OCR (B) Biology A-level

3.3 Non-communicable diseases

Notes

3.3.1 The cellular basis of cancer and treatment

Risk factors contributing to non-communicable diseases:

- Hereditary

- Ageing

- Types of radiation – i.e. ultraviolet rays

- Carcinogens

- Viruses – human papillomavirus which can result in cervical cancer

- Air pollution

- Diseases – cancer, asthma

- Lifestyle

    - Smoking – lung cancer

    - Air pollution/ urban areas – asthma

Cellular basis of cancer

- Uncontrolled division of cells due to mutation in DNA; improper regulation of cell division

- Mutations isolated in certain genes known as onco-genes (known as proto-oncogenes prior to mutations)

- Oncogenes accelerate cell growth and division

    - Examples:
        - **Ras –** regulate cellular signalling transmission. Hyperactivity can result in cancer.
        - **Myc –** constant expression of a certain gene. Contribute to cell proliferation and hence cancer.
        - **Oncogenes may mutate –** i.e. duplicated or overexpressed hence causing uncontrolled cell proliferation.

- Tumour suppression genes suppress cell division

    - Examples:
        - **p53 tumour suppressor gene**

- Tumour suppressor genes regulate rapid cell division and offers an opportunity for DNA repair. Mutations within these genes may result in uncontrolled cell division and hence cancer.

- Hormones may also contribute to the onset of cancer

  - Oestrogen and progesterone – breast cancer
  - Testosterone – prostate cancer

Diagnosis

- There are many methods of detecting cancer:

- Symptoms of the patient
- Signs found when the doctor performs an examination
- Blood tests – check for tumour markers, and the function of the liver, kidneys etc.
- Ultrasound scan – use of sound waves to obtain an image
- X-Ray - Chest X-Ray: e.g. mass in the left lung (image below)

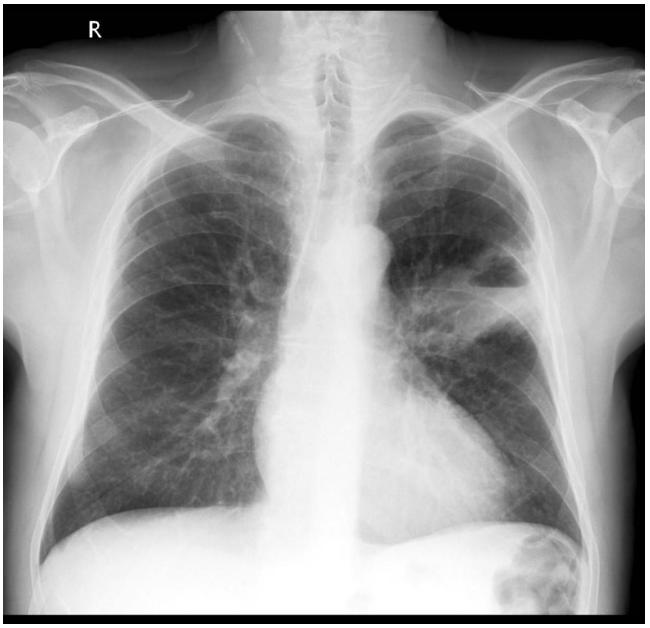

Image source: wikidoc.org

- Magnetic resonance imaging [MRI]
- Computed tomography [CT] scan (a normal CT scan of the brain is shown below)
- Biopsy – an incision made to obtain a sample of tissue for analysis
- Positron emission tomography [PET] scan
- Mammography: x-ray signals used to visualize breast tissue

- The method used depends on the type of cancer that is suspected and the part of the body it is arising from.

<u>Treatment</u> Options:

- Surgery – if cancer is localised, easily accessible, benefits of invasive surgery outweigh the risks

- Chemotherapy – chemicals to target proliferating cancer cells

  - Side effects include fatigue, nausea, hair loss, sore mouth, itchy skin, diarrhoea

- Radiotherapy – radiation to target proliferating cancer cells

- Immunotherapy - uses the body's immune system to fight cancer by introducing specific antibodies to train it to detect cancer cells

- Hormone therapy – hormones such as oestrogen and testosterone are associated with breast and prostate cancer, respectively. By giving patients hormone blockers or suppressors, the accelerated growth of cancer cells can be slowed down.

- Treatment of cancer is aimed at regulating and controlling cell division

3.3.2 Respiratory diseases and treatment

Pollutants include:

- Tobacco smoke – damage the cilia which line the respiratory system. Usually, cilia clear the dirt and particles – loss of cilia results in mucus build-up and cough.
- Asbestos – small fibres and particles lodge within the lungs resulting in damage
- Fungal spores – cause severe infections, especially in individuals who are immunocompromised

These can interfere with the respiratory system and breathing.

Overtime, the build-up of harmful particles results in inflammation of the lining of the lungs, trachea and airways. This is known as chronic obstructive pulmonary disease (COPD).

Symptoms:

- Cough
- Wheeze
- Sputum production
- Shortness of breath

Chronic bronchitis: symptoms which persist for >3 months

Emphysema predominantly results from prolonged exposure to cigarette smoke (some types are also inherited, but this is beyond the scope of the specification). The lung tissue becomes dilated and thicker, decreasing the rate of diffusion of gases such as oxygen and carbon dioxide. The lungs also lose their elasticity, hence making exhalation more difficult.

Continued exposure to such pollutants, results in accumulation of inflammatory mediators. This exposes the individual to increased risk of infection. Overtime, this leads to a build-up of scar tissue within the respiratory tract – this process is known as fibrosis. Fibrosis causes the lungs to stiffen, and hence alters the oxygen exchange between the lungs and the blood vessels.

Lung cancer is a complication of the diseases mentioned above.

- Symptoms include cough, sputum (sometimes with the presence of blood), shortness of breath, wheezing, weight loss and lack of energy.
- There are many forms of lung cancer – this depends on the risk factors involved (i.e. asbestos or tobacco use) and the type of cells which grow and become cancerous.
- The treatment depends on how early the cancer is identified, whether it has spread to other organs or glands and the characteristics of the patient. Options include surgery, chemotherapy or radiotherapy.

Asthma is another form of lung disease. It results from constriction of the smaller airways – bronchioles. This means less air reaches the lungs. Asthma is more common in individuals that suffer from skin conditions such as eczema or those who have hay fever. Other risk factors include cold weather, exercise, stress and air pollution.

- Unlike the diseases mentioned above, asthma does not cause fibrosis and the surface area of the alveoli is not affected.

- Asthma is treated by medication which dilates the bronchioles. The respiratory tract is lined with receptors including beta-receptors and cholinergic receptors. Drugs are manufactured to target these receptors.
    - Salbutamol – short acting beta-receptor agonist – relax the smooth muscle of bronchioles.
    - Steroids (i.e. Prednisolone) – reduce the inflammatory response

Plants as sources of medicinal drugs

Theophylline – *Theobroma cacao* **– tea and cocoa plants -** treatment of COPD and asthma
Topotecan - *Camptotheca acuminata* – **bark of a tree –** treatment of lung cancer
Aspirin - *Salix spp.* – **leaves and bark of the willow tree –** anti-inflammatory and anticoagulant (blood thinner)
Quinine - *Cinchona spp.* – **flowering plants of Cinchona spp. –** used against malaria

Clinical trials

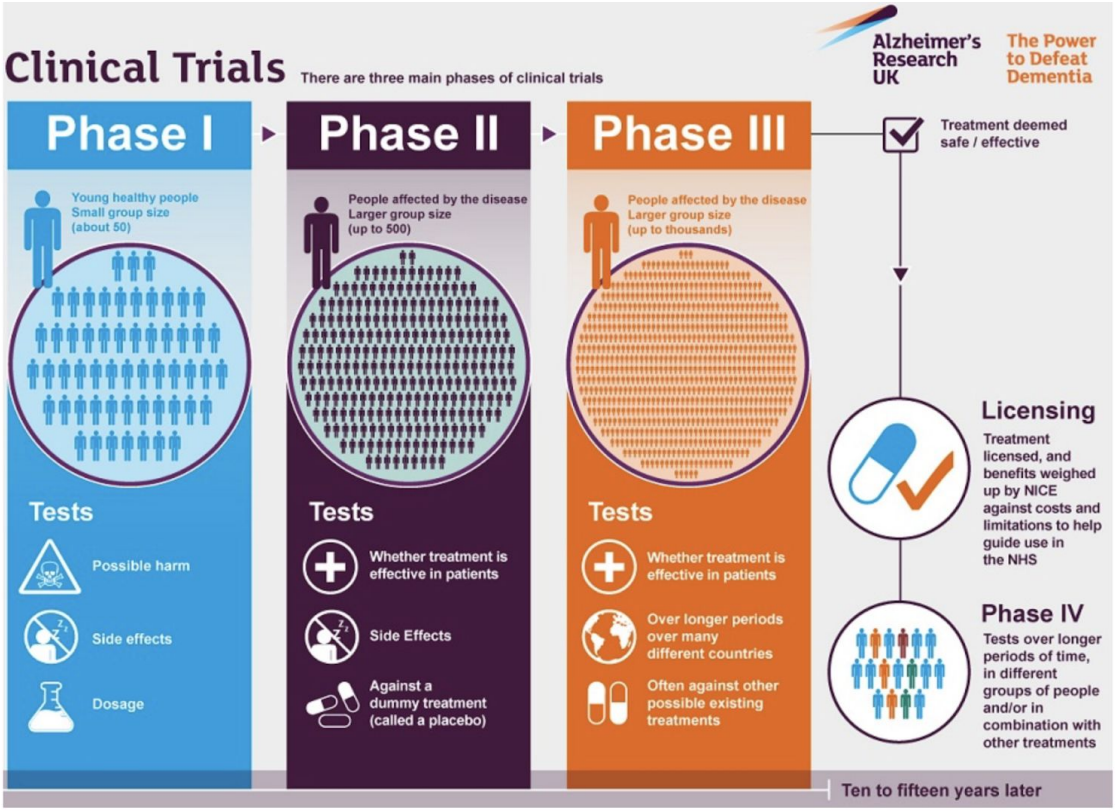

Image source: news.joindementiaresearch.nihr.ac.uk

Following **licensing**, the **cost** and limitations of the treatment are assessed by the **National Institute for Health and Care Excellence** (NICE) to produce **guidelines** for the use of the treatment by the NHS in the UK and by other healthcare practitioners and institutions. Doctors follow these guidelines when selecting the best treatment of a condition.