Local name: Mullam pandri)**

The most common and largest porcupine of India and this rodent is covered with long black and white quills with a long crest of spines flowing from the forehead to the middle of the back. Its tail ends in a bunch of thick white quills.

- **Best seen at:** Sariska National Park (Rajasthan), Bandipur and Nagarhole National Park (Karnataka)
PUG MARK

HYENA

JUNGLE CAT

JACKAL
PUG MARK

TIGRESS
PUG MARK

MALE TIGER
Exotic mega mammals

**GIRAFFE**

Giraffes are seen from Somalia and Sudan to Southern Africa and Westwards to Northern Nigeria in open acacia savannah. It is a ruminant, and is the tallest land animal. They have extremely long legs and neck. Head has two blunt horns. Color of body is pale with large angular brown blotches in reticulate form. Tongue is long and protrusible. One of the anatomical features is their elastic blood vessel in the neck and head, which prevent the back flow of the blood from their long neck. Life span is 25 to 40 years.

**HIPPOPOTAMUS**

Largest terrestrial animal after elephant and rhinoceros. Its weight is 2.5 to 3.5 tonnes. They are found in Sub Sahara i.e., Central Southern and Western Africa. They have good sense of smell. Life span is 70 to 80 years. They have broad snout, large mouth, short barrel like body, short stocky legs and big head. The position of the ears, eyes and nostrils enable the animal to hear, see and breathe with its head under water. Chief weapons of defence are the lower canine. Its tusks like canines are even longer than other teeth.

**ZEBRA**

They are distinguished by their colourful stripe on the body. These are seen in East African grassland and in African savanna. The pattern of stripe vastly and markedly differ from individual to individual. Their ears are flexible and can be rotated to gather the sound without the movement of neck. Life span is 20 - 25 years.
<table>
<thead>
<tr>
<th>Common name</th>
<th>Longevity (in years)</th>
<th>Age of Maturity (in years)</th>
<th>Frequency of Oestrous cycle</th>
<th>Length of gestation period</th>
<th>Number of offspring born</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiger</td>
<td>20-25</td>
<td>Male: 4-6 Female: 3</td>
<td>Polyoestrous through out the year</td>
<td>105-112</td>
<td>2-3 cubs/litter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lion</td>
<td>30</td>
<td>Male: 5 Female: 2</td>
<td>Polyoestrous through out the year</td>
<td>100-116</td>
<td>2-3 cubs/litter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leopard or Panther</td>
<td>21</td>
<td>Male: 4 Female: 2</td>
<td>Through out the (length 3-14 days) year</td>
<td>93-105</td>
<td>2 cubs/litter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheetah</td>
<td>15</td>
<td>Male: 14-16 months Female: 14-16 months</td>
<td>Seasonally polyoestrous</td>
<td>91-95</td>
<td>2-4 cubs/litter</td>
</tr>
<tr>
<td>Sloth bear</td>
<td>40</td>
<td>Male: 3 Female: 2</td>
<td></td>
<td>210</td>
<td>2-3 cubs/litter</td>
</tr>
<tr>
<td>Elephant</td>
<td>60 - 70 up to 100</td>
<td>Male: 9-10 Female: 6</td>
<td>Oestrous cycle 16 weeks</td>
<td>630-660</td>
<td>1 calf / calving</td>
</tr>
<tr>
<td>Asiatic wild ass</td>
<td>22</td>
<td>Male: 5 Before &gt; 5</td>
<td></td>
<td>330-365</td>
<td>1 foal / foaling</td>
</tr>
<tr>
<td>Great Indian one horned rhinoceros</td>
<td>40</td>
<td>Male: 5-7 Female: 3-4</td>
<td>28-38 days</td>
<td>470-490</td>
<td>1 calf / calving</td>
</tr>
<tr>
<td>Gaur / Indian bison</td>
<td>25</td>
<td>Male: 3 Female: 16-28</td>
<td></td>
<td>270-285</td>
<td>1 calf / calving</td>
</tr>
<tr>
<td>Himalayan tahr</td>
<td></td>
<td></td>
<td></td>
<td>150-180</td>
<td>1 or 2 kids / kidding</td>
</tr>
<tr>
<td>Chinkara or Indian Gazelle</td>
<td>10</td>
<td>Male: Variab le Female: Variable</td>
<td>Variable</td>
<td>150-200</td>
<td>1 or 2 calves / calving</td>
</tr>
<tr>
<td>Black buck or Indian antelope</td>
<td>15</td>
<td>Male: 19-23 months Female: 12 months</td>
<td>All seasons</td>
<td>180</td>
<td>1 or 2 fawns</td>
</tr>
<tr>
<td>Chowsingha or four horned antelope</td>
<td>15</td>
<td>Male: 2 ½ years Female: 24 months</td>
<td>All seasons</td>
<td>240 - 255</td>
<td>1 or 2 fawns</td>
</tr>
<tr>
<td>Nilgai or blue bulf</td>
<td>15</td>
<td>Male: 25 months Female: 21 months</td>
<td>All seasons</td>
<td>240 - 250</td>
<td>1 or 2 calf / calving</td>
</tr>
<tr>
<td>Sambar</td>
<td></td>
<td>Male: 2 years Female: 16 months</td>
<td></td>
<td>240</td>
<td>1 or 2 fawns</td>
</tr>
<tr>
<td>Hog deer</td>
<td>17</td>
<td></td>
<td></td>
<td>230-240</td>
<td>1</td>
</tr>
<tr>
<td>Species</td>
<td>Life Stage</td>
<td>Reproduction Details</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spotted deer (Chital)</td>
<td>2 years</td>
<td>16-18 months Every 6 months (21 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muntjac or Barking deer</td>
<td>15</td>
<td>210-225 1 or 2 fawns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musk deer</td>
<td>3</td>
<td>150-180 1 or 2 fawns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian wild boar</td>
<td>14</td>
<td>21-23 days 4-6 piglets / furrowing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian pangolin</td>
<td>2</td>
<td>May occur at any season</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common dolphin</td>
<td>25</td>
<td>350-390 1 calf / calving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zebra</td>
<td>21</td>
<td>365 1 foal / foaling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>Over 50</td>
<td>225-229 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Striped hyena</td>
<td>16</td>
<td>99-130 3-4 pups / littering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hippopotamus</td>
<td>41</td>
<td>227-240 1 calf / calving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian wild dog (Dhole)</td>
<td>Upto 40</td>
<td>390 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td>Over 30</td>
<td>420-468 1 or twins / calf / calving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lion tailed macaque</td>
<td>12-15 years</td>
<td>163-167 day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhesus macaque</td>
<td>5-6 years</td>
<td>163-167 day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonnet macaque</td>
<td>12 - 15 years</td>
<td>2 ½ - 3 months 30 days 210 days 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nilgiri langur</td>
<td>2 ½ - 3 months 30 days 6 month 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common langur</td>
<td>15 years</td>
<td>66 days 3-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jungle cat</td>
<td>-</td>
<td>Polyoestrous 66 days 3-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wolf</td>
<td>12-15 years</td>
<td>63 days 4-5 max. 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jackal</td>
<td>12 years</td>
<td>2-6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nilgiri langur</td>
<td>-</td>
<td>60-70 days 4-6</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
REPTILES

The class reptilian has 6547 species and evolved from primitive amphibians. Reptiles have lungs and no gills, dry waterproof skin with horny scales and the scales are not separated as seen in fish, but they are folds of skin. Reptiles are further classified into four orders:

1. Squamata (Snakes and Lizards)
2. Chelonia (Tortoises and Turtles)
3. Crocodylia (Lorica - Crocodiles and Alligators) and
4. Rhynchocephalia (Tuatara - a rare lizard like reptile of New Zealand)

Majority of the reptiles are carnivores especially the snakes. The land turtles (tortoises), Marine Green Turtle are herbivore. Teeth of most reptiles are replaced throughout their life, but turtles and tortoises have no teeth at all. Most of the reptiles have well-developed vision, but have poor and rudimentary central nervous system. Reptiles are poikilothermic. Their energy requirements are comparatively less and they can go without food for long intervals, extending up to months.

ORDER SQUAMATA

Snakes

About 2750 species of snakes are found worldwide. Snakes do not chew their prey that include animals and eggs, but swallows them. They have long cylindrical body without limbs and eyelids. Their skins molt several times a year. Most of the snakes are oviparous, e.g. Rat Snake, Cobra, krait and Python. All Vipers and green vine Snake are viviparous. Some snakes are ovo-viviparous.

King Cobra is the largest venomous snake in the world. It is the only snake known to build a nest to lay its eggs. Body colour varies from deep olive green to yellowish with a jet-black tail tip.

Cobra is the most widely distributed in India. Color varies from dark brown to yellow. Presence of a hood with spectacle mark is the characteristic feature. Average length is one metre. It has a smooth scaled body and black eyes.

Russell’s Viper is a heavy rough scaled snake with vertical pupils. Body color is brown or yellowish with pattern of dark, round spots edged with black and white. Head is distinctly triangular.

Krait is a bluish black colored snake with distinct paired white cross bands, around 40, on the dorsal part of the body. Head and neck are free from the cross bands. There is an enlarged chain of large hexagonal scales on the dorsal surface in the middle.

Indian Rock Python is the second largest, non-venomous and heaviest of all Indian snakes. It ranges from 2.5 m to 4.5 m in total length; maximum length recorded is 7 m. Head is purely demarcated from the neck and has symmetrical shields. Its eyes have vertical pupils.

Sea Snakes are seen only in the warm waters and estuaries. 20 species are seen in the Indian sub-continent. They vary in length from 45 - 180 cm.

LIZARDS

Lizards are seen all over the world except in the coldest regions. They differ from snakes in having eyelids and an obvious ear opening. Lizards comprise of Home lizards (Gecko), Garden lizards, Chameleons and Monitor Lizards. Common Monitors found in India are Common Monitor, Water Monitor and Yellow Monitor.
ORDER CHELONIA

Tortoises, Turtles and terrapins come under the order Chelonia.

Turtles are considered as the longest living reptiles. They live up to or over 100 more years. Turtle shells have two parts, the upper one, carapace and the lower one, plastron that are joined on either side.

Tortoises are herbivorous and feed on plants. They lay leathery eggs varying in number from 1-200. Incubation depends on the warmth of the soil and incubation period can vary from few weeks to ten months, depending on the species.

ORDER CROCODYLIA

Crocodilians include Crocodiles, Alligators and Gharials. They are native to tropical rivers and estuaries worldwide. Crocodiles grow up to 7.5 metres in length.

Common Crocodiles of India: Feed mainly on fish
1. Mugger or Marsh Crocodile
2. Estuarine or salt water Crocodile
3. Gharial or long snouted Crocodile

CROCODILES

Indian crocodiles look alike. Hence it is difficult to distinguish between Marsh crocodiles living in lakes and rivers and the estuarine crocodiles, living in the coastal river estuaries.

- The nostril is placed at tip of the snout enabling the animal to breathe when the rest of the body is submerged in water.
- Nostrils and ears are provided with flaps for closing them, while in water.
- The eye has a transparent third eyelid, permitting limited underwater vision.
- Folds on the tongue and palate prevent water from entering the lungs.
- Nostrils are connected by long tubes to the throat behind a dividing flap from the mouth, permitting breathing with the prey inside the mouth, while partially submerged.
- Teeth are shed and replaced throughout life (as in other reptiles).
- On land, they walk or slide on their belly. Walk at a speed of about 3 km/hour with the body raised well above the ground - termed as 'high walk'.
- All are carnivorous.
- Incubation period of eggs - 60 - 90 days.
- Longevity - about 30 yrs. In captivity 50-60 yrs.
CLASSIFICATION OF AVIFAUNA

Like mammals, birds are descended from reptilian ancestors.

The classification based on DNA analysis recognizes 23 orders, as quoted below:

<table>
<thead>
<tr>
<th>Order</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Struthioniformes</td>
<td>(Ratites)</td>
</tr>
<tr>
<td>2. Tinamiformes</td>
<td>(tinamous)</td>
</tr>
<tr>
<td>3. Craciformes</td>
<td>(curassows, gunas, magapodes)</td>
</tr>
<tr>
<td>4. Galliformes</td>
<td>(game birds)</td>
</tr>
<tr>
<td>5. Anseriformes</td>
<td>(waterfowl)</td>
</tr>
<tr>
<td>6. Turniciformes</td>
<td>(quail)</td>
</tr>
<tr>
<td>7. Piciformes</td>
<td>(barbets and wood peckers)</td>
</tr>
<tr>
<td>8. Galbuliformes</td>
<td>(jacanas and puff birds)</td>
</tr>
<tr>
<td>9. Bucerotiformes</td>
<td>(hombills)</td>
</tr>
<tr>
<td>10. Upupiformes</td>
<td>(hoopoes)</td>
</tr>
<tr>
<td>11. Trogoniformes</td>
<td>(trogons)</td>
</tr>
<tr>
<td>12. Coraciiformes</td>
<td>(kingfishers, rollers, bee-eaters)</td>
</tr>
<tr>
<td>13. Coliiformes</td>
<td>(collies)</td>
</tr>
<tr>
<td>14. Cuculiformes</td>
<td>(cuckoo)</td>
</tr>
<tr>
<td>15. Psittaciformes</td>
<td>(parrots)</td>
</tr>
<tr>
<td>16. Apodiformes</td>
<td>(swifts)</td>
</tr>
<tr>
<td>17. Trochiliformes</td>
<td>(humming birds)</td>
</tr>
<tr>
<td>18. Musophagiformes</td>
<td>(turacos)</td>
</tr>
<tr>
<td>19. Strigiformes</td>
<td>(owls)</td>
</tr>
<tr>
<td>20. Columbiformes</td>
<td>(pigeons)</td>
</tr>
<tr>
<td>21. Gruiformes</td>
<td>(cranes)</td>
</tr>
<tr>
<td>22. Ciconiiformes</td>
<td>(water birds and birds of prey)</td>
</tr>
<tr>
<td>23. Passeriformes</td>
<td>(song birds)</td>
</tr>
</tbody>
</table>
HABITAT

Definition: Habitat is the place where an organism or community lives.

There are 2 major habitats in the biosphere viz,

1. Aquatic Habitat
   - Marine habitat
   - Estuarine habitat
   - Freshwater habitat
2. Terrestrial Habitat
   - The tundra biome
   - The Forest biome
   - The Grassland biome
   - The Desert biome
   - The Mountain biome
   - The Cave biome

A biome is a large unit of terrestrial community characterized by typical flora and fauna components.

COMPONENTS OF A WILDLIFE HABITAT

A wildlife habitat has four basic components viz., 1. Food; 2. Cover; 3. Water; 4. Space.

FOOD

Food is an essential prerequisite for any organism. Food availability in a habitat changes with season. Herbivores depend upon the plant materials for their sustenance whereas carnivores survive on the availability of prey animals.

COVER

The basic idea under the term "cover" is to afford shelter to various animals. Cover affords protection to animals from weather, predators or enemies by offering a better vantage point. Cover may be artificial or natural.

REFUGE COVER

This essentially means a vegetation from which the wild animals cannot be driven out during huntngs.

AMBUSH COVER

This means any cover used by a predatory animal for ambushing its prey. It may be vegetal or non-vegetal.

LOAFING COVER

Some animals, at certain points in time, may prefer to spend their time aimlessly at some secluded place in a habitat. This is called as "loafing cover".

26
BREEDING COVER

This is important in mammals since they exhibit parenteral care; certain birds also have well built nests during the breeding season, where the young ones are nurtured for sometime.

ROOSTING COVER FOR BIRDS

Birds require a safe place for resting which is known as "roosting cover". Some large birds like vultures have considerable wing span and they require tree cover to take off in the air, since raising directly to soaring height in one stroke is not possible from ground level.

NON-VEGETAL COVERS

Usually caves and overhangs act as non-vegetal covers, Dry stream beds, abandoned buildings in a forest, burrows, distance between two animals and the like also have cover value.

Territory relates to a space, which is defended by the animal

WATER

Water replenishment is essential for all wild animals. Good wildlife areas have well distributed water points.

SPACE

Animals require physical space to live; its day to day requirements like procurement of food, water, cover and mates are met from this space. The amount of space required depends on the population size, which in turn is dependent on the habits and body size of animal species and the diversity available in the habitat to meet the various requirements.
HOUSING OF ZOO ANIMALS

HOUSING TO WILD ANIMALS AND BIRDS IS DONE

1. To protect from adverse environmental conditions.
2. To facilitate breeding, feeding, watering and treatments in captivity.
3. To protect from stress due to visitors and also to protect the visitors as well.

PRINCIPLES OF HOUSING

1. The floor space and height of the roof must be adequate and as per the norms depending on species, size and behaviour of the animals.
2. There should be economy in construction but should provide maximum comfort to the captive animals. Over crowding within the enclosure must be avoided.
3. There should be adequate provision of ventilation and exposure to maximum sunlight.
4. Safety of animals, care takers and visitors must be given due consideration while designing the animal house.
5. For the animals, which are having the burrowing habits, e.g., rabbits, mongoose, etc., the floor must be cement and concrete.
6. Separate enclosures should be provided for advance pregnant animals and also to the recently born young ones with their lactating mother.
7. There should be separate ward for the sick animals, in proximity with veterinary dispensary within premises of the zoo.
8. All the animal houses and enclosures should be equipped with resting platforms, bedding materials, feeding and watering troughs, nesting boxes, open to sky raised platforms, etc. as per the need of the individual species.

- Designing an enclosure depends on the animal’s physical activities like climbing, burrowing, jumping, wallowing. Climate and biological requisites of the social group in wild have to be considered. Floor must be designed for easy cleaning and must have proper drainage.
- Provision to have a safe buffer zone between the visitor and the animal is important for human safety, safeguard against visitor disturbances and to prevent zoonoses.
- Adequate living space depends upon the spaces to be exhibited, providing free movement and exercise as well as protecting from extreme temperature.
- The quality and type of enclosure are of great importance depending upon the different type of species. Enclosure should have provision for easy viewing by the visitors.
- Enclosures should have resting and retreating places (sleeping shelves, perches, platforms, trees, caves or sand banks), hiding places (dens, burrows, holes, bushes, stone heaps), place to give birth, or brood (nesting boxes, nesting materials and hollow trees), grooming (for skin and claw pawing logs, stones, pools, wallowing pools, mud bath, dust bath etc.), camouflage
(tree and branches, various types of vegetation) and mental stimulation (swings, balls, poles) that can be changed periodically to avoid boredom. Play objects are important and this will stimulate their play with littermates.

- Enclosure should be free from health hazards like broken glasses, nails, toxic fruits, sharp corners or any similar objects or poisons that could be hazardous to animals.
- Fence barriers like chain link fence may not give a visual barrier for the timid animals and may injure themselves. Lack of binocular vision in ungulates adds to this by poor depth or distance assessment.
- A hard floor is required for hoofed stock to prevent the overgrowth of the hooves. Soft-footed animals should have soft ground if not, it will lead to sore paws.
- Similarly pawing of soft wood will prevent in-growing nails. Elephant and rhino rub their body on tree trunk and this has beneficial effect for skin in addition to the pleasure they derive out of it.
- A hiding place from the crowds and pestering visitors will often help the animal to avoid stress. At least one area of the enclosure should not have access to visitors. This will help the animal to retreat to that area when disturbed by the visitors.
- Nocturnal animals require poorly lit areas and hence in many Zoos special nocturnal houses are designed to avoid stress and strain.
- Exothermic animals like reptiles are heat sensitive and hence serpentarium should have provision to keep the temperature in moderation.
- Provision for cleaning the left over food, excreta and even flushing if necessary should be available.

**ENCLOSURE BARRIERS**

Enclosure barriers are the special features for the wild animals housing in zoo for extra protection.

**Types of enclosure barrier**

1. Wet and dry moat
2. wire mesh fencing
3. vertical walls
4. glass and plastic panels
5. high tensile vertical wires
6. electrically charged wires

Any one or combination of enclosure barriers can be constructed depending on biological capabilities (like jumping, climbing, swimming) of the animals.

**Do's and Don'ts for Efficient Housing and Management of Wild Animals in captivity**

**Do's.**

1. Study the psychology, shelter seeking, behavior, feeding habits, sexual behavior and mothering ability of the animals in captivity and provide conditions accordingly.
2. Animal should be grouped and placed according to age, size and sex. Male and female should be housed separately.
1. Calculate the feeding requirements in terms of proximate principles and the quantum as per species, age, sex and lactation and provide feed accordingly.

2. Provide extra care to young ones, advanced pregnant and sick animals. Very advanced pregnant animals and sick animals should be housed separately and due care must be guaranteed.

3. Young ones must be provided with optimum amount of colostrum and milk as per their need.

4. Weaning must be practiced at appropriate age.

5. Provide housing conditions in captivity as natural as possible.

6. All the hygienic measures must be adopted within the enclosure and in premises of the zoo.

7. Dead animals must be disposed off quickly.

8. Zoo attendants, veterinarians and other personnel should develop friendship with the animals in captivity.

Don'ts

1. Do not house male and female together.

2. Do not allow the feedstuffs from outside the zoo or feeding by the visitor must not be allowed. This may carry infection.

3. Do not feed stale and unfresh meat and other feedstuff to the animals in captivity.

4. Do not allow the visitor to tease the animal especially monkeys and elephant.

5. Do not allow the entry of pet dogs, cats and birds along with visitors in the zoo.

6. The zoo premises must be smoking free zones.

7. The visitors must not be allowed with weapons (even toy guns) within the zoo and safari parks.

8. The exit and entry points in the zoo must not be left unguarded.

9. Fire crackers within and nearby zoo must not be allowed.
SANITATION

- The excreta and the left over food must be properly discarded.
- Hard floors should be cleaned with pressure washer and kept from cracks.
- Drainage should be sufficient to keep the animal home clean.
- Sanitation has to be carefully looked into picnic spots, toilets, food kiosk and cafeteria,
- A good and effective disinfectant has to be selected.
- Moats wet or dry are to be cleaned regularly and refilled if necessary with clean water.
- Feeding utensils, water trough and food storage containers are to be checked periodically and prompt cleaning measures to be taken.
- Stray dogs and cats, crows, rodents, snails and insects transmit various diseases both passively and actively. Hence strict control on their breeding and elimination of them are to be carried out regularly.
- Lime treatment of the soil and burning of the ground when found necessary must be done.
- A hand held kerosene run blowpipe can be used to sterilize cracks and crevices in animal houses and iron cages.
- Cleaning of the post-mortem room and disposal of carcasses after autopsy is very important.
- Sufficient precaution has to be taken so that dogs, foxes and jackals do not dig out the carcass.
- Installation of incineration facilities has to be encouraged.

Points to be considered for Zoo Hygiene
1. Usage of suitable disinfectant (natural / synthetic).
2. Proper disposal of carcasses (burning/incineration).
3. Speedy and proper disposal of feed wastes.
4. Supply of hygienic water.
5. Animal keepers and handlers hygiene.
7. Disposal of left - over feed items and polythene bags by visitors.
8. White washing of water container tanks in a periodical manner.
9. Adaptation of suitable fly control measures (fly catcher lights) especially in main feed receiving spots.
10. Cleaning of sheds immediately after the calving/cubbling/pawing ie., placenta , discharge etc.
11. Speedy clearance of sheds / cages after the occurrence of diarrhoeic stools/ after conducting of operations.
12. Strengthening of rodent or pest proof barriers or cages or fences especially in aviaries or birds exhibit places to avoid diseases.
13. Usage of aseptic infra structures like sterilized needles, syringes, sample - collectors etc.,
FEEDING OF WILD ANIMALS

Based on the physiology of digestion and food habits, the wild animals can be classified into:

1. Herbivores → Ingest plant origin. It may be sub divided into 2 types.
   1) Simple stomached or non-ruminant. Eg: elephant, zebra, wild horse, rhino, hippo, monkeys etc.
   2) Complex stomached or ruminants. Eg: bison, deer, and giraffe etc.
      (Pseudo ruminants. Eg: camel - has 3 compartments. Omasum absent)

2. Carnivores → Ingest animal origin. Eg: cheetah, leopard, tiger, lion, fox, bear, wild cats etc.

3. Omnivores → Ingest both animal and plant origin. Eg: wild pigs, rodents, bear, and monkeys etc.

According to activity it may be

a) Nocturnal → Hunt their prey during night time.

b) Diurnal → Hunt their prey during day time.

c) Crepuscular → Active at dawn or dusk

Based on behaviour;

a) Solitary → Feed alone. Eg: tiger

b) Gregarious → Feed in groups. Eg: deer, lion, etc.

It may be

a) Continuous feeders ie, feeding continuously. Eg: Peafowl

b) Occasional feeders. Eg: Snakes.

Depending upon the nature of feeding;

1. Euryphagous → Prefer a variety of food.

2. Stenophagous → Feeds on specialized foods.


Factors to be considered while feeding

1. Food should be qualitatively and quantitatively sufficient to maintain proper health as well as for reproduction. Factors like age, sex, size, physical status like pregnancy and lactation should be considered. It should also be palatable and free from toxic elements.
2. Feed selected should be as far as possible similar to the natural feeds of the animals. Time of feeding should be strictly adhered to.

3. Necessary changes both in quality and quantity should be made based on the physiological needs of the animal. Eg: pregnancy, lactation, disease and convalescence.

4. Predators like tigers, panther, lion, and cheetah hunt their prey in their natural habitat. Hence to satisfy the hunting instincts, these species should be provided with live birds and live rabbits in their cages at some periodical intervals.

5. Carnivores should be fed alone since they can't tolerate the presence of other animal in proximity. They are generally fed for 6 days, a week and fasted for one day.

6. For herbivores, plenty of green grasses, hay silage, along with concentrate mixture, mineral and vitamin supplements are very essential. Herbivores are fed daily.

7. Snakes must be fed individually and simultaneously to avoid 2 snakes seize the opposite sides of the same prey.

8. The group feeder like deer should have enough feeding space and points to avoid competition.

9. Nocturnal animals can be fed during late evening to avoid wastage of feed.

10. Animals live in social groups tend to feed less when isolated or separated from the group, when compared to solitary animals, which prefer to take feed alone. Similarly animals caught from wild will feed less initially due to stress.

11. Nature of food like hard or soft should also be considered. Rodents need hard food as they have continuously growing incisors and the seed eating birds like parrots need a feed to crack. Wild cats and bears have the natural habit of eating the hidden food. To satisfy this instinct, the feed can be hidden in the treetop of the enclosure.

12. As far as possible one person should feed one set of animals on a regular basis. The left over should be removed promptly.

13. Mineral supplements like salt lick and vitamins can be provided to avoid mineral and vitamin deficiency.

14. Food items should be inspected daily at supply point, store and in the enclosure. Foreign bodies in the enclosure must be avoided.

Feeds and feeding of wild mammals

Feed must be supplied in a balanced manner so that it contains the proper levels of protein, carbohydrates, and fats and includes vitamins and minerals. There is diversity of feed taking place amongst animals to a considerable level. The carnivores mainly depend upon meat, as these animals are able to make energy from protein sources. The meat requirement is roughly based on one-tenth of their body weight for an adult animal.
Fish is a preferable food item for fishing cats and the otter. Fish, along with meat, is provided to jungle cats. Boiled eggs along with meat are provided to the small Indian civet and binturong. Meat along with bread, biscuits, molasses and some fruits, even milk is supplied to bears.

The feeding habits of primates in captivity are likely to change. Readymade bread or a small amount of boiled rice is supplied as the prime carbohydrate resource. Vegetables like pumpkin, cucumber, ladies finger and beans and different fresh leaves along with fruits, which are rich in vitamin C, are supplied to these animals for their maintenance. Most animals or primate groups are vegetarians, but some animals like the slow Loris and a few varieties of both langurs and monkeys require animal protein. Small live birds are supplied to Loris. Chimpanzee, gorillas are supplied with honey, condensed milk, dates, grapes, etc. Supply of one boiled egg a week also substitutes for animal protein in some animals of the primate group. The other important food items are soaked gram, plantains, sweet potatoes, papaya etc.

Deer and antelope are browsers and some are both browsers and grazers. Grazers can thrive well on grasses, but animals in captivity are supplied with soaked gram, paddy straw, bran mixture of cereals, namely, gram, wheat, corn and carrots, etc. Sambar deer being the largest among all deer require bulk amount of food for their existence.

Large animals, namely, the Indian rhinoceros, the Indian elephant and the wild ox, namely gaur, mithun, wild water buffalo, etc. require bulk amount of feed consisting of different crushed grains like gram, oat, corn along with paddy straw, bran hay and a measurable amount of salt. Extra supply of fodder, namely, jackfruit leaves, figs or banyan leaves are required to be supplied in maximum amount to the Indian rhinoceros and the Indian elephant. Supply of at least 10 kg boiled rice and pulses should be offered along with bulk supply of green leaves, etc. for Indian elephants. Main stem of plantains and bamboo leaves are also preferable food for an Indian elephant. Salt, either mixed with grain or in small lumps, for licking and grass bran should be supplied.

The large Indian squirrel is supplied with fruits, nuts, corn, along with other grains and vegetables and even with biscuits. Porcupines should be maintained on carrots, sweet potato and some grains etc.

Feeding requirements

<table>
<thead>
<tr>
<th>S.no</th>
<th>Name of the animal</th>
<th>Diet given for each animal in general</th>
<th>Qty. for each animal per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bonnet Macaque</td>
<td>Rice, Banana, Orange/Mango or Guava</td>
<td>50 gms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundnut (W.O.S)</td>
<td>15 gms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bengal gram</td>
<td>15 gms</td>
</tr>
<tr>
<td>2</td>
<td>Jungle cat</td>
<td>Chopped beef, Bread slice, Milk</td>
<td>250 gms, 2 nos., 100 ml</td>
</tr>
</tbody>
</table>

The feeding requirements of primates in captivity are shown in the table above.
<p>| 4 | Jackal | Beef without bone | 500 gm |
|   |       | Liver             | 100 gm |
|   |       | Chicken           | 250 gm weekly once |
| 6 | Hyena | Beef without bone | 3 kg/day |
|   |       | Liver             | 100 gm/day |
|   |       | Chicken           | 500 gms weekly once |
| 7 | Sloth bear | Ragi (cooked)     | 250 gm |
|   |       | Rice Gruel with black gram | 150+50 gms |
|   |       | Orange/Mango or Guava | 2 nos. |
|   |       | Tapioca           | 100 gms |
|   |       | Jaggery           | 200 gms |
|   |       | Groundnut (W.O.S) | 100 gms |
|   |       | Honey             | Bi – weekly |
|   |       | Milk              | ½ lt |
|   |       | Radish            | 100 gms |
|   |       | Bread slices      | 2 no. |
|   |       | Carrot            | 200 gms |
| 8 | Otter | Fish              | 1.5 kg |
|   |       | Crab (weekly twice) | 300 gms |
|   |       | Scardine          | 1.5 kg |
| 9 | Indian elephant | Ragi              | 7 kg |
|   |       | Horse gram        | 2 kg |
|   |       | Salt              | 200 gms |
|   |       | Jaggery           | 250 gms |
|   |       | Grass             | 200 kgs |
|   |       | Sugarcane         | 4 nos. |
|   |       | Green tree leaves bamboo / stylo | 250 kgs |
|   |       | Coconut           | 500 gms (1no.) |
| 10 | Porcupine | Rice              | 100 gms |
|    |       | Carrot            | 100 gms |
|    |       | Cabbage           | 100 gms |
|    |       | Tapioca or sweet potato | 100 gms |
|    |       | Soyabean          | 20 gms |
|    |       | Groundnut (W.O.S) | 150 gms |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Animal</th>
<th>Ingredients</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Lion and Tiger</td>
<td>Beef (With Bones) 10 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liver 500 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicken 1 kg (weekly once)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Panther</td>
<td>Beef (With Bones) 3 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liver 250 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicken 1 kg (weekly once)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Zebra -adult</td>
<td>Wheat bran 2 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>White Bengal gram 100 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass and leaves 30 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral mixture 10 days in a month</td>
<td>regular intervals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lucerne 5 kgs</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Camel</td>
<td>Wheat bran 2 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>White Bengal gram 500 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass 30 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves (neem, bamboo, subabul,</td>
<td>20 gms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bauhinia, hibiscus)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Salt 50 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cabbage 2 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Banana 6 nos.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves of Acacia 5 gms</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Indian gaur (bison)</td>
<td>Wheat bran 3 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bengal gram 0.500 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green leaves / grass L.S.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Barking deer/Spotted</td>
<td>Wheat bran 1 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>deer / Sambar</td>
<td>White Bengal gram 25 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass 7 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green Leaves 3 kgs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Salt 10 gms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stylo / Lucerne 2 kgs</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Peach faced love bird,</td>
<td>Apple (to all) 1 no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fisher's love bird,</td>
<td>Banana (to all) 1 no</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sky blue mask love bird,</td>
<td>Thinai 10 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Love bird (Split)</td>
<td>Paddy 5 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mixed grain 10 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>White Bengal gram 5 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Onion 10 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greens 10 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shell grit Q.S.</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Species</td>
<td>Items</td>
<td>Quantities</td>
</tr>
<tr>
<td>-----</td>
<td>---------------</td>
<td>--------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>21</td>
<td>Parakeet</td>
<td>Bread slice</td>
<td>1 no.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apple (L.S)</td>
<td>3 nos.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sathukudi/orange/mango</td>
<td>¼ nos</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guava</td>
<td>1 no.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundnut (W.O.S)</td>
<td>20 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chilly fruit</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garlic</td>
<td>02 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paddy</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mixed grains</td>
<td>20 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bengal gram</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sunflower seed</td>
<td>40 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green gram</td>
<td>10 g</td>
</tr>
<tr>
<td>22</td>
<td>Indian Peafowl</td>
<td>Cabbage</td>
<td>25 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mixed grain</td>
<td>25 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paddy</td>
<td>25 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White Bengal gram</td>
<td>50 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greens</td>
<td>100 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garlic</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundnut (W.O.S)</td>
<td>50 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shell grit</td>
<td>1 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green gram</td>
<td>25 g</td>
</tr>
<tr>
<td>23</td>
<td>Owl</td>
<td>Chopped beef or rat (each 100 to 150 g size)</td>
<td>150 g/2 nos./day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicks</td>
<td>100 g (once in a week)</td>
</tr>
<tr>
<td>24</td>
<td>Budgerigar</td>
<td>Thinai</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greens</td>
<td>10 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shell grit</td>
<td>20 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bengal gram</td>
<td>5 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green gram</td>
<td>5 g</td>
</tr>
<tr>
<td>25</td>
<td>Emu</td>
<td>Green gram</td>
<td>250 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wheat</td>
<td>250 g (soaked)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broiler finisher grumble diet</td>
<td>250 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rice</td>
<td>250 g (cooked)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Milk</td>
<td>100 ml (boiled)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tomato</td>
<td>100 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green banana</td>
<td>2 nos.</td>
</tr>
<tr>
<td>No.</td>
<td>Animal</td>
<td>Food Item</td>
<td>Frequency</td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>26</td>
<td>Marsh Crocodiles adult</td>
<td>Fish (twice a week)</td>
<td>250 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bone (vertebral column)</td>
<td>100 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beef</td>
<td>250 g</td>
</tr>
<tr>
<td>27</td>
<td>Gharial adult</td>
<td>Fish (twice a week)</td>
<td>1 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bone (vertebral)</td>
<td>100 g</td>
</tr>
<tr>
<td>28</td>
<td>Python</td>
<td>Chicken</td>
<td>1 kg (twice a month)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rat</td>
<td>8 nos. (twice a month) each 150 g size.</td>
</tr>
<tr>
<td>29</td>
<td>Viper</td>
<td>Chicken</td>
<td>3 nos.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rat 100-150 g size (weekly once)</td>
<td>4 nos.</td>
</tr>
<tr>
<td>30</td>
<td>Cobra</td>
<td>Chicken</td>
<td>3 nos.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rat 100-150 g size (weekly once)</td>
<td>4 nos.</td>
</tr>
<tr>
<td>31</td>
<td>Iguana</td>
<td>Carrot</td>
<td>50 g (daily)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cabbage</td>
<td>50 g (daily)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tomato</td>
<td>50 g (daily)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greens</td>
<td>100 g (daily)</td>
</tr>
<tr>
<td>32</td>
<td>Star tortoise</td>
<td>Carrot</td>
<td>30 g (daily)</td>
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<td></td>
<td></td>
<td>Cabbage</td>
<td>30 g (daily)</td>
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<tr>
<td></td>
<td></td>
<td>Tomato</td>
<td>30 g (daily)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greens (L.S)</td>
<td>500 g (daily)</td>
</tr>
</tbody>
</table>
PUBLIC HEALTH PROBLEMS ARISING FROM ZOOS

In zoological gardens, parks, and zoos, the public may encounter a wide variety of zoonotic diseases. Wild animals can transmit disease to humans in the following ways:

- **Direct contact** - which includes bites and scratches as well as handling animals or their tissues.
- **Indirect contact** - includes contact with infected urine, faeces, secretions, blood samples, contaminated soil or fomites and aerosols.

Certain procedures should be followed in order to decrease possible health hazards to human personnel.

- New animals should be properly checked out, before they are added to the collection and a quarantine period of 30 to 90 days is required, depending on the case.
- Proper restraint technique, either physical or chemical should be employed to prevent animal bites.
- Protective clothing that can be cleaned or disposed off after use.
- Personnel hygiene, including washing hands before eating, should be strictly enforced.
- Good sanitation and ventilation greatly decrease the rate of disease transmission.
- Vaccination of keepers for measles, polio, rabies, mumps, tetanus etc. is beneficial.
- Zoos should not receive or transport any animals that are in bad condition.
- Proper report of zoonotic disease is essential.

Precautionary measures to be followed when dealing with wild animal exhibits in zoos by both staff and public

For staff members

- Hands should be washed frequently especially after handling the animal, its food, bedding, enclosure materials, excrement and / or tissue and body fluids.
- Cages should be cleaned so as to minimize the risk of creating aerosols or droplets of potentially infectious materials. Wearing protective clothing, especially masks, gloves and glasses or goggles helps to avoid direct contact with pathogens.
- The staff should be instructed to engage in proper personnel hygiene procedures in and out of the workplace.
- Staff members who are ill with a cold should avoid working around the animals.
- If staff members get sick, they should seek medical attention.
- A baseline serum sample should be collected from all personnel working with animals for periodical screening for infectious diseases.
- Staff members should take precautions to avoid physical injury.
• An effective means for handling, reporting, evaluating and treating occupational exposures to possible zoonotic infections should be developed for the institution.

• Individuals with a known immuno deficiency diseases should be extremely cautious in working with potentially infected animals or materials.

• An active insect and rodent control program should be instituted in the facility.

• Personnel who have open cuts or sores on their hands should wear gloves while working around animals and their faeces.

For visitors

In addition to the precautions to be followed by the staff members, visitors are at their own risk and also acts as agents in spreading the diseases.

• Visitors should not spit inside the animal premises, which may lead to spread of infection.

• Avoid touching of animal cages as it may be contaminated.

• Avoid chewing of tobacco, spitting, smoking.
PREVENTION AND CONTROL OF DISEASES IN ZOOS

Several factors contribute to the occurrence of the disease like the environmental factors, age, inherent disease resistance and the species. Environmental factors include air, water, food, fodder and space in the enclosure, social group and climate. Infectious diseases can be controlled by measures like quarantine, isolation, proper sanitation, parasite control and vaccination programs (where applicable).

QUARANTINE

Proper quarantine of a newly received animal is important. The period depends upon the species and health status of the animal. The minimum period is 30 – 40 days. It may be extended up to 3 – 6 months. The animals must be carefully observed for any abnormal behavior, appetite or symptoms suggestive of any disease. Initial screening should include a thorough physical examination, faecal and blood smear examination. Clinico pathological examination of blood, urine, skins scrapings, dental check and for mammals tuberculin tests, should be done.

Quarantine shelter helps the animals to adapt themselves to the new environment; recover from the stress of capture and transportation. Quarantine enclosures should be away from the display area and the zoo hospital.

ISOLATION

It is done when an animal is suffering from any infectious disease. Suspected animals are isolated as early as possible and given the required treatment.

SANITATION

Hygiene is of the utmost importance to animal health. The animal enclosures may be designed to facilitate easy cleaning. Proper handling and disposal of the carcass of dead animals is important.

PARASITE CONTROL

Regular deworming schedule and vector control measures must be adopted.

VACCINATION

To be considered if necessary.
PHYSICAL RESTRAINT

INTS TO BE CONSIDERED BEFORE PHYSICAL RESTRAINT

Whether the procedure to be adopted is safe to the restraining person.

What may be the expected hazards of that restraining technique. Eg; injuries - in confinement of the wild animals.

Whether it solves the purpose of restraint.

Whether the site selected for exercising the restraint procedure is safe for them and for the operating personnel.

Whether the procedure to be adopted is safe and/or suitable to the wild animal under study. Eg; blackbuck jumping against the fence.

Whether the transport facilities have been arranged promptly.

Whether it is the excitable spp.

Whether sufficient man power available for restraint.

Restrainer needs to know manner of attack by wild animals during restraint procedures.

PURPOSE OF RESTRANNING OF WILD ANIMAL

For treatment purposes in sick animals.

For clinical examination of the wild animals in a periodical manner.

For obtaining of specimens. e.g.; collection of blood, CSF, collection of urine etc.

For translocation purpose.

For biological researchers and wild animal health-related researches.

For assessment of environmental effects because of their being as the indicators of the environmental hazards.

Whenever, wild animals get trapped by human beings by accident.

If there is an extensive damage to welfare of people it becomes a need to restrain them. Eg; man-eating tigers.

TECHNICAL AIDS APPLIED DURING THE PHYSICAL RESTRAINT TECHNIQUES

Nets / fences → walls

→ tensile wire

→ electrical wire (common in wildlife centres)/towels/free clothes.

Clothes/wire baskets.

Cages/squeeze cages/adjustable partitions/camp trays for capture of large no. of animals at a time.
4. Cage traps with baits.
6. Drop gate
7. shields → glass
   → Plywood.
9. Cloth bags / special restraint bags / jute sacks/ gunny bag.
10. Snares / "ketch - all pole" / wire - panels or solid gates / plastic tubes.

<table>
<thead>
<tr>
<th>PHYSICAL GADGETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEATHER GLOVES</td>
</tr>
<tr>
<td>Many types are available and gloves are not an absolute guarantee of protection from biting. Should be loose adequately</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MERITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longer the gloves, it is more protective to wrist and arm.</td>
</tr>
<tr>
<td>Presence of padding is more helpful in minimizing the bite stress; padding is helpful as long as the glove is pliable and easily maneuvered.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEMERITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>If thicker is the glove the touch and reflex of restraints is reduced.</td>
</tr>
</tbody>
</table>

**ELECTRIC SHOCK RODS (ELECTRIC SHOCKER)**

Especially these shockers are more used as a means of defense; however to make the wild animal to enter into another cage, it can be used especially in highly aggressive wild animal.

**CO₂ CHARGED FIRE EXTINGUISHERS**

Useful to encourage or frighten the wild animal to move out or into another enclosure; the sound and/or the fog of the Co₂ extinguisher is the prime cause for making a good restraint of the wild animals.

**BAFFLE BOARDS**

These are the large pieces of plywood with handles on the back and rounded corners; the handler can hide behind this board and hence, handler is out of danger from antlers. Unfit for Giraffe like animals because of their height factor. Plastic shields are more useful in restraining especially the large non- venomous reptiles and some birds and some of the smaller mammals.

**USE OF BLANKETS**

Blankets are useful as shields.
E OF MATTRESS

Is thicker than blankets and hence more cushion ie., protection to both wild animals and the trainer.

E OF HEAD SCREEN (HELMET LIKE)

Especially when restraining the primates it is more useful because primates used to attack most the times.

LES OF STRAW

Useful as physical barrier especially to minimize the effects of kicking by wild animals especially herbivores or wild ass; also usage of these bales of straws help to prevent traumatization of the s of the wild animal that kicks.

E OF "PRESSURE FORCE" AS TOOL OF RESTRAINT

The application of pressure force varies with spp. of wild animals ie., pressure force needed to be a parakeet digit from the one applied to a macaque or deer.

APTURE BY SPOT LIGHTS

Initially wild animal herds are located using vehicles on a moonless night and eyes of cervids located in the beam of head lamps; later, the head lights are to be dimmed and the wild animals ve to be approached from the opposite side now with dim light. (ie., the powerful quartz - iodide sealed beam search light).

APTURE BY DROP NETS

Heavy grade mesh nets may be either dropped over a target area or delivered by a ground fired nnnon system.

IT - GUN CAPTURE

They are essentially the rifles which have been modified to fire a projectile net over considerable stance.

ST NETS

Are the ultra fine mesh nets that are typically strung between 2 objects

RECTED VISUAL BARRIERS

The barrier should be solid in appearance, light weight and supported at intervals.

LD ROOKS

Commonly referred as "snake hooks"/anguish - for elephants in Kerala state.

PPETS

For control of cranes etc.,

OD (CLOTH BAG)

Used for control of Ostriches and falcons.
WHISTLES

Duck whistle/cormorant whistle etc. may be used to attract the wild bird spp. to the particular site of capture.

GUNNY BAGS

Useful for physical restraint of macaques / langurs etc.

SPECIFIC TRAPS

PADDED FOOT HOLD TRAP

1. Adjust the trigger mechanism so that the animal with less than 1 kg weight cannot be trapped.
2. Should be suitably designed with required size and construction to capture the target animal.

TECHNIQUES OF RESTRAINT, USING DIMINISHED SENSE PERCEPTIONS

Diminishing the sense perception helps not only in reducing the stress condition but also helps for a better control of the wild animal species.

DARKNESS

A parakeet may be easily restrained when the room is darkened or in semi-darkness.

BLINDFOLDING

A blindfolded animal may lie quietly for a long period, on which the non-painful manipulations are carried out.

COOLING

Cooling also will reduce the sense of perception especially the poikilothermic species.

STROKES ON WILD ANIMALS

Stroking at proper areas of body in the proper direction may lead a better restraint.
CHEMICAL IMMOBILIZATION

pose of chemical immobilization

Translocation of wild animals from one region to another, as a means and ecological balance.
To counter the genetic drifting.
To counter balance the present "over-concentration" of populations of one species.
For veterinary care of captive and free-ranging wild animals, including the vaccination of free-ranging wild animals in wildlife areas.
For biological and veterinary research aspects.
For capture of problematic animals or animals in distress.
For translocation of wild animals due to artificial meddling in a wildlife area, eg: construction of Dam in a wildlife area.
To restrain the highly excitable wild animals which otherwise exhibit high degrees of excitability, when physical restraint methods are employed with them.

<table>
<thead>
<tr>
<th>Group</th>
<th>Class</th>
<th>Drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthetics</td>
<td>Dissociative anaesthetics</td>
<td>Ketamine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tiletamine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phencyclidine</td>
</tr>
<tr>
<td></td>
<td>Steroid anaesthetics</td>
<td>Alphaxolone/alphadolone</td>
</tr>
<tr>
<td></td>
<td>Barbiturates</td>
<td>Pentobarbital</td>
</tr>
<tr>
<td></td>
<td>Inhalation anaesthetics</td>
<td>Thiopentone</td>
</tr>
<tr>
<td>Opioids</td>
<td>Morphine derivatives</td>
<td>Etorphine</td>
</tr>
<tr>
<td></td>
<td>Opiate substitute</td>
<td>Fentanyl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carfentanil</td>
</tr>
<tr>
<td>Hypnotics &amp; sedatives</td>
<td>Diazepinones</td>
<td>Diazepam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Midazolam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clomazolam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zoletapam</td>
</tr>
<tr>
<td></td>
<td>Alpha -2-adrenoceptor agonists</td>
<td>Xylazine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detomidine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medetomidine</td>
</tr>
<tr>
<td>Tranquilizers (Neuroleptics)</td>
<td>Phenothiazine derivatives</td>
<td>Acepromazine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chlorpromazine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Propionylpromazine</td>
</tr>
<tr>
<td></td>
<td>Butyrophenones</td>
<td>Azaperone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Haloperidol</td>
</tr>
<tr>
<td>Neuromuscular blockers</td>
<td>Competitive antagonists</td>
<td>Gallamine</td>
</tr>
<tr>
<td></td>
<td>Non-competitive antagonists</td>
<td>Suxamethonium</td>
</tr>
<tr>
<td></td>
<td>Ganglion blockers</td>
<td>Hexamethonium</td>
</tr>
</tbody>
</table>
DARTING SITES

- Monkey
- Cat
- Deer
- Rhinoceros
- Elephant
REMOTE DELIVERY SYSTEM

BREECH BOLT SAFETY RING  
BREECH BOLT  
COCKING KNOB  
KNURLED TUBE CAP  
SAFETY

Long Range CO₂ Projector showing Working parts

DART

Air pressurized blow dart (Telinject) 1 = drug chamber, 2 = Pressurization chamber way valve, A: Dart Pressurized in flight, B: Dart in final stage of injection.
The properties of the ideal immobilization drug

1. An effective drug should not exceed the volume of the dart.
2. Should have less risk to wildlife veterinarians handling the drug.
3. Should not cause tissue irritation.
4. Should be rapidly eliminated from the body.
5. The recovery and induction periods should be calm.
6. The duration of effects should be adequately long enough.
7. Should have a wide margin of safety.
8. Should have rapid onset of action, resulting in the adequate immobilization.
10. Availability of reliable antidote.
11. No permanent damage to the wild animal.
12. No drastic effect on the pregnant animals.
13. Should have suitable stability.

Dose rates of immobilizing drugs in different wild animal species (mg/kg)

<table>
<thead>
<tr>
<th>s.no</th>
<th>Animal</th>
<th>Xylazine</th>
<th>Ketamine</th>
<th>XY:Ket</th>
<th>Etorphine</th>
<th>ET: XYL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Elephants</td>
<td>0.04-0.08</td>
<td>-</td>
<td>012:0.33</td>
<td>0.0022</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Non-human primates</td>
<td>-</td>
<td>8-15</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-3</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>Carnivores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Canids</td>
<td>2-5</td>
<td>10-15</td>
<td>1-2.5:5-10</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>b.</td>
<td>Ursids</td>
<td>2-10</td>
<td>-</td>
<td>2-3:5:10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>c.</td>
<td>Procyonids (raccoons)</td>
<td>2-5</td>
<td>-</td>
<td>0.5-1:5-10</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>d.</td>
<td>Mustelids (otter)</td>
<td>-</td>
<td>10-15</td>
<td>1-2:5:10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>e.</td>
<td>Hyaenids</td>
<td>2.5-5</td>
<td>10-15</td>
<td>0.5-1:8-10</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>f.</td>
<td>Felids (general)</td>
<td>-</td>
<td>-</td>
<td>1:10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1)</td>
<td>Tiger</td>
<td>2-7</td>
<td>-</td>
<td>1:10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2)</td>
<td>African lion</td>
<td>8-10</td>
<td>-</td>
<td>1:5-6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>g.</td>
<td>Viverids (mongoose, civet cat)</td>
<td>-</td>
<td>-</td>
<td>1-2:5-10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Rhinoceros</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4:100</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Equidae</td>
<td>-</td>
<td>-</td>
<td>2-3:5-10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Wild suids</td>
<td>-</td>
<td>-</td>
<td>1:10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Hippopotamus</td>
<td>-</td>
<td>-</td>
<td>1:10</td>
<td>02.25</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(total dose)</td>
<td></td>
</tr>
</tbody>
</table>
Cervidae 0.2 - 1.5-2.5-7 - 0.04-0.08:0.5-0.7
Bovidae - - 0.5-2.5-10 - 0.008-0.01:0.1
3. Small mammals
a. Pangolian - 5-15 - - 
1. Bats - 5-15 - - 
2. Birds
a. Raptors - 5-15 - - 
2. Reptiles
a. Crocodilians - 50 - - 
b. Chelonians - 15-50 - -
c. Snake - 50-100 - -
d. Lizard - 50-80 - -

CAPTURE STRESS

Capture stress is a cumulative response and is the result of animals interaction with its environment through receptors; the quantum of stress reactions are actually dependent on the antum of stress causing factors. This is an adaptive phenomenon.

Factors accounting on "stress physiology" are:

Somatic stressors include strange sound, increased sound, unusual sight and odours.

Physiological stressors that include excitement/fear/changes in routine or normal activities, which leads to anxiety, fear, frustration, restlessness, terror, enragemnt and shock.

Behavioral stressors include unfamiliar surroundings, over crowding, territorial or hierarchical upsets, changes in biological rhythms, lack of social contact, (or conversely, lack of isolation), lack of habitual or imprinted foods.

Miscellaneous stressors include malnutrition, toxins, parasites, infectious agents, burns, surgery, drugs, chemical- or physical immobilization.
TRANSPORT OF WILD ANIMALS

PLACE AND PURPOSE OF TRANSPORT

- Many a time, wild animals need to be transported from place to place. Eg: From one zoo to another, festivals/functions (Eg: elephant).
- Animal exchange related matters between countries.
- Gift by governments.
- For research purposes.
- For treatment.
- Confiscating matters.
- To facilitate outbreeding.

MODE OF TRANSPORT

Truck/ tempo/ aero plane/ helicopter/ lorry/ ship/ through foot for the short distance.

FACTORS TO BE TAKEN CARE OF

- Size of the animal.
- Weight of the wild animal.
- Posture of the wild animal.
- Ferocious nature of the animal.
- Feeding habits of the animal.
- Anatomical peculiarity of the animal.
- Body status of the animal.
- Vaccination status.
- Deworming status.
- Type of bedding material.
- Watering arrangements during transport.
- Feeding arrangements during transport.
- Number of animals in the cage.
PHYSICAL EXAMINATION OF THE WILD ANIMAL DURING CAPTURE TRANSPORT

1. Observe the respiratory rate.

2. Estimate the body temperature by using non-contact infra red thermometers.

3. Assess the following abnormalities
   - bruises/wounds/injuries/fracture signs.
   - Excessive salivation in any.
   - Bleeding points.
   - Postural differences.

4. Whether animal has resumed normal defecation or urination activities.

5. Dullness of the animal needs to be assessed by close observation.

6. Observe for presence of abnormal clinical signs if any;
   - Bloat in herbivores.
   - Vomiting or diarrhea in carnivores
   - Bloody urine in multiple spp. of wild animals.

TRANSPORT OF THE CAPTURED WILD ANIMALS

WILD HERBIVORES

1. Females may be transported in groups but males need to be transported either in a separate container or in tranquillized state.

2. Training before the actual transport: Hold the wild herbivores in captivity until they have tamed down and become accustomed to the sights, sounds & smell associated with human activity (it usually involves the period of 4 to 8 weeks).

3. Avoid unnecessary offloading & reloading.

4. Wildlife veterinarian should take the decision on whether the chemical immobilization is required for the animals to be shifted.

5. Mortality during transport is mainly due to stress / temp. extremes / injuries.

WILD CARNIVORES

1. Better to isolate sexes.

2. Better to use single containers

3. Animals should not be exposed to direct heat like direct sunlight (esp. nocturnal animals)

4. Reduce feed for a short time (never overfeed)

5. Education to animal attenders.
CARE OF CONTAINERS DURING TRANSPORT

1. Doors should be securely closed.
2. Adequately ventilated
3. Adequately darkened
4. Convenient hand-holds should be provided.
5. Enough space needs to be provided for the wild animal
6. All slats should have rounded edges
7. Need of adequate litter to absorb excreta
8. Should be leak proof & escape proof
9. Should have food & water troughs which are easily accessible from outside.
10. Proper documents should be carried out.
HANDLING AND PHYSICAL EXAMINATION

In wild animals, handling will be the feature mainly in case of immobilized wild animals only and never, handling becomes an important component in case of transport of wild animal also.

POSTURE

The recumbent animals should be placed in correct posture in order to avoid undue respiratory problems in the wild animal under investigation.

Ruminant needs placement in sternal recumbancy to avoid the development of bloat.

EYES

The eyes should be protected from the sunlight and may even be applied with a bland eye ointment to avoid drying. The wild animal may be blindfolded, thus it becomes possible to minimize stress factors, which are the significant causal factors for the capture related problems in health. A bandage or a mask can be used for covering the eyes - they protect the eyes from both light and trauma. Avoid touching of the cornea in a chemically immobilized wild animal.

RESPIRATION

Breathing is the indication for the well being of the animal; presence of normal breathing ie, normal in amplitude, frequency and sound, indicates that the wild animal is still not deeply narcotized. Pink mucosa means adequate oxygenation and sufficient oxygenation of the tissues.

HEART RATE

By auscultation using a stethoscope, heart sounds can be assessed. Certain drugs may affect heart rate; portable ECG may be used. Eg: Xylazine reduces the cardiac activity.

TEMPERATURE OF THE BODY

Take care of the thermo-regulatory measures. Both the hyperthermia and the hypothermia ad the veterinary intervention.

If wild animal is immobilized in hot season (summer periods):

Take the wild animal to a place with tree shade.

When shade is absent, the body should be kept wet.

Tarpaulins - should be kept ready and it should be spread over the trees or from roof, to provide equate shade to the immobilized wild animal.

Example of drug affecting the thermo regulation: Eg: Promazine compounds when used for the chemical immobilization may often cause the hypothermia in wild animals.

FIRST AID MEASURE

Haemorrhage / abrasion or laceration / cut injuries/infections / fractures etc. needs to be tackled technically.
7. CAPTURE MYOPATHY

This is one of the important problem one can anticipate in case of excited wild animals.

Occurrence

Capture myopathy occurs commonly within 7-14 days after the capture or transport. May also be noticed even after 30 days, following the capture and handling.

Susceptibility

Mostly, the highly excitable species (chital, Musk deer) are highly prone for Capture myopathy. However, it can be seen in wild animal, which are relatively quiet.

Pre-disposing factors

Fear, anxiety and over exertion, repeated handling, failure to allow the wild animal to rest before the transportation, prolonged transportation, constant muscle tension as in case of protected alarm reaction.

Pathogenesis

Prolonged muscle exertion - Lactic acid accumulation (with insufficient metabolism of lactic acid, when compared to the rate of production) - muscles get cramped into strange position in crates. Local muscular anoxia leads to necrosis and results in local and systemic acidosis.

8. REGURGITATION:

Means the forceful expulsion of the contents of stomach or rumen and regurgitation occurs if the animal is not handled properly.

Bruises/fracture/kicks/bite wounds are the consequences of failure to adopt a properly planned restraint and subsequent handling procedures.

TRANSPORT RELATED HANDLING

- Take more care during transport related handling procedures in case of felids or elephants or primates.
- Animal should not be watered before transport fully and similarly, feeding shall be restricted before the transport and intermittent rest shall be given in a place with shades during transport in day time under the hot sun.
- Animal like Sambar deer or elephant or hippopotamus or wild pig may be sprayed with water while under transport under the hot sun.

HANDLING OF "INFANTS"

a) If restraint procedure (chemical) is adopted in a primate cage (with many primates) on an infant, after the sedation, infants are easily crushed, trampled, bitten by the cage mates or even by the dam, which might be excited by the capture operations.

b) Young wild animals are highly susceptible to heat and cold stress than the adult wild animals; likewise infants are generally highly prone for the development of the hypoglycemia.
HANDLING OF NONHUMAN PRIMATES

Handling of awake non-human primate weighing between 3 and 12 kg should never involve restrain of only one arm and if so, fracture may occur.

A medium sized primate should be handled by holding it's arms behind its back and the handler's finger inserted between the arms gives added security.

HANDLING OF ELEPHANTS

Elephant hook may be used to control the elephants and however, legal issue has to be taken care.

Many elephants are able to tolerate even quite painful procedures with physical restraint alone.

HANDLING OF URSIDS

Bears have a compact body and tremendous strength. Only immature bears can be handled in nets or snares.

HANDLING OF AVIARY FAUNA

The handler should not carry the bird like water fowl by the wings alone or by the feet since temporary or permanent brachial paralysis may occur in such situations. This is a problem especially in geese. The anseriformes like duck, geese etc should be carried easily under the arm. One hand should support the body, while the other controls the head and neck.

More stress seems to be caused by the mere fact of being caught and restrained, especially if the bird is allowed to flap and kick about.

Cages or baskets (purchased from pet stores) are very practical. Cages with holes (chicks) and good boxes sealed properly may be used to transport birds for a smaller distance.
NUTRITIONAL AND METABOLIC DISEASES IN ZOO ANIMALS

Balance diet in terms of digestible crude protein and total digestible nutrients are very essential for all types of wild animals.

MALNUTRITION

Young animals are most severely affected in situations of limited feed intake because they have higher nutritional demands associated with growth and greater heat loss due to smaller body size, lack of fat reserves and subordination in the social hierarchy resulting in decreased access to feed.

ESSENTIAL FATTY ACIDS

Totally fat-free diet would lead to vitamin deficiencies marked to loss of hair, scaly skin, and coarse dry hair coat, parakeratosis of the epidermis, sub-cutaneous haemorrhages, increased susceptibility to skin infection, impaired growth, reproductive failure, etc.

PROTEIN

Protein deficiency may cause lower reproduction, lighter birth weights and delay heat cycle, depression of growth, lactation, plasma albumin and resistance to diseases in carnivore species.

MINERALS AND VITAMINS

Minerals needed in relatively large amounts are calcium, phosphorous, sodium, potassium, magnesium, sulphur and chloride. The trace elements: iodine, iron, copper, selenium, zinc, manganese are required in very small quantities but nevertheless they are important elements for all animal species. Growing, pregnant and lactating animals have higher demands for minerals.

The common disorders noticed among the felines are metabolic bone diseases such as rickets and osteomalacia due to calcium and vitamin D deficiency. The disorders are easily discerned by the enlargement of bones and bending and painful condition of the long bones on palpation.

Calcium and phosphorous are very important for skeletal growth, antlers growth, rumen function and cellular metabolism. Ca:P must be 2:1.

Lactation paralysis in tiger, lion, leopard and other animals is due to heavy drains in the calcium and salt. Nursing anaemia are common complications developing due to salt depletion. Deficiency of phosphorous leads to weight loss and osteoporosis in all types of wild fauna. Walking on egg shell gait, lameness, spontaneous fractures, anorexia, pica and reduced fertility, are some of the other manifestations.

Magnesium deficiency may lead to depression or hypersensitivity to touch (tactile), tremors and convulsions. Iron deficiency may cause anaemia, pale mucous membrane, weakness and increase in susceptibility to infection.
Copper is required as a catalyst for cellular metabolism and for proper growth of hair, hoof, istic connective tissue and bones. The deficiency of these minerals may lead to anaemia, diarrhea, or keratinization of wool and hair lameness and acute cardiac failure. Iodine deficiency is also cored in wild ruminants, which leads to congenital goiter and dead foetus. Cobalt is essential for amin B₁₂ synthesis in rumen. Deficiency symptoms include lacrimation, anaemia and emaciation.

Liver necrosis and nutritional muscular dystrophy, muscle stiffness, hyaline degeneration and icification are the symptoms of selenium deficiency. Zinc acts as an enzyme activator and is monopent of insulin. The deficiency of zinc leads to weaknesses and other metabolic disorder. hite muscle diseases are associated with deficiency of vitamin E and selenium. The symptoms of s disease include chronic anaemia and advanced fibrous muscular dystrophy of skeletal muscle.

Water soluble and fat-soluble vitamins are highly essential in the diet of wild animals. The deficiencies of these vitamins cause infertility and poor growth.

Vitamin A deficiency may lead to loss of skin luster and poor reproduction, birth of weak, alformed, or stillbirth offspring and xerophthalmia in growing individuals. Congenital defects include eque cornea, etc. Vitamin C deficiency in primates causes scurvy and lack of resistance against ectious diseases in animals. Vitamin B₁ (Thiamin) deficiency in non-ruminant mammalian species uses polyneuritis.
<table>
<thead>
<tr>
<th>DISEASES</th>
<th>ETIOLOGY</th>
<th>ANIMALS SUSCEPTIBLE</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>bovis</em></td>
<td></td>
<td>Progressive emaciation, Chronic cough, respiratory distress, dullness, enlargement of lymphnodes etc.</td>
</tr>
<tr>
<td></td>
<td><em>M. avium</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>M. tuberculosis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>M. microti</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>M. lucknowi</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemorrhagic septicaemia (Pasteurellosis)</td>
<td><em>Pasteurella multocida</em> or <em>P. hemolytica</em></td>
<td>Artiodactylids, Carnivores, Non-humans primates, Perissodactyls, Proboscids, marsupials, reptiles etc.</td>
<td>Pyrexia, edematous swelling in the brisket and throat regions, respiratory distress, prostration, diarrhoea etc.</td>
</tr>
<tr>
<td>Anthrax</td>
<td><em>Bacillus anthracis</em></td>
<td>Antelopes, Antlers, wild pigs, primates, perissodactyls, proboscids, felids, canids, marsupials etc.</td>
<td>Epistaxis, pyrexia, depression, diarrhoea dyspnoea, edematous swelling in the brisket, flank and throat regions and colic</td>
</tr>
<tr>
<td>E.coli Infections</td>
<td><em>Escherichia coli</em></td>
<td>Artiodactylids, Carnivores, Non human primates, Perissodactyls, Proboscids</td>
<td>Diarrhoea, inappetence, dehydration, vomiting, dyspepsia</td>
</tr>
<tr>
<td>Disease</td>
<td>Species/Description</td>
<td>Signs</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Leptospirosis</td>
<td><em>Leptospira icterohaemorrhagiae</em>, <em>L. borgpetersenii</em>, <em>L. pomona</em>, <em>L. biflexa</em></td>
<td>Anorexia, Pyrexia, Colic, Still births, abortion, reproductive insufficiency, mastitis, nephritis, icterus, hemoglobinuria etc.</td>
<td></td>
</tr>
<tr>
<td>Salmonellosis</td>
<td><em>Salmonella</em> sp viz <em>S. typhimurium</em>, <em>S. bareilly</em>, <em>S. enteritidis</em>, <em>S. cholerae</em></td>
<td>Jaundice, Hemoglobinuria, diarrhoea/Dysentry, Inappetance, Dehydration</td>
<td></td>
</tr>
<tr>
<td>Corynebacterial Infections</td>
<td><em>Corynebacterium pyogenes</em>, <em>C. bovis</em>, <em>C. ovis</em>, <em>C. equi</em></td>
<td>Suppurative wound, fistula, abscess and mandibular swelling</td>
<td></td>
</tr>
<tr>
<td>Clostridium Infections</td>
<td><em>Clostridium perfringens</em></td>
<td>Restlessness, inappetance, vomiting, convulsions and orthotonus, reluctance to move, diarrhoea, lock jaw, salivation and stiff gait</td>
<td></td>
</tr>
<tr>
<td>Shigellosis</td>
<td><em>Shigella</em> spp. viz <em>S. dysenteriae</em>, <em>S. sonnei</em>, <em>S. flexneri</em>, <em>S. bovis</em></td>
<td>Weakness, prostration, edema of the face, diarrhoea/dysentry, inappetance, dehydration, pyrexia, nervous signs etc.</td>
<td></td>
</tr>
<tr>
<td>Listeriosis</td>
<td><em>Listeria monocytogenes</em></td>
<td>- Young are more susceptible than adults.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- No pathognomonic signs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Old birds may die suddenly while young birds exhibit some wasting before death. Encephalitic symptoms are rarely reported in affected birds.</td>
<td></td>
</tr>
<tr>
<td>Disease</td>
<td>Pathogen</td>
<td>Hosts</td>
<td>Symptoms and Signs</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tetanus</td>
<td><em>Clostridium tetani</em></td>
<td>Non-human primates, Proboscids, Perissodactylida, Artiodactyla</td>
<td>Contraction of the muscles, drooping of third eyelid, lock jaw, stiff gait, difficulty in movement</td>
</tr>
<tr>
<td>Paratuberculosis (Johnes disease)</td>
<td><em>Mycobacterium paratuberculosis</em></td>
<td>Artiodactyla- Hangul stag, Chital, Swamp deer, Gaur Primates- Macaque etc.</td>
<td>Progressive emaciation despite good appetite and feeding and diarrhoea which is neither offensive nor blood stained.</td>
</tr>
<tr>
<td>Brucellosis</td>
<td><em>Brucella abortus</em>, <em>B. melitensis</em>, <em>B. ovis</em>, <em>B. canis</em></td>
<td>Artiodactyla</td>
<td>Still births, abortion, metritis, orchitis, infertility etc.</td>
</tr>
<tr>
<td>S.NO</td>
<td>DISEASES</td>
<td>ANIMALS SUSCEPTIBLE</td>
<td>SIGNIFICANT SYMPTOMS</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Foot and mouth disease</td>
<td>Ruminants and other artiodactylids</td>
<td>Vesicles in foot, tongue and gums. Anorexia</td>
</tr>
<tr>
<td>2.</td>
<td>Kyasanur forest disease (KFD)</td>
<td>Non human primates like macaques etc</td>
<td>Signs of encephalomyelitis</td>
</tr>
<tr>
<td>3.</td>
<td>Blue tongue</td>
<td>Ruminants especially deers, antelopes etc. Pseudoruminant like cameldids</td>
<td>Facial oedema, oedema and cyanosis of tongue, diarrhoea, lameness, nasal discharge etc</td>
</tr>
<tr>
<td>4.</td>
<td>Canine distemper</td>
<td>Canids like Jackal, Mustelids, Viverrids and hyena</td>
<td>Nasal discharge, dyspnoea, conjunctivitis, diphasic fever, hyperkeratosis of foot pads</td>
</tr>
<tr>
<td>5.</td>
<td>Rinderpest</td>
<td>Wild ruminants like cervids, bovids etc and hippopotamus</td>
<td>Shooting diarrhoea, emaciation in later stages.</td>
</tr>
<tr>
<td>6.</td>
<td>Infectious hepatitis</td>
<td>Canids and felids</td>
<td>Dullness, diarrhoea etc</td>
</tr>
<tr>
<td>7.</td>
<td>Malignant catarrhal fever (MCF)</td>
<td>Wild ruminants</td>
<td>Pyrexia</td>
</tr>
<tr>
<td>8.</td>
<td>Herpes viruses like canine, feline, carnivore, equine, bovine, simian herpes viruses and marelk's disease</td>
<td>Almost most of the wild animal species are affected</td>
<td>Symptoms varies with species</td>
</tr>
<tr>
<td>9.</td>
<td>African horse sickness</td>
<td>Equids especially young ones (wild ass etc)</td>
<td>Pyrexia, dyspnoea, cough, abortion etc</td>
</tr>
<tr>
<td>10.</td>
<td>Feline panleukopenzis (FPL)</td>
<td>Felids</td>
<td>Diarrhoea, vomiting, dullness, convulsions etc</td>
</tr>
<tr>
<td>11.</td>
<td>Feline infectious peritonitis (FIP)</td>
<td>Felids</td>
<td>Pyrexia, ascites, icterus, cough and weight loss</td>
</tr>
<tr>
<td>12.</td>
<td>Pox (camel-pox, monkey pox, fowl pox, magpie pox etc)</td>
<td>Many wild animal species like psittacine birds</td>
<td>Pox lesions in body</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| 13. | Rabies | Big Cats, Leopard,Foxes,Jackals,Bears, Mongoose,Hyena,Deer,Monkey | Furious form  
Excitability, attacking others indiscriminately, striking of head against hard objects, hypersensitive to sounds, inappetance, hydrophobia, dilated pupils  
Dumb form  
Morose condition  
Vacant look  
Hanging of lower jaw  
Dribbling of saliva  
Death occurs in 3-4 days after onset of symptoms. At any rate, death occurs within 10 days. |
| 14. | New castle disease (ranikhet disease / pseudofowl plaque/ doyle's disease) | Pet birds  
- Waterfowls  
- Jungle birds  
- Game fowls or birds of prey  
- Pest birds such as sparrows and starlings that enter poultry yards.  
Migrating song birds | 1. Young birds – sudden death  
2. Bloody diarrhea  
3. Coughing  
4. Sneezing  
5. Dyspnoea  
6. In some birds nervous signs – ataxia, incoordination, torticollis, hyperexcitability and opisthotonos, tremor of head, nodding or jerking of head, unilateral or bilateral paralysis of the extremities.  
7. Reported cases have corresponded to outbreaks in nearby poultry flocks. |
# PARASITIC DISEASES

## MATODE INFECTIONS

<table>
<thead>
<tr>
<th>Type</th>
<th>Causative agent</th>
<th>Animals affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>ioliosis</td>
<td>Fasciola gigantica</td>
<td>Cheetal, Black buck, Bison, Elephants</td>
</tr>
<tr>
<td></td>
<td>Fasciolopsis buski</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fasciola jacksoni</td>
<td>Elephants, Wild boars, Elephants</td>
</tr>
<tr>
<td>unphistomosis</td>
<td>Cotylphoron cotylophorum</td>
<td>Wild ruminants</td>
</tr>
<tr>
<td></td>
<td>Paramphistomum cervi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gastrothylax crumenifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pseudodiscus collinsi</td>
<td>Elephants</td>
</tr>
<tr>
<td></td>
<td>Pseudodiscus hawkesii</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gastrodiscus secundus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pfenderius sp.</td>
<td></td>
</tr>
<tr>
<td>istosomosis</td>
<td>Bivitellobilharzia nairi</td>
<td>Elephants</td>
</tr>
<tr>
<td>agoninosis</td>
<td>Paragonimus westermanii</td>
<td>Tiger, Panther</td>
</tr>
</tbody>
</table>

## STODE INFECTIONS

<table>
<thead>
<tr>
<th>No</th>
<th>Parasite / Intermediate Stage</th>
<th>Animals affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Taenia sp.</td>
<td>Tiger</td>
</tr>
<tr>
<td>2.</td>
<td>Cysticercus tenuicollis</td>
<td>Deer, Gibbon, black buck</td>
</tr>
<tr>
<td>3.</td>
<td>Anoplocephala sp.</td>
<td>Elephant, Rhinocerous</td>
</tr>
<tr>
<td>4.</td>
<td>Diphyllobothrium sp.</td>
<td>Tiger, Hyaena, Fox</td>
</tr>
<tr>
<td>5.</td>
<td>Spirometra sp.</td>
<td>Jungle cat, Tiger, African lion, Clouded leopard</td>
</tr>
<tr>
<td>6.</td>
<td>Hydatid</td>
<td>Elephants, Lion, Monkeys, Squirrels</td>
</tr>
<tr>
<td>7.</td>
<td>Echinococcus granulosus</td>
<td>Wolf, Bison, Common Langur, Giant Squirrel</td>
</tr>
<tr>
<td>8.</td>
<td>Stilesia globipunctata</td>
<td>Chital, Black buck</td>
</tr>
</tbody>
</table>
### NEMATODE INFECTIONS

<table>
<thead>
<tr>
<th>s.no</th>
<th>Parasite</th>
<th>Animals affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Oxyuris sp.</td>
<td>Zebra</td>
</tr>
<tr>
<td>2.</td>
<td>Enterobius sp.</td>
<td>Rhesus Monkey, Chimpanzee, Lion, Langur</td>
</tr>
<tr>
<td>3.</td>
<td>Syphacia sp.</td>
<td>Squirrel</td>
</tr>
<tr>
<td>4.</td>
<td>Ascaris sp.</td>
<td>Wild pig, Chital, Wild boars</td>
</tr>
<tr>
<td>5.</td>
<td>Toxascaris leonina</td>
<td>Lion, Tiger, Leopard, Snow Leopard, Fox</td>
</tr>
<tr>
<td>6.</td>
<td>Toxocara sp.</td>
<td>Tiger, Lion, Snow Leopard</td>
</tr>
<tr>
<td>7.</td>
<td>Subulura sp.</td>
<td>Fox, Slender loris,</td>
</tr>
<tr>
<td>8.</td>
<td>Syngamus sp.</td>
<td>Pheasants</td>
</tr>
<tr>
<td>9.</td>
<td>Heterakis sp.</td>
<td>Partridges, Pheasants, Quails</td>
</tr>
<tr>
<td>10.</td>
<td>Capillaria sp.</td>
<td>Pheasants</td>
</tr>
<tr>
<td>11.</td>
<td>Trichostrongylus sp.</td>
<td>Elephant, Capachun</td>
</tr>
<tr>
<td>12.</td>
<td>Strongyloides sp.</td>
<td>Elephant, Langur</td>
</tr>
<tr>
<td>13.</td>
<td>Oesophagostomum sp.</td>
<td>Hog deer, Chital, Nilgai, Hoolock Gibbon, Langur</td>
</tr>
<tr>
<td>14.</td>
<td>Trichuris sp.</td>
<td>Black Buck, Tiger, Baboon, Langur, Mongoose</td>
</tr>
<tr>
<td>15.</td>
<td>Trichinella sp.</td>
<td>Wild boar, Civet cat</td>
</tr>
<tr>
<td>17.</td>
<td>Globocephalus sp.</td>
<td>Wild boar</td>
</tr>
<tr>
<td>18.</td>
<td>Ancylostoma sp.</td>
<td>Cheetah, Dog, Fox, Polar bear, Lion, Hyena, Jackal, Civet cat, Tiger</td>
</tr>
<tr>
<td>19.</td>
<td>Uncinaria sp.</td>
<td>Leopard cat, Indian ratel, Fox, Civet cat</td>
</tr>
<tr>
<td>20.</td>
<td>Kalicephalus sp.</td>
<td>Rat snake, Green snake, Cobra, Sand snake</td>
</tr>
<tr>
<td>21.</td>
<td>Thelazia sp.</td>
<td>Elephant</td>
</tr>
<tr>
<td>22.</td>
<td>Spirocerca sp.</td>
<td>Jackals, Lion</td>
</tr>
<tr>
<td>23.</td>
<td>Gnathostomum sp.</td>
<td>Pig, Reptiles</td>
</tr>
<tr>
<td>24.</td>
<td>Physaloptera sp.</td>
<td>Fox, Mongoose, Tiger</td>
</tr>
<tr>
<td>25.</td>
<td>Gongylonema sp.</td>
<td>Capuchin Monkey</td>
</tr>
<tr>
<td>26.</td>
<td>Stephanofilaria sp.</td>
<td>Nilgai, Sambar</td>
</tr>
<tr>
<td>27.</td>
<td>Microfilaria sp.</td>
<td>Elephants</td>
</tr>
<tr>
<td>28.</td>
<td>Indofilaria sp.</td>
<td>Elephants</td>
</tr>
</tbody>
</table>
**ECTOPARASITES**

| Artiodactylids | Ticks - *Boophilus microplus*, *Haemaphysalis* sp., *Amblyomma* sp.  
| Fly - *Lipoptena cervi* |
| Carnivores | Ticks - *Rhipicephalus sanguineus*, *Amblyomma javanense*, *Haemaphysalis* sp.  
| Flea - *Ctenocephalides felis*  
| Mites - *Sarcoptes scabiei* |
| Non-human Primates | Mites - *Sarcoptes scabiei* |
| Proboscidea | Lice - *Haematomyssus elephantis* |
| Rodentia | Ticks - *Rhipicephalus ramachandrai*, *Ornithonyssus bacoti*  
| Mite infection |
| Pholidota | Ticks - *Amblyomma javanense*, *Aponomma gervaisi* |
| Avian species | Lice - *Columbicola columbae*, *Menopan gallinae*, *Lipeurus caponis*  
| Mites - *Megninia bakeri*, *Diplaegidea columbae*  
| Ticks - *Haemaphysalis sp.*, *Pseudolynchia canariensis* |
| Reptilian species | Ticks - *Aponomma sp.*  
| Mite infection |

**Protozoan diseases**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Causative organism</th>
<th>Animals affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babesiosis</td>
<td><em>Babesia bigemina</em>, <em>Babesia bovis</em>, <em>Babesia gilsoni</em></td>
<td>All types of deers, leopard, tiger, mongoose and primates</td>
</tr>
<tr>
<td>Theileriosis</td>
<td><em>Theileria annulata</em></td>
<td>Deers</td>
</tr>
<tr>
<td>Anaplasmosis</td>
<td><em>Anaplasma marginale</em></td>
<td>Zebra, Bison, Antelopes, Elk and Camel</td>
</tr>
<tr>
<td>Trypanosomosis</td>
<td><em>Trypanosoma evansi</em></td>
<td>Sambar, tiger, leopard, primates, elephants</td>
</tr>
<tr>
<td>Plasmodiosis</td>
<td><em>Plasmodium sp.</em></td>
<td>Monkeys, flying fox, avian sp.</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td><em>Toxoplasma gondii</em></td>
<td>Rhesus monkey</td>
</tr>
<tr>
<td>Coccidiosis</td>
<td><em>Eimeria sp.</em></td>
<td>All wild animals and avian sp.</td>
</tr>
<tr>
<td>Entamoebiosis</td>
<td><em>Entamoeba histolytica</em></td>
<td>Primates, carnivores</td>
</tr>
<tr>
<td>Balantidiosis</td>
<td><em>Balantidium coli</em></td>
<td>Primates</td>
</tr>
<tr>
<td>Trichomoniosis</td>
<td><em>Trichomonas gallinace</em>, <em>Trichomonas hominis</em></td>
<td>Avian sp., Rhesus monkey</td>
</tr>
<tr>
<td>Haemoproteus</td>
<td><em>Haemoproteus columbae</em></td>
<td>Turtle, Wild pigeons and other wild birds</td>
</tr>
</tbody>
</table>
PSEUDOPARASITES

Yeast

Undigested muscle fibre

Oil droplets

Mold

Stone Cells of pear

Plant epidermal gland Cell

Cotton fibre

Bast Cells of plant

Palisade Cells of plants

Broccoli

Pollen

Pine

Plant Cell walls

Vascular Structures of plants

Plant epidermal Cells

Parenchymal Cells of potato

Plant epidermal hairs

67
FISH PRESERVATION

ASON

Fish is a highly perishable commodity (due to high moisture content of 60 to 80%). All the fish caught can't be utilized immediately.

Quality degradation occurs in fishes due the following factors:

- Microbiological factors
- Enzymatic factors
- Oxidative factors
- Hydrolytic factors: Fish is to be preserved from the time of catch till the time it reaches the customers.

ANNING

This is one of the most effective methods of preservation. Product remains good and retainsavor. In this process the following steps are carried out:

- Removal of blood, fins, viscera, bone and heart from fresh fish.
- Passing from the jet of warm water of 400° c.
- Cutting into elongated pieces, 5 cm length and 2.5 cm breadth and on 1.5 cm thickness.
- Sealing the can under vacuum.
- Sterilization to prevent growth of intrinsic and extrinsic bacteria at 140° to 145°c.
- Passing the cans from the water tank to check the leakage.
- Sun drying, mechanical drying, dry salting, brining, smoking and pickling are some of the other methods of preservation of fishes practiced traditionally.

ROCESS

HILLING

Chilling can never prevent spoilage but the colder the fish are, the greater the reduction in bacterial and enzymatic actions.

ALTING

Sodium chloride is added (salt aids in removal of water from fish by osmosis). Salt slows down prevent most bacterial action.

RYING

For removal of water by evaporation, use solar drier / drier / floor drying / raised racks.
SMOKING

Heavily salt the fish and smoke them.

FREEZING

Freezing is of 2 types.
1. Slow freezing
2. Quick freezing

Quick freezing is advantageous than slow freezing. About 90% of bacteria in fish are destroyed during freezing and activity of enzymes is highly reduced.

DEMERTS

Thiamine deficiency occurs.

Types of freezers
1. Horizontal plate freezer
2. Vertical contact plate freezer
3. Tunnel / air blast freezer
4. Shelf freezer
5. Immersion freezer
6. Cryogenic freezing (use of liquid nitrogen)

PICKLING

Done for domestic and export market.

PIT CURING

Salt rubbed fish is packed in pits and palmyrah leaves line the pits, after a period of time it is sun dried.

Demerits: Has poor acceptance by consumers. Rarely practiced now.

SEMI DRYING

This is mostly done for prawns.

CARE OF FISH

FISH INSPECTION

Closer examination is required for finding out the freshness and wholesomeness of fish.

Check the followings

1. Gills

The lamellae of the gills should be brightly reddish and not dull red or brown in fresh fishes.
s

should be convex, fresh and glistening, whereas in spoiled fish, the eyes are flat and sunken.

Fish and body

Then applying, it should not pit on pressure.

Texture

Fresh fish has firm and smooth texture and should not be gritty and soft.

Odor

Fermentation or stale odor indicates the deteriorating changes in fish.

Ant Fish diseases

Mouth disease / hemorrhagic septicemia by Aeromonas, Pseudomonas

Cerative disease by Aeromonas sp.

N Rot and tail rot disease by Aeromonas, Pseudomonas.

RY AS A METHOD OF RECYCLING ANIMAL AND POULTRY WASTE AND FEED LUS

$ FOR FISH

Micellular algae and large algae (green and blue)

Agellates / protozoans / worms / insects / content of sewage water

Dairy excreta, pig excreta, duck excreta, cattle excreta

Nails, frog meat

Kitchen waste, household scrapes, sweepings of grain stores

Vegetable food like meals, cakes, leafy food, tubers, roots, cereals, maize and pulses

Cultivated insects like silkworm pupae, winged insect which are attracted by light.

ICIAL FEEDING OF FISH

Feed should contain 30% protein, 10% fat, 50% carbohydrate, 5% cellulose and 5% vitamin and minerals.

Artificial feed could be compounded by mixing rice bran and groundnut cake in ratio of 1:1 and fed at rate of 2% body weight.

\[
\text{Feed conversion ratio (FCR)} = \frac{\text{Quantity of feed}}{\text{Increase in weight}}
\]

AND NURSERY MANAGEMENT

Major carps - Eg: Catla, Rohu, Mrigal, Cauvery carp

Carps - Eg: Silver carp, Grass carp, Common carp
In monoculture system
Net output is 600 kg/ha/yr
In composite fish culture system, it is 10,000 kg/ha/yr

Pond design

Types of ponds

a. Nursery ponds
Ponds those are small and shallow (0.02 - 0.06 ha in size and 1-1.5 mt in depth).
Use: Used for raising fry from spawn.

b. Rearing ponds
Ponds used for rearing fry up to fingerling and above (0.06 - 0.1 ha in size and 1.5 to 2 mt in depth)

c. Stocking or Culture ponds
These are the ponds used for stocking fry or fingerlings to rear them to table size. It should be rectangular in shape and width should not exceed 40 mt. Slope of pond bunds may be 1:15 (vertical: horizontal). The bottom of the ponds should be of gentle slope towards the outlet and ponds should have controlled inlets and outlets to enable filling and draining easily.

Requisites of pond and nursery management
1. Apply lime in ponds.
2. Clear aquatic weed and weed fish.
3. Use organic and inorganic fertilizers in ponds.
4. 15 days after construction, water filling, lime application, fertilizer application etc., may be carried out.
5. Aeration of pond.
6. First observe for 48 hrs the newly introduced fishling.

Significance of pond and nursery management
Effective pond management is fit for the survival and maximum production of fish. Factors to be considered are:
1. Area of pond.
2. Stocking density.
3. Soft or hard water.
4. Manpower for management
5. Retention of water.
6. Oxygen status in water and aeration of water by stirring.
7. Feed - resources in ponds.
Provision of correct type of feeding materials.
Compatibility of fish species.

Removal of adult fish at accurate time to avoid danger to small fishes.

**SPAWN MANAGEMENT AND ECONOMIC PRODUCTION**

**Types of eggs**
- Pelagic eggs (buoyant egg)
- Semi pelagic eggs (semi buoyant egg)
- Demersal egg (non-buoyant egg)

**Pelagic spawning survey**
- Survey the area of intense spawning / spawning season / rate of mortality during the planktotrophic life of fish.
- Sample and monitor the spawning biomass of several spp. of fish.
- Assess the planktonic fauna in that area of spawning.

**Quantitative sampling of eggs and larvae**

**Identification features of fish larvae**
- Body shape
- Pigment patterns
- Gut length
- Head size
- Shape of viscera
- Length of fins during growth

**SPAWN breeding and management of fisheries**
- Marine fish
- Brackish water fish
- Fresh-water fish

**GENERAL TIPS**
- Take care of feed management - Eg: algae, plants, insects, and worms,
- Construction of suitable pond system for breeding purpose:

**POND MANAGEMENT**
- Select low-lying area with soil of good water holding capacity.
- Digging and construction of pond with suitable and uniform depth.
- Compartmentalize the pond by means of artificial barriers. Eg: Breeding place, hatching place.
WATER QUALITY

1. Water should be aerated, warm and non-polluted.
2. Clean soft water is best and should have proper place.
3. Salinity water from industrial waste and toxic pollutant resources should be avoided.

AERATION OF WATER

1. Provision should be there for periodic aeration of water in the pond.
2. Aeration may be carried out at the rate of 2 - 4 hr / day during late night, in order to maintain the dissolved oxygen level of 3-5 mg /l.

BREEDING RELATED INDUCED BREEDING IN FISH

1. Select breeder fish (male and female of healthy ones, adult, weighing 2 - 4kg body weight).
2. Release breeder fish of both sex at least 24 hrs prior to induced breeding and this is for the purpose of acclimatization. The sex ratio for introduction is 2: 1.
3. Usage of pituitary extract for induction of breeding.

HYPAS FIXATION

BREEDING HYPA

Hypa means the confinement bag (thick meshed cloth available readymade). Hang the hypa in the 4 corners of the pond. Release the hormone.

HATCHING HYPA

Release the swollen fertilized eggs into the hatching hypa inside the pond and the condition of both breeding hypa and hatching hypa should be the same.

FISH BYPRODUCTS

FISH OIL

Significant ones are the extracted oils from sardines, shark and cods.

Others

1. Bone and skin of shark
2. Dried air bladder, fish macus
3. Shells of prawns, crab, lobster
4. Body oil from sardines and liver oil from shark.

Food related

1. Dry fish
2. Pickled fish
3. Fish protein concentrate (FPC)
4. Fish hydrolysate
5. Bacteriological peptone and pet food and other by products of fish industry.
ation of fish in animal feed

Fishes are highly nutritious and offers quality protein.
More anti oxidant.
Good source of vitamin A and D also.

oil and fish meal
These are the fish byproducts used in poultry sector.

Fish meal in dried farm is included in starter diet of poultry to extent of 30%
Fish meal contains following:
- Essential amino acids like isoleucine, lysine, tryptophan and threonine which are considered as critical for egg production.
- Has choline, vitamin B2, Pantothenic acid, vitamin B12
- Has 18-21% mineral contents with high proportion of co factors.
- Fishmeal has more growth factors for animals and are called as Animal growth factors.

Int of fishmeal in animal diet
- Up to 15% in diet of young animals.
- Up to 5% in diet of old animals.
Avoid fishmeal during fattening and slaughter to avoid tainting of carcass.
Inclusion of >5% in the ration may taint milk / eggs.

Use of poor quality fishmeal
- Usage as manure (due to high protein and phosphorous from bone, the fishmeal is used as manure).

Use of fishmeal in simple stomached animal and young ruminants:
Due to presence of animal protein factors, these gap of animals get gruel, benefited.

CULTURE
- of fish culture and requirements
- Monospecies culture
  - choice - Giant River Prawn (weighs 50 gm in 6 months)
- Composite fish culture (Polyculture)
  - fish of different spp. that are fast growing with different feeding habits are employed.
  - In same pond following species are reared:
    - Grass carp (weed eater)
    - Mrigal (boticism feeder)
3. Silver carp (surface feeder - phytoplankton)
4. Catla (surface feeder)
5. Common carp (omnivorous)

3. Weeding
Excessive weed growth is a menace for commercial fish farming. Biological control like introduction of grass-eating carp.

4. Provision of good feeding
Artificial feeding can increase the net profit to nearly 3 folds.

Requirements of composite culture
- Ideal depth is one metre.
- To clear predator fish from the ponds, first apply mahua at rate of 2.5 tonnes/hectare.

COLLECTION OF FISH
Fishing means capturing and collection of fish and many gadgets are used for efficient and economic fishing.
- Net with different sizes
- Swiels are the steel devices used to allow rotation of a certain section of rope or cable.
- Fish hooks: With pulley system, it is available.
- Ropes and cables
- Floats are used to keep a section of net floating. A log of wood or empty water cans or plastic, is used which can serve as the float.
- Anchors.
METHODS OF PACKING AND TRANSPORT

Two methods of packing are in vogue: a) Open system comprising open carriers, with or without official aeration / oxygenation / water circulation, and b) Closed system having sealed airtight carriers with oxygen.

Before transporting to long distances whether in open or in closed systems of transport, spawn fry are conditioned in order to rid them of excreta and to lure them to subsist in a restricted area. The most common method of conditioning is to store fry in a cloth 'hapa' in ponds or in a still part of a river. Various types of conditioning containers are used, namely boxes made of wire meshes, bamboo or cane wicker work, barrels or boats with perforated bottoms, temporary enclosures made of setting or bamboo matting, etc.

EN SYSTEMS

The traditional method of transporting fry and fingerlings, is practiced in Bengal. The additional hundi is an earthen vessel but lately aluminium hundies are also being used. Though hundies are of variable size, they are generally of two types, the smaller one of 20 cm diameter and 23 l capacity carried as a head load, and the other larger one of 23 cm diameter and 32 l capacity, used for the transport by rail. The hundies are filled with water from the same source as the source of oxygen supply is not the open air but air or oxygen is supplied into enclosed space above the water. Sealed metal containers with oxygen have successfully been employed for transporting spawn and fry involving long durations. The fish under transit thus gets an atmosphere of oxygen.

CLOSED SYSTEMS

In this system, the source of oxygen supply is not the open air but air or oxygen is supplied into enclosed space above the water. Sealed metal containers with oxygen have successfully been employed for transporting spawn and fry involving long durations. The fish under transit thus gets an atmosphere of oxygen.

OF CHEMICALS IN LIVE - FISH TRANSPORT

The sedating of fish brings in practical benefits by way of: a) decreasing the rate of oxygen consumption and reducing the rate of excretion of carbon dioxide, ammonia and other toxic wastes, controlling the excitability of the fish and thereby reducing chances of injury, and c) reducing the time required for handling them.