بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Arthropoda
المحاضرة الثانية

By

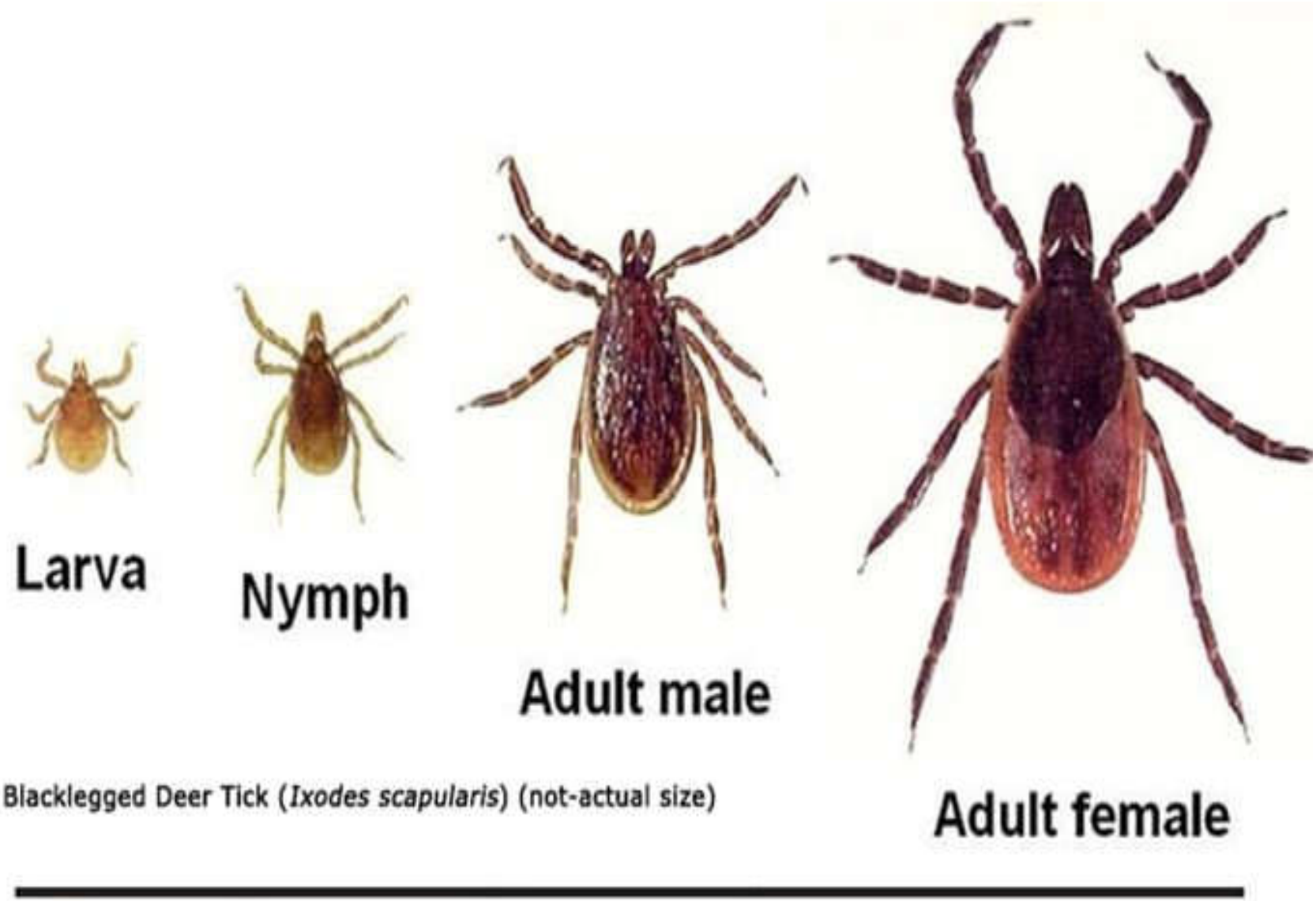
Dr Hesham Ibrahim

TICKS

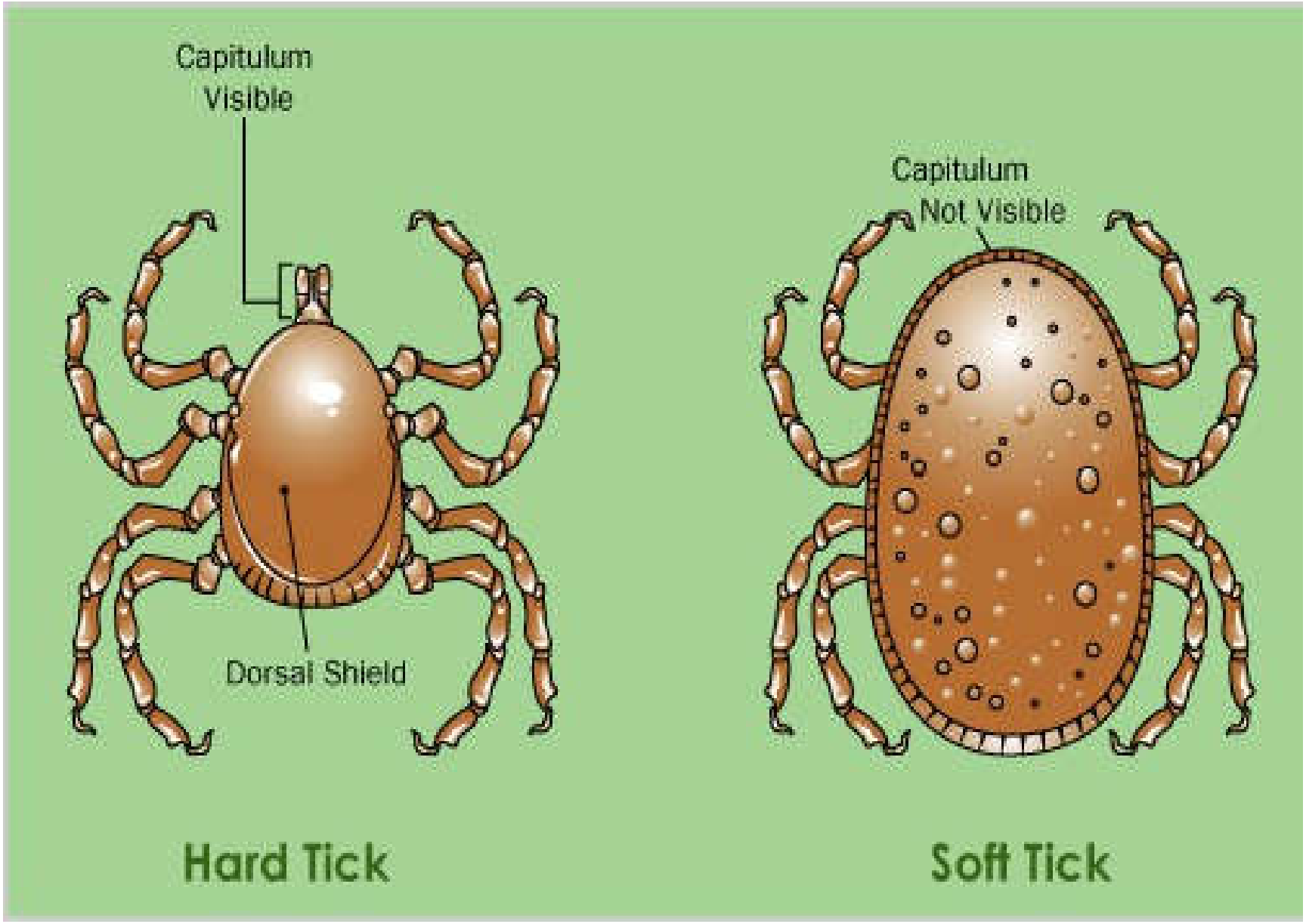
(Hard ticks and Soft ticks)

- These are large sized, with hairless or shorthaired leathery body.
- All ticks have 4 stages of life cycle: egg, larva, nymph, and adult.
- A blood meal is needed before any stage.
- The engorged female drops to the ground to lay a batch of eggs of 100-18,000.
- a 6-legged larva hatches and climbs to the host, feeds and molts to 8-legged nymph, this feeds again and molts to the next stage.

- If ticks feed and molt through all instars on the same host they are called “one host tick”, but if larval stages feed on one host and adults on another, they are called “two host ticks”. Many species of ticks use more than one or even two hosts; this increases the opportunity of transmission of pathogens.
- Ticks can withstand periods of starvation for years, as long as 16 years.
- Ticks of medical importance belong to two families: Ixodidae (hard ticks) and Argasidae (soft ticks).
- Important genera in hard ticks are:
- *Ixodes, Amblyomma, Boophilus, Haemaphysalis, Rhipicephalus, Demaentor,*
- Important genera in soft ticks are:
- *Argas* and *Ornithodorus*



Blacklegged Deer Tick (*Ixodes scapularis*) (not-actual size)


Capitulum
Visible
Dorsal Shield
Capitulum
Not Visible
Hard Tick
Soft Tick

Pathogenesis and medical importance:

- Infestation with ticks in animals and man can produce:
- Anemia, this occurs according to extent of infestation and the size of the animal. It is most apparent in small animals and birds.
- Dermatosis, in the form of inflammation, swelling, ulceration and itching due to tick bite. This can occur also on incomplete removal of mouthparts form the bite wound, aggravated by secondary infection.
- Paralysis: tick paralysis occurs in humans, dogs, cattle and other mammals bitten by ticks near the base of the skull. It is caused by the toxic secretions of the tick and rapidly relieves on extraction of the tick.

- Infections: ticks are vectors of many human diseases which are:
- **Rickettsial diseases:**
  - Rocky mountain spotted fever (*Rickettsia rickettsii*). Main vectors are *Dermacentor*, *Ixodes* and *Ornithodorus*. It is present in North America, Mexico and Brazil.
  - Boutonneuse fever of African tick fever (*R. conorii*) and Queensland tick typhus (*R. australis*), transmitted mainly by *Rhipicephalus*, and can be transmitted by many other genera.
  - Q fever (*Coxiella burnetii*), this disease is transmitted to domestic animals by *Dermacentor*, *Ixodes*, *Amblyomma*, *Rhipicephalus* and *Ornithodorus*. Human infection is mainly acquired by contact with infected animals.

- **Viral diseases:**
  - Colorado tick fever, by *Dermacentor*.
  - Hemorrhagic fevers (Crimean-Congo), by *Hyalomma*.
  - Russian spring-summer encephalitis, by *Ixodes*.
- **Bacterial diseases:**
  - Tick-borne relapsing fever, by *Ornithodorus*.
  - Tularemia (*Francisella tularensis*), by *Amblyomma*, *Dermacentor*, *Ixodes* and *Rhipicephalus*.
  - Lyme disease (*Borrelia burgdorferi*), by *Ixodes*
- **Protozoal diseases:**
  - Babesiosis (*Babesia microti*), by *Ixodes*.

Control:

- Argasid ticks:
  - Destroying the nests or lairs. Infested bird or animal huts should be burned, or the walls and floors should be plastered to eliminate crevices and cracks.
  - Spraying with tick killing insecticides like BHC or diazinon.
- Ixodid ticks:
  - Getting rid of rodent hosts and destroying their habitats.
  - The infested ground, housing and animals must be sprayed with diazinon, dieldrin or BHC. More than one application may be required sometimes.
  - Getting rid of stray dogs, and use of repellents on being in a tick infested area.

PARASITIC MITES

Sarcoptes scabiei

Itch Mites, Scabies Mites, Mange Mites

Distribution:

- Cosmopolitan, especially among rural poor areas.

Life cycle:

- The mites live in a slightly serpiginious cutneous burrows. When activated by warmth of skin, usually at night, the female burrows into the skin in a rate of 2-3 mm/day.
- The burrow is confined to most superficial layers of epidermis.
- The eggs are deposited in the burrows singly in a bead-like manner.
- Larvae hatch in 3-10 days, and burrow new tunnels or lateral branches, feeding on plasma and debris and molt into 8-legged nymphs.
- The female has 2 nymphal stages, while the male needs one stage to maturity.
- The life cycle is completed in 8-15 days.

Pathogenesis:

- Scabies is transmitted by personal contact, especially by sharing beds, towels, clothing, and bed linen.
- Infection is more common in slum areas, prisons and armies.
- The sites of predilection are interdigital spaces, the flexor surfaces of the wrist and forearm, elbows, axillae, back, flanks, lower abdomen and inguinal region.
- Early lesions appear as reddish, slightly elevated tracts in the skin, may end with minute vesicles due to female deposits or exudates.
- Irritation by mites and their deposits induces severe itching and scratching, which opens the tunnels and spreads the infection, also it predisposes to secondary bacterial infection.
- The case is thus aggravated by multiple papular, vesicular and pustular lesions. After sometime the skin becomes sensitized resulting in severe itching, widespread erythematous eruption.

- **Norwegian**, or crusted scabies is a heavy form of infestation, occurs in individuals with depression of T cell immune function. This form can occur also in immunocompromised persons and AIDS patients. There are extensive, hyperkeratotic, scaling lesions especially in the extremities, and sometimes distorting of finger nails. Itching in these cases is **absent** or minimal. Demonstration of mites by microscopic examination of crusts is easy due to heavy infestation.

Diagnosis:

- The type of lesion and itching rash are suggestive.
- Mites can be demonstrated by putting a drop of mineral oil on a fresh lesion and scratching with a needle or scalpel blade.

Treatment:

- Application of ointment containing 1% benzene hexachloride, but this may be toxic due to systemic absorption from large infested areas.
- 5% permethrine cream for a single overnight treatment.

Control:

This requires treatment of infested individuals, sterilization of clothes and beddings by boiling and personal cleanliness.

Demodex folliculorum
(Hair follicle mites)

- Parasites of hair follicles and sebaceous glands of mammals.
- ***Demodex folliculorum*** is a cosmopolitan parasite of hair follicles of humans.
- It is present in a good percentage of men and women over 40 years' age. It rarely causes discomfort. Sometimes it may cause acne, blackheads or localized inflammations (rosacea) especially in women using facial creams instead of soap and water. Treatment is rarely required.

Trombicula spp.

(Chigger mites, Red bugs)

Trombiculid mites, chigger mites, harvest mites or red bugs are a group of annoying pests to man in America, Europe and Far East temperate climates and tropical region.

- The patient feels discomfort from continuous itching, which may disturb sleep. Heavy infestation may produce fever and secondary infection from scratching.
- In the Far East and Australia *Trombicula acamushi* is the vector of scrub typhus or **Tsutsugamushi** disease. It is a rickettsial disease which has transovarian transmission among mites, and its main host is rodents. It is thus a zoonotic disease, characterizes in man by an initial ulcer at the site of bite, remittent fever, lymphadenitis, splenomegaly and a bright red eruption.
- Treatment of chigger mite's bite is by hot water and soap wash then application of 10% sulfur ointment containing 1% phenol. And that of rickettsial infection is chloramphenicol.

- **Other mites that can infest humans:**
- Mites can act as antigens causing allergic rhinitis and asthma under certain conditions. Large populations of **"storage mites"** are present in enclosed spaces where grins are stored and grain dust accumulates. These are species of *Dermatophagoides* (*D. farinae*) and can be present in kitchens. Also *D. pteronyssus* and maybe other species of the same genus are called **house dust mites** and they are abundant in mattresses, carpets, floors, curtains, feeding on the human falling hairs and skin scales, plant and animal fibers. They cause asthma and allergic rhinitis by inhalation of whole mites or their excrement.

- Chicken mite, *Dermanyssus gallinae* sometimes attacks humans, the bite causes an itching dermatitis in poultry farmers, usually on the back of hands and forearms.
- The rat mite *Ornyhtonyssus bacoti*, present in many warm countries, can bite humans working in stores, factories and warehouses. The bites produce papulovesicular dermatitis, and utricaria. It can also transmit *Rickettsia typhi*, the causative agent of endemic typhus from rat to rat.
- The food mites of the family **Tyrogliphidae** feed on cheese, cereals and dried vegetables and fruits. A few species can also feed on hair, feathers and insects. They produce a temporary pruritus by penetrating the superficial epidermis, this is called **grocer's itch**.

ORDER ARANIEDA

(SPIDERS)

- Spiders use venom to paralyze their prey. They rarely attack humans, but some species can produce systemic poisoning by their bites.
- The most important ones belong to genus *Latrodectus*, these possess a potent venom that can produce serious symptoms.
- They are present in Europe, Australia, New Zealand, Philippines, Africa, the West Indies, South and North America.
- They infest lumber wood heaps, rail fences, cracks in basements, and even houses. They avoid strong light and usually bite only when disturbed.
- The small brown spider *Loxosceles spp*. of North and South America produces necrotic cutaneous lesions. In an hour edema and erythema develop in large skin areas. The edema subsides and gangrene develops, then sloughing leaving areas of deep ulceration.

ORDER SCORPIONIDA

(SCORPIONS)

- They are nocturnal in activity, and lie under rocks, logs, and other protective coverings during day. They can come in contact with hands, legs or feet if they hide in clothing, shoes, drawers, or elsewhere when people sleep on the ground or walk barefooted at night in infested areas.
- The small species either are not capable to penetrate human skin or cause minor symptoms by their stings, but the large sized species of ***Buthos*** in North Africa and Southern Europe, and ***Centruroides*** in Arizona and Mexico are venomous and their stings may be fatal. They cause serious systemic reactions especially in children.

- **Grades of *Scorpion* envenomation**
- There are four grades of scorpion stings.
  - Grade I - Local pain and/or paresthesias at the site of envenomation.
  - Grade II - Pain and/or paresthesias remote from the site of the sting, in addition to local findings.
  - Grade III - Either cranial nerve/autonomic dysfunction or somatic skeletal neuromuscular dysfunction.
    - Cranial nerve dysfunction - Blurred vision, roving eye movements, hypersalivation, tongue fasciculations, dysphagia, dysphonia, problems with upper airway.
    - Somatic skeletal neuromuscular dysfunction - Restlessness, severe involuntary shaking or jerking of the extremities that may be mistaken for a seizure.
  - Grade IV - Combined cranial nerve/autonomic dysfunction and somatic nerve dysfunction.

- **Management:**
- Because the clinical manifestations and severity of the symptoms vary among patients, individualize management of scorpion stings do. Furthermore, frequent patient monitoring allows earlier recognition of the life-threatening problems of scorpion envenomation. Treatment generally consists of moving the patient away from the scorpion and stabilizing the patient's airway and vital signs, followed by administration of antivenin and institution of symptomatic and local treatment.

- **Local treatment:**
  - A negative-pressure extraction device may be useful. Oral extraction is contraindicated.
  - Use ice bags to reduce pain and to slow the absorption of venom via vasoconstriction. This is most effective during the first 2 hours following the sting.
  - Immobilize the affected part in a functional position below the level of the heart to delay venom absorption.
  - Calm the patient to lower the heart rate and blood pressure, thus limiting the spread of the venom.
  - For medical delay secondary to remoteness, consider applying a lymphatic-venous compression wrap 1 inch proximal to the sting site to reduce superficial venous and lymphatic flow of the venom but not to stop the arterial flow
  - Apply a topical or local anesthetic agent to the wound to decrease paresthesia.
  - Administer local wound care and topical antibiotic to the wound.
  - Administer tetanus prophylaxis.
  - Administer systemic antibiotics if signs of secondary infection occur.
  - Administer muscle relaxants for severe muscle spasms (ie, benzodiazepines.)
- **Systemic treatment**: is instituted by directing supportive care toward the organ specifically affected by the venom

ORDER PENTASTOMIDA

(Tongue Worms)

- Species of medical importance are *Linguatula serrata*, *Armillifer armillatus* and *A. moniliformis*. *Linguatula serrata* encapsulated in cattle or sheep liver can cause the uncommon parasitic pharyngitis or **Halzoun**. The nymphs attach by their hooks to the pharyngeal wall causing severe irritation, inflammation, pain and sometimes stridor. Affected people sometimes notice the coughing up of a 5-10 mm. white worm after gargling with alcohol or spirits.

CLASS COPEPODA

Cyclops spp.

Distribution:

- It is a cosmopolitan copepod, living in fresh water of canals, rivers and wells.

Medical importance:

- It acts as intermediate host for:
- *Diphyllobothrium latum*.
- *D. mansoni*.
- *Dracanculus medinensis*.

Control:

- Filtration of water.
- Boiling of water.
- Killing of *Cyclops* in wells by the use of heated steam, or calcium oxide.

Parasite immunity

Evasion of immune response

Many infective agents have acquired mechanisms that allow them to avoid elemination by specific and nonspecific defense mechanisms

Avoidance of intracellular digestion:

- The organisms may secrete molecules that prevent the formation of functional phagolysosomes. This is the case in ***Toxoplasma***.It also may synthsize an outer coat or enzymes that protect it from proteolytic enzymes and free toxic radicals.
- It may move rapidly from the phagosome into the cytoplasm, where it is protected from the respiratory burst and large concentrations of proteolytic enzymes. This is the case in ***Trypanosoma cruzi***.
- It may synthesize compounds that neutralize the activating effect of IFN-γ. ***Leishmania*** inhibits the response of monocytes and neutrophils to the cytokines, so it becomes resistant to phagocytosis.

Antigenic variation. This has been characterized in some parasites as trypanosomes and *Giardia lamblia*.

- Parasites as *Giardia* change the antigenic membrane proteins by sequentially activating a pool of more than 20 genes that code for what termed the variable major proteins. The genes of the pool are sequentially activated by duplicative transposition to an expression site, allowing the emergence of new mutants that can proliferate unchecked until antibodies are formed. The continuation of infection corresponds to the emergence of new mutants.

- In sleeping sickness trypanosomes cause chronic infection in spite of the active humoral immune response due to the following:
  - the surface coat of the parasite is formed mainly of a single glycoprotein which has 10x3 genes in its chromosome codes. Every 10x6 0r 10x7 cell divisions, a mutation occurs causing replacement of an active gene in the expression site with a previously silent gene. This new gene code allows the mutant strain to proliferate unchecked for a period of time.
- - as antibodies are formed to the new mutant , parasitemia declines, and then increases as soon as a new mutation occurs.

- In malaria the immune response of the host is directed against a parasite protein inserted in the membrane of parasite-infested erythrocytes. *Plasmodium* evades the immune response by periodically switching the gene coding for that protein.

- Interference with the immune response, this is a common mechanism of escape with many different variations.
- Interference with inductive stages of immune response. Some multicellular parasites interfere with the induction of CMI by disturbing the immune regulatory circuits.
- interference with the immune effector mechanisms
- The synthesis of ineffective antibodies, known as blocking factors, prevents the recognition of an infective agent by the effector mechanisms e.g. the synthesis non-complement fixing IgA.

- Schistosomes have multiple mechanisms of evasion, including

1- stimulation of suppressor monocytes.

2-down-regulation of surface protein expression.

3- adsorption of host proteins to their external surface.

- The last two mechanisms prevent proper recognition by antischistosomal antibodies.

Laboratory Role in Diagnosis Of Some Parasitic Diseases

- Fecal examination.
- Urinary examination.
- Blood examination.
- Sputum examination.
- Immunological examination.
- Serological examination.
- Cultures.
- Animal inoculation.
- Biopsy.
- Radiology.
- Special methods.
- Epidemiological studies.

- **Fecal Examination**
- General advices for sample collection:
- The patient should be asked about his/her current and previous treatment.
- Samples should be collected in clean containers, and to be freshly examined.
- Repeated samples may be needed.
- Samples of about 5-10 gm are usually enough, but some may need the whole matter.
- Some parasites are better detected in the last piece: e.g. *Schistosoma* eggs, others in the first: e.g. pin worms and others in mucous: e.g. *Entamoeba histolytica* trophozoite and *Schistosoma* eggs.
- For preservation 10% formalin or MIF could be used.

- **Methods of examination:**

Macroscopic examination:

- For observation of: consistency (formed or loose), mass, colour, odor, blood (fresh or digested), mucous…etc
- Some times visible macroscopic parasites could be detected as: segments of *Taenia*, nematode adults of *Ascaris* or *Enterobius* or dipterous flies' larvae in case of intestinal myiasis.

Microscopic examination:

- Direct smear method: about a match stick size of the sample is mixed with few drops of saline, covered with a glass cover slip and examined under the microscope. Sometimes a drop of iodine is added to stain *Entamoeba histolytica* cysts and Giardia cyst if present.

Concentration methods:

1) Sedimentation:

a) Simple sedimentation:

(e.g. for detection of *Fasciola* and *Schistosoma* eggs).

b) Formol-ether sedimentation technique:

(can be used for detection of vast majority of eggs, larvae and cysts).

c) Kato thick smear:

for schistomes and other eggs.

2) Flotation methods:

- Simple flotation:

e.g. of *Tricocephalus, Ancylostoma* and others).

- Zinc-sulphate flotation.

- Sheather's (sugar) solution flotation:

Used for cysts of *cryptosporidium* and *Isospora*

Stoll's egg counting technique:

Used for counting *Ascaris* and hookworm ova, which have a regular rate of egg production?

Harada-mori culture:

For differentiation between hook worms infection through the recovery of their larvae from eggs present in the fecal samples.

Baerman's technique :

- For isolation of living nematode larvae or adults in soil or fecal samples

Hatching technique (for *Schistosoma* eggs):

- **Urinary examination**
- Macroscopic examination: to comment on the colour, presence of visible sediments, lymph or blood.
- Sedimentation method: Simple, in the sedimentation funnel, or by centrifugation, then miceroscopic examination of sediment

Blood examination

- Complete blood picture: may be indicative in case of eosinophilia, leucocytosis: amoebic liver abscess, leucopenia: *Leishmania donovani* and anaemia: as in *Ancylostoma*.
- Wet blood film: to diagnose trypanosomes or microfilariae with their characteristic movement.
- Stained blood films (with: Geimsa, Leishman, Wright's stains or others)
- Thin blood film: a drop of fresh blood is placed near the end of an alcohol-cleaned slide, another slide is used to spread the blood from side to side and then held at the 30 degree and the spreading slide is pushed forward to the other end. The film is left to dry, fixed, stained and examined.
- Thick blood film: 2-3 drops of fresh blood are placed on an alcohol-cleaned slide. Spread with a circular movement (for 30 sec. to prevent fibrin strands formation) on an area of about one cm^2. Leave to dry, put in a buffer solution for dehaemoglobinization, Leave to dry, apply a fixative (as methyl alcohol) then stain.

- **Sputum examination**
- Macroscopic examination for colour, blood ….etc
- Microscopic examination:
- - With few iodine drops to detect *Entamoeba histolytica* trophozoite.
- - After addition of a mucolytic and sedimentation examine the sediment for eggs or larvae
- **Immunological examination**
- As intradermal tests described before e.g. Toxoplasmin test.

Serological examination

- -The Enzyme linked immunoabsorbant assay (ELISA).
- - Counter current immuno electrophoresis.
- - PCR. (Genome technology).

Cultures

- Used for diagnosis of some protozoa as:
- - *Leishmania spp*.: on N.N.N. medium (Novy, Mac Neal and Nicolle).
- - *Acanthamoeba* : on modified agar medium.
- - *Trichomonas vaginalis*: on diamond medium.
- And some nematodes as:
- *Strongyloides stercoralis*: on modified agar medium.

Animal inoculation

- Rarely used for diagnostic purposes nowadays, though it was used earlier for diagnosis of: *Toxoplasma gondii*, *Leismania donovani* and *Trypanosoma cruzi*.

Biopsy

- May be obtained from: -lymphnodes (e.g. *Toxoplasma gondii*, *Leismania donovani*) . –skin snips as in *Onchocerca volvulus*.

  - Muscles as in *Sarcosysts or Trichinella spiralis*.

Radiology

- - Chest x-ray: may be used for diagnosis of
- - Calcified worms as: Cysticercus cellulosae.
- - MRI: may be used in diagnosing some parasites as Hydatid cyst.

Special methods *As:*

-N.I.H. swab (National Institute of Health) used for the diagnosis of: Enterobius vermicularis.

- The duodenal capsule: for duodenal parasites e.g. *Giardia lamblia*.

- Sigmoidoscope as in cases of *Entamoeba histolytica* and *Schistosoma. Mansoni* infection.

- Cystoscope as in case of *Schistosoma hematobium*.

Thank you