Infectious Diseases

Lecture 3

Pathology and Clinical Science 1 (BIOC211)

Department of Bioscience

Text Reference:

© endeavour.edu.au
Session Learning Outcomes

This session aims are to understand:

- Common causes of infection
- Common pathways by which the human body can acquire an infection
- Normal course of infection and the clinical features present during an infection
- Complications of infections
- Some common infections and their treatments
Definition of Infection

- The invasion of the body by pathogenic micro-organisms that reproduce and multiply causing disease

OR

- A disease caused by invasion of the body by pathogenic organisms
Normal Flora & Opportunistic Infections

- Resident flora have a role in preventing the growth of invading pathogens.

- These microbes exist in various locations and are site specific.

- The balance of these resident microbes must be maintained for health and wellbeing.

- If microbes are transferred from one location to another, if the body’s normal defences are impaired or if the balance of organisms is lost, disease can result.

- Such infections are known as opportunistic.
### Organisms causing Infections

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prions</strong></td>
<td>Unusual infectious agents which appear to consist only of protein without any genetic material</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td>Very small intracellular parasites that require a living host for replication</td>
</tr>
<tr>
<td><strong>Bacteria</strong></td>
<td>Unicellular organisms that do not require living tissue to survive</td>
</tr>
<tr>
<td><strong>Fungi</strong></td>
<td>Single to multi-cellular, diverse range of yeasts and moulds</td>
</tr>
</tbody>
</table>

![Prion Image](http://www.whozoo.org/mac/Music/images/prion1.gif)

![Virus Image](http://thumbs.dreamstime.com/z/grippevirus-2231588.jpg)

![Bacteria Image](https://guoyxin960112.wordpress.com/2015/06/16/bacteria/)

![Fungi Image](http://farm9.staticflickr.com/8432/7675823936_af97a43c73_o.jpg)
Organisms causing Infections

Parasites

- **Protozoa** - unicellular organisms with no cell wall
- **Helminths** - multi-cellular organisms (worms)
- **Arthropods** - insects
# Relative Size of Micro-organisms

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Size</th>
<th>Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viruses</td>
<td>0.01-0.03μm</td>
<td>electron microscope</td>
</tr>
<tr>
<td>Bacteria</td>
<td>1-10 μm</td>
<td>light microscope</td>
</tr>
<tr>
<td>RBC</td>
<td>8 μm</td>
<td>light microscope</td>
</tr>
<tr>
<td>Fungi</td>
<td>3-20 μm</td>
<td>light microscope</td>
</tr>
<tr>
<td>Protozoa</td>
<td>5-100 μm</td>
<td>light microscope</td>
</tr>
<tr>
<td>Human hair</td>
<td>75 μm</td>
<td>human eye (limit)</td>
</tr>
<tr>
<td>Arthropod</td>
<td>100 μm</td>
<td>human eye</td>
</tr>
</tbody>
</table>
Principles of Infection

“In order to acquire an infectious disease an individual must be exposed to a reservoir or source of the potential pathogen and a situation must exist whereby the pathogen can be transmitted to the human body and gain entry in sufficient numbers to cause an infection.”

## Principles of Infection

- **Susceptibility to infection relies on a number of factors**
  - Source of infection/disease reservoir
  - Infection can come from animals and birds, insects, food, soil, water, inanimate objects, people
- **Method of transmission**
  - Contact: Direct, Indirect, Droplet transmission
  - Vehicle: Air-Borne, Water-Borne, Food-Borne
  - Vector: Mechanical, Biological
- **Host resistance** (both innate and acquired)
- **Circumstances of infection**
- **Virulence of the pathogen**
## Transmission of Microbes

<table>
<thead>
<tr>
<th>Contact - Direct</th>
<th>Contact - Indirect</th>
<th>Contact - Droplet transmission</th>
</tr>
</thead>
</table>
| o No intermediate, must have close or intimate contact with the source of the infection  
- Self to self (children - faecal / oral route)  
- Person to person  
- Animal to person (tinea, anthrax)  
- Soil or water to person | o Left behind by others  
- Use of Fomites (inanimate objects) as intermediates | o Coughing, sneezing |

http://www.bing.com/images/search?q=germ+transmission+images&qs=n&form=QBIR&pq=germ+transmission+images&sc=1-24&sp=-1&sk=#x0y9273
## Transmission of Microbes

<table>
<thead>
<tr>
<th><strong>Airborne</strong></th>
<th>Contracted by inhalation, microbes carried on air currents over distances of more than 1m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water-borne</strong></td>
<td>Transmitted via ingestion/bathing</td>
</tr>
<tr>
<td><strong>Food borne</strong></td>
<td>Food spoilage due to microbial growth</td>
</tr>
</tbody>
</table>
| **Vector - transmission by a carrier** | **Mechanical**: Passive transport on the outside of an insects body to a susceptible host i.e. the house fly, from the garbage tip  
**Biological**: Infected insect bites susceptible host and passes on infection |
Host Resistance
The ability of the host (person) to fight off an infection

<table>
<thead>
<tr>
<th>Factors that decrease host resistance include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (infants and the elderly)</td>
</tr>
<tr>
<td>Genetics (eg. cystic fibrosis)</td>
</tr>
<tr>
<td>Immunodeficiency or immunosuppression (of any type)</td>
</tr>
<tr>
<td>Malnutrition (low protein intake)</td>
</tr>
<tr>
<td>Chronic disease (cancer, CAD, Diabetes)</td>
</tr>
<tr>
<td>Severe stress (physical or emotional)</td>
</tr>
<tr>
<td>Damaged primary defense mechanisms (burns, cuts)</td>
</tr>
<tr>
<td>Poor inflammatory response</td>
</tr>
</tbody>
</table>
Sources of Infection

- Socioeconomic factors (eg hygiene)
- Nosocomial
- Iatrogenic
- Zoonotic (exposure to animals)
Virulence

- The degree of Pathogenicity of an organism
- The potential of the organism to establish and cause disease

Factors influencing virulence

- Invasive qualities
- Viruses (small size)
- Adherence Factors
  - Pili
  - Fimbriae
- Production of toxins
- Production of destructive enzymes
- Immune evasion
- Resistance to treatment – “super bugs”
Pathogenicity

To be a successful pathogen a micro-organism must:

- Gain entry into the host
- Attach to the host tissues and multiply
- Evade the host defence mechanisms
- Damage tissue and produce disease symptoms

Pathogenic effect of infection is influenced by
- Rate of replication
- Infectious dose
## Portals of Entry

### Skin

- Mucosal surfaces
- Ears
- Conjunctiva, lacrimal glands
- Puncture wounds, needle sticks
- Burrowing parasites and insect derived infections
- Splits or tears from dehydration or oedema,
- Hair follicles and sebaceous glands
- Scratching itching bites or rashes
- Burns or damage to skin integrity
- Contact with blood products if skin is broken
IMPETIGO
http://www.sciencephoto.com/image/258867/530wm/M1800105-Impetigo_skin_infection-SPL.jpg

MRSA Infection of the Hand
http://www.sciencephoto.com/image/138544/350wm/C0075586-MRSA_Hand_Infection-SPL.jpg
Acute Otitis Media

http://otitismedia.hawklibrary.com/albums/aom/1_15.sized.jpg
Conjunctivitis
Puncture wounds

http://upload.wikimedia.org/wikipedia/commons/7/74/Knee_puncture.JPG
Scabies

Portals of Entry

Respiratory Tract

- Inhaled aerosols
- Inhaled spores or respiratory droplets
- Air currents from air conditioning – especially in hospitals
- Common use of ventilators, humidifiers, nebulisers

http://www.bmolchem.wisc.edu/labs/hull/images/figure1.jpg
Portals of Entry

Gastrointestinal Tract

- Contaminated food and/or water
- Must be resistant to acid so commonly the spores of the bacteria or the eggs or the cysts of Helminths and protozoa (like Giardia) are ingested in contaminated food or water and later hatch in the GIT
- Many GIT pathogens have a very low infective dose so the few that survive the stomach acid are adequate to cause infection
- Can also ingest the toxin rather than the bug such as in botulism and still get disease
Portals of Entry

Genitourinary system

- Urethra- contamination from faecal route
- Catheters
- Urinary retention
- Sexually transmitted diseases
- Blood borne viruses in semen and vaginal secretions

E-Coli

http://www.psmicrographs.co.uk/_assets/uploads/escherichia-coli--e--coli--bacteria-80013959-l.jpg

http://www.nationalscrubs.com/ProductImages/medline007/dynd11552.jpg
Affects on the Body

- Dependent on pathogen
- All cause tissue damage and therefore activate the immune response
- The role of the immune system is to try to clear the infection from the body through elimination from the body or destruction of the pathogen
- Therefore the bugs have to get out or find somewhere to hide if they want to survive
- Some bugs can evade the immune system by leaving the body and finding a new home
## Portals of Exit

- Sputum and mucosal secretions
- Saliva
- Semen and vaginal secretions
- Urine
- Faeces
- Blood
The Course of the Infection

- Incubation
- Prodromal Illness
- Acute or Invasive phase
- Fatal outcome: *If infection not checked*
- Decline: *Immune response or Treatment*
- Convalescence
- Recovery
- Acute identifiable Disease syndrome
- Mild Signs or symptoms
- No signs or symptoms

Number of pathogens present vs. Time
Incubation Period

- The time interval between exposure of to the infectious agent and the onset of symptoms of infection

- Factors vary dependent on:
  - Properties of the pathogen (virulence)
  - The infectious dose
  - Route of entry relative to target organ
  - Host resistance
## Incubation Period

### Examples

<table>
<thead>
<tr>
<th>Disease</th>
<th>Incubation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Poisoning</td>
<td>12-36 hours</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>4-12 weeks</td>
</tr>
<tr>
<td>Chickenpox</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>Mumps</td>
<td>12-25 days</td>
</tr>
<tr>
<td>Influenza</td>
<td>2-3 days</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>3-5 weeks</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>2-6 months</td>
</tr>
<tr>
<td>Glandular fever</td>
<td>4-6 weeks</td>
</tr>
<tr>
<td>HIV</td>
<td>min 3 weeks to months or years</td>
</tr>
</tbody>
</table>
Prodromal Period

- The onset of disease symptoms, signals the beginning of the disease

- As the pathogen multiplies non-specific disease symptoms emerge such as
  - Headache
  - Nausea
  - General malaise

- If the host defences overcome the pathogen symptoms may disappear before a recognisable disease pattern occurs which may or may not result in acquired immunity to the infection
Acute or Invasive Stage

- Period of acute disease (specific signs and symptoms relative to the disease are observed)
- Pathogen invades and damages host tissue
- Often characterised by fever and chills caused by the release of pyrogens
- Some invasive phases reach a crisis or peak over a short time period after which symptoms subside
- Other infections have a longer invasive phase in which further signs and symptoms emerge such as cough, diarrhoea, jaundice, swelling, pain, discharge etc
The Outcome of the Infection

- The ability of the host to overcome the invasive phase determines the outcome of the disease.
  
  Recovery OR Death

Decline Phase

- The effect of the onset of protective immunity
- The immune system overcomes the effects of the pathogen
- Symptoms subside and patient begins to recover
- In some cases host defences are inadequate to completely eradicate the pathogen and may result in a latent or chronic state
Outcome of Infection

Convalescence

- The time when the body repairs itself and regains strength
- Energy used to activate and support the immune system is directed back into the processes of cell regeneration and tissue repair
- If insufficient time is allowed for the body to recover exposure to a subsequent pathogen may result in a second more serious infection as the immune system and body are already weakened and cannot protect the body effectively
**Variations of the Infection Course**

- **Acute**
  - characteristic symptoms appear and the disease runs its course quickly

- **Fulminating**
  - symptoms appear suddenly and the disease runs its course rapidly, often to a fatal outcome

- **Chronic**
  - disease progresses slowly and persists for long periods with continuous shedding of the pathogen

- **Latent**
  - the pathogen is dormant in the host and may be reactivated at a later stage

- **Subclinical**
  - the infection produces an immune response without recognisable symptoms
### Types of Infections

- **Localised**
  - confined to one area of the body

- **Systemic**
  - pathogen affects more than one organ

- **Mixed**
  - disease is due to the effect of more than one pathogen

- **Primary**
  - the first sign of an infection in a healthy host

- **Secondary**
  - develops when the defences are lowered by the primary infection

- **Super-infection**
  - results from the overgrowth of opportunistic organisms following the destruction of normal flora
Signs and Symptoms of Infection

- Inflammation
- Pain or tenderness
- Swelling
- Redness
- Warmth
- Purulent exudate - bacterial
- Serous exudate - viral
- Fever
- Fatigue
- Weakness
- Headache
- Nausea
- Skin rashes - can be both specific and non-specific
Specimens Used for Diagnosis

- **Swabs**
- **Blood**
- **Urine**
- **CSF**
- **Faeces**
- **Sputum**
- **Saliva (rarer)**

Wound Swabs
[Link](http://www.pathology.leedsth.nhs.uk/pathology/Portals/0/images/microbiology_images/how2sample_page/sample_containers/swabs.jpg)

Blood samples
[Link](http://www.delivery.superstock.com/WI/223/4128/PreviewComp/SuperStock_4128R-2328.jpg)

Urine sample
[Link](http://www.sciencephoto.com/image/298514/530wm/M9201078-Urine_samples-SPL.jpg)
Treatment of Infection

- Self limiting nature of infection
- Use of antibiotics
- Use of anti-viral agents
- Treatment of parasites - i.e. anti-malarials
- Immunosuppressive agents
- Symptom relief - i.e. anti-pyretics
How does the Immune System Respond to Infection?

<table>
<thead>
<tr>
<th>Non-specific immune defences</th>
<th>Specific immune defences</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fever</td>
<td>• Antibody production</td>
</tr>
<tr>
<td>• Inflammation</td>
<td>• Cytotoxic T-cells</td>
</tr>
<tr>
<td>• Complement</td>
<td></td>
</tr>
<tr>
<td>• Macrophages and NK cells</td>
<td></td>
</tr>
</tbody>
</table>
## Clearance Mechanisms

- The immune system is activated to produce immune molecules and immune cells to remove or clear the pathogen from the body.

- There are a number of ways in which clearance of the pathogen is achieved.

- In many cases more than one type of clearance mechanism is required to be able to remove the pathogen entirely.
Clearance Mechanisms

- **Complement**
  - Activated in two ways

- **Mechanisms of clearance**
  - Inflammation
  - Opsonisation
  - Membrane attack complex

- **Phagocytosis**

- **Interferon**
  - Anti-viral agents
  - Activate NK cells
Common symptoms

Many diseases present with very similar symptoms

Look at the following symptoms:
Sore throat, fever, fatigue, malaise, pharyngeal inflammation, vomiting, petechia, loss of appetite

These symptoms might indicate the following diseases:
Common colds, influenza, Acute HIV, Leukaemia, Tonsillitis, Diphtheria, Epstein Barr virus (glandular fever)

Treatment and prognosis varies depending on which disease is responsible
Differential Diagnosis

- The process of ‘differential diagnosis’ allows us to determine which disease is responsible for the symptoms.
- Listing all the possible diagnoses, and then attempting to remove some until only one remains
  - Through further observation and diagnostic tests
  - Rule – look for the simplest diagnosis that makes sense
  - Not every case will be straight off House
Readings and Resources

Resources:

- **Set Textbooks:**

- **Additional textbooks:**
COMMONWEALTH OF AUSTRALIA
Copyright Regulations 1969
WARNING
This material has been reproduced and communicated to you by or on behalf of the Endeavour College of Natural Health pursuant to Part VB of the Copyright Act 1968 (the Act). The material in this communication may be subject to copyright under the Act. Any further reproduction or communication of this material by you may be the subject of copyright protection under the Act. Do not remove this notice.