LEARNING OUTCOMES

On completion of this element, you should be able to demonstrate understanding of the content through the application of knowledge to familiar and unfamiliar situations and the critical analysis and evaluation of information presented in both quantitative and qualitative forms. In particular, you should be able to:

1. Explain the types and properties of biological agents found at work.

2. Explain the assessment and control of risk from exposure to biological agents at work.
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In this first section of the element a short introduction to biological agents is presented. The element then focuses on the specific requirements for assessing and controlling the risks inherent in work with potential for exposure to these agents.

**DEFINITION**

The ILO defines a biological agent as:

>“any micro-organism, cell culture, or human endoparasite, which may cause any infection, allergy, toxicity or otherwise create a hazard to human health. These include viruses and bacteria which can cause infection and disease, dangerous plants and animals (for example parasites or insects); biologically contaminated dusts, or wastes from humans and animals.”

Source: Health, Safety and Environment: A series of trade union education manuals for agricultural workers (Manual 4, Fact Sheet 3), Copyright © International Labour Organisation 2004

**TYPES OF BIOLOGICAL AGENT**

Though the definition of the term ‘biological agent’ is very broad and encompasses many different forms of entity, this element will focus on three principal types of biological agent: fungi, bacteria and viruses.

- **Fungi**
  
  Fungi include moulds and yeasts. Some fungi are able to cause infection on or inside the human body (e.g. athlete’s foot). Some fungi produce toxins (mycotoxins) that are harmful to humans. Fungi reproduce by forming spores that are released, dispersed and find a suitable environment to grow in. Inhalation of large numbers of these tiny spores can cause lung disease, such as farmer’s lung. Generally most fungi are harmless in an occupational context.

- **Bacteria**
  
  Bacteria are simple single-celled organisms. They vary widely in shape and many have a tail (flagella) that allows them to move through liquid. Some form hardy spores that can survive adverse conditions such as heat, cold and lack of water (e.g. bacillus anthracis, the bacteria responsible for anthrax). Bacteria grow in virtually every environment on the planet, from water and soil to deep ocean and subterranean rock. There are approximately ten times as many bacteria growing in or on the typical human body as there are human cells. Most of these do not cause disease because of the immune system. Some (e.g. certain gut bacteria) are actually beneficial. Some bacteria can cause disease (e.g. [Legionnaires’ disease](https://www.hse.gov.uk/pubns/iacl27.pdf)). Antibiotics such as penicillin can be used to treat most bacterial infections.
• **Viruses**

   Viruses are micro-organisms but are not strictly alive. They are self-replicating molecules (genetic material contained in a protein shell) that invade host cells, take control of the cell to produce more viruses, and then release these viruses to repeat the cycle. Virus particles are much smaller than fungal and bacterial cells. Hepatitis and Acquired Immune Deficiency Syndrome (AIDS) are two diseases of occupational significance that are caused by viruses present in human body fluids. Viral infections are usually prevented or halted by the body’s immune system. This immune response takes time to come into effect; however, so there is often a period of illness before the body’s defences become effective (an effect seen every time you catch a cold). Some viral infections are so severe that the immune system cannot respond effectively and serious disease or death results (e.g. smallpox). Some viral infections are not dealt with effectively by the body and so can persist (e.g. Human Immunodeficiency Virus (HIV), the causative agent of AIDS).

**Sources of Biological Agents**

Pathogenic (disease-causing) biological agents come from three main sources; humans, animals and the environment.

### GLOSSARY

**PATHOGEN**

A biological agent capable of causing disease.

• **Human sources** – many fungal, bacterial and viral infections are passed from person-to-person. This can happen by transfer of body fluids (e.g. viral Hepatitis can be transferred by a needle-stick injury), by droplet infection (e.g. Tuberculosis (TB) can be spread by coughing and sneezing) or by physical cross-contamination (e.g. ‘Flu virus can be spread by touching the nose and then touching a surface that others then come into contact with).

• **Animal sources** – some serious fungal, bacterial and viral infections are passed from animals to humans. This can happen by the same general mechanisms as for person-to-person infection. For example:
  - Rabies is a viral disease that can be passed from infected animals to people, usually via a bite.
  - Leptospirosis is a bacterial disease spread by coming into contact with water or surfaces contaminated with an infected animal’s urine (e.g. rat urine).

A disease that can pass from animals to humans is referred to as a zoonosis (or zoonotic disease).

• **Environmental sources** – some serious occupational diseases originate in the general environment rather than coming from a human or animal source. A classic example of this is Legionnaires’ disease (or legionellosis) caused by the Legionella bacterium, which occurs naturally in damp soil and water courses.

**PROPERTIES OF BIOLOGICAL AGENTS**

It is possible to think of biological agents as being simply another form of chemical agent. In the UK, for example, the Control of Substances Hazardous to Health (COSHH) Regulations define biological agents as a type of hazardous substance, in effect putting them in the same category as hazardous chemicals.

This simple approach can be a little misleading however, because biological agents can have the following special properties:

• **Rapid mutation** – like all living organisms, biological agents are subject to mutation; their genetic code changes over time, changing the characteristics of the organism. However, unlike many organisms, some biological agents have a very high mutation rate. This means that their genetic code and their characteristics change quickly, making it very difficult for the human body to effectively recognise and attack them. HIV, for example, is very difficult for the body to combat because the virus is constantly changing.

• **Incubation period** – there is usually a time delay between infection (when a person catches a disease) and when the first signs and symptoms of the disease become apparent. This incubation period can range from 1-3 days (for ‘Flu) to many years (perhaps 30-50 years for Creutzfeldt-Jakob disease (CJD)). This means that the presence of a biological agent may not be readily detectable and that a link between the source of an infection and the symptoms of the disease may not be made.

• **Infectious** – it is often the case that a person (or animal) suffering from a disease is infectious, i.e. capable of spreading the agent to others. Many diseases spread by making the carrier infectious. When this is the case, an infected person poses a risk to:
  - Their colleagues.
  - Others that they might come into direct contact with.
  - In some cases, the community at large. Tuberculosis is an example of a highly infectious disease that can spread within the community.
Some diseases are not infectious, e.g. Legionnaires’ disease is not passed from one person to another. In some cases, a person may be infected with a disease and become infectious without showing any signs or symptoms of the disease (they are asymptomatic); they become a carrier, capable of spreading the disease, but unaware of their infectious state. Hepatitis C is an example of this type of disease.

- **Rapid multiplication** – micro-organisms can multiply very rapidly when environmental conditions are right. For example, the *E. coli* bacterium (a gut bacterium) is capable of multiplying at a rate greater than one cell division every 30 minutes. Though this may not sound impressive, it becomes more so when you consider that in a 24 hour period one bacterium can multiply to become over 200,000,000,000,000. It does not take long for a small number of agents (that might not present a risk of infection) to multiply to become large numbers that are capable of overcoming the body’s defences to cause infection.

In general with biological agents, there will not be a simple dose-response relationship of the kind that exists for chemical substances, and risk may be high even at small exposures.

**MORE...**

Several authorities have websites with useful information relating to biological agents:

- www.hse.gov.uk
- www.gov.uk/government/organisations/public-health-england

Dozens of websites also have background information on micro-organisms.

**REVISION QUESTIONS**

1. How does the ILO define a biological agent?
2. What are the three main categories of micro-organism?

(Suggested Answers are at the end.)
KEY INFORMATION

• Generally, exposure to biological agents can be grouped into three categories:
  – Exposure resulting from a deliberate intention to work with a biological agent.
  – Exposure which arises out of the work activity, but is incidental to it.
  – Exposure which does not arise out of the work activity itself.

  Regulations only apply to the first two categories.

• Occupational diseases of note caused by biological agents include Cryptosporidiosis, Farmer’s Lung, Hepatitis, AIDS, Legionellosis, Leptospirosis, *E. coli* infection, zoonoses, MRSA, *C. diff* and emerging health issues.

• Biological agents may be classified according to the risk they pose to health. For example, the Approved List of Biological Agents published in the UK is a list of pathogens classified into Hazard Groups according to four criteria: their ability to cause human disease; the hazard they present to workers; the likelihood of spread to the community; and the availability of prophylaxis and treatment.

• The WHO Laboratory Biosafety Manual lists factors to consider when undertaking a risk assessment of potential exposure to biological agents in laboratory work. It also outlines the requirements for laboratories at different Biosafety Levels.

• General control methods can be applied to biological agents: containment including the use of microbiological safety cabinets; sharps control; vaccination; decontamination and disinfection; effluent and waste disposal; personal hygiene measures; and PPE.

• The specification of workrooms to a Containment Level and the class of microbiological safety cabinet used in rooms are often determined by reference to the Hazard Group classification of the agent being worked with.

INTENTIONAL WORK AND INCIDENTAL EXPOSURE

Generally there are three categories of exposure to biological agents:

• Exposure resulting from a *deliberate intention* to work with a biological agent, i.e. work with biological agents that involves research, development, teaching or diagnosis.

• Exposure which arises out of the work activity, but is *incidental* to it, i.e. the activity does not involve direct work with the agent itself. For example, health care, food production, agriculture, refuse disposal and work in sewage purification.

• Exposure which *does not arise out of the work activity itself*, for example where one employee catches a respiratory infection from another. This might be thought of as an exposure resulting from normal life, in that it could and would occur simply as a result of living in the community.

Regulatory frameworks only apply to the first two categories of exposure described above because *health and safety legislation* covers only those circumstances where risks of exposure are *work-related* and not those where they have no direct connection with the work being done.

DISEASES CAUSED BY BIOLOGICAL AGENTS

This section considers a range of diseases caused by biological agents, together with the occupational contexts of exposure and the preventive measures commonly applied.
TOPIC FOCUS

Zoonoses
Zoonoses (or zoonotic diseases) are those that can be transferred to humans from animals. Several types of zoonoses will be outlined in this element, such as Leptospirosis, E. coli 0157 and Cryptosporidiosis. Other zoonoses briefly mentioned include Rabies, Orf and Anthrax. There are many more.

Occupations at risk from zoonoses will vary depending on the disease in question, but clearly people whose work brings them intentionally or incidentally into close proximity with animals will be at risk from one or several zoonotic diseases. For example:

- Farm workers.
- Vets.
- Zoo workers.
- Pet shop workers.
- Sewage workers.
- Construction workers.

Though control measures will vary depending on circumstances, the general preventive measures described later for Leptospirosis and E. coli are relevant to all zoonoses.

MORE...

The UK HSE website has a wealth of information and short guides on various zoonotic diseases available at:

www.hse.gov.uk/biosafety/diseases/zoonoses.htm

Cryptosporidiosis

Cryptosporidiosis is a parasitic infection caused by the protozoa Cryptosporidium parvum. The common symptoms are watery diarrhoea and abdominal pain with ‘Flu-like symptoms. Those who contract the infection usually get better of their own accord but in certain cases, such as in young children and the immuno-compromised, the infection can be very severe and potentially fatal. The disease is contracted by the faecal-oral route, including contact with infected persons and animals (particularly calves, lambs and goats). Outbreaks have been associated with public water supplies, contaminated food, and petting farms. The disease is a particular risk to agricultural workers.

Preventive measures include:

- Minimising the risk of infection by keeping carriers (both people and animals) healthy.
- Avoiding or reducing contact with animals.
- Wearing suitable protective clothing such as overalls when handling carriers, especially if they are sick, and gloves and a waterproof apron if handling potentially infected material such as muck or sewage.
- Good personal hygiene such as hand-washing and drying before eating, drinking or smoking.
- Immediate washing and drying of cuts and grazes and use of waterproof dressings.

Farmer’s Lung

Straw and hay quickly become mouldy if stored wet. The moisture encourages the rapid growth of green-grey dusty moulds, which produce clouds of spores when handled. The average size of these spores is about one micron, so when inhaled they penetrate to the alveoli. It has been estimated that a farm worker handling mouldy hay may inhale as many as a million spores a minute. The disease Farmer’s Lung is the result of hypersensitivity due to an antigen present in the dust of this mouldy hay.

Short-term effects include:

- Irritation of the nose and eyes.
- Acute bronchitis with cough and phlegm.
- Acute Farmer’s Lung with fever, headache, chest tightness, breathlessness and weight loss.
- Acute occupational asthma with chest tightness and wheezing.
- Grain fever with shivering, headache, fever and general aches and pains.

Long-term effects include:

- Chronic bronchitis with cough, phlegm and shortness of breath.
- Chronic Farmer’s Lung with increasing shortness of breath and weight loss.
- Chronic occupational asthma with persistent chest tightness and wheezing.
- Damage to the heart.

Preventive measures include:

- Avoiding the creation of dust when working.
- Using farm machinery that has been selected to contain dust as far as possible.
- Adequate ventilation when handling straw, etc. indoors (perhaps by use of local exhaust ventilation or dilution ventilation).
• Good housekeeping practices where materials are being handled. In particular, using industrial vacuum cleaners rather than brushing to remove excess dust from the floors, walls, etc.

• Good personal hygiene, such as keeping clothing and hair dust-free by wearing overalls or disposable protective clothing.

• In certain instances, using suitable Respiratory Protective Equipment (RPE).

Psittacosis
Farmer’s lung is caused by the inhalation of biological dust containing mould spores. A similar transmission route can cause the disease Psittacosis, through inhalation of aerosols (e.g. respiratory secretions, dried faecal or feather dust) from infected birds such as parrots, budgerigars, pigeons and doves. As a consequence, it can be an occupational disease of poultry farmers, veterinarians, zoo and pet-shop employees, or others whose occupation places them at risk of exposure.

Psittacosis typically causes influenza-like symptoms, and can lead to severe pneumonia and non-respiratory health problems. Human disease is often mild or moderate, but can be severe in elderly persons or those with a weakened immune system. Psittacosis can be difficult to diagnose and mild cases often go unreported.

Biological agents may cause an allergic reaction in an individual so that subsequent exposure causes an extreme reaction, which may cause respiratory difficulties such as asthma and/or a skin reaction such as dermatitis. Many individuals develop an allergy to animal hairs which manifests itself as sneezing and difficulty in breathing. Skin contact may cause the symptoms of dermatitis. Farmer’s Lung is a good example of this biological sensitisation. Workers exposed to animal faeces and hair/fur are particularly at risk from this form of ill health.

Hepatitis
There are at least five types of viral Hepatitis, all caused by different viruses – types A, B, C, D and E. Hepatitis A is usually contracted by the faecal-oral route. The other types are blood-borne viruses transmitted by contact with contaminated body fluids. In recent years, infectious Hepatitis has become the most common occupational disease amongst medical staff, those at risk include doctors, surgeons, nurses and ancillary staff such as hospital porters. Refuse disposal operatives form another group of workers exposed to animal faeces and hair/fur are particularly at risk from this form of ill health.

• Prohibition of eating, drinking, smoking and the application of cosmetics in working areas where there is a risk of contamination.

• Prevention of puncture wounds, cuts and abrasions, especially in the presence of blood and body fluids.

• Avoiding the use of, or exposure to, sharps such as needles, glass, metal, etc. If exposure is unavoidable, take care when handling and disposing of sharps.

• Using devices incorporating safety features, such as safer needle devices and blunt-ended scissors.

• Covering all breaks in exposed skin by using waterproof dressings and suitable gloves.

• Protecting the eyes and mouth by using a visor/goggles/safety spectacles and a mask, where splashing is possible.

• Avoiding contamination by using water-resistant protective clothing.

• Wearing rubber boots or plastic disposable overshoes when the floor or ground is likely to be contaminated.

• Using good basic hygiene practices, such as hand washing.

• Using appropriate decontamination and waste disposal procedures.

MORE...

The UK HSE guidance document INDG342 Blood-Borne Viruses in the Workplace is available from:

www.hse.gov.uk/pubns/indg342.pdf

General information and advice regarding Hepatitis is also available from the National Health Service (NHS) in the UK and the World Health Organisation (WHO):

www.nhs.uk/conditions/Hepatitis/Pages/Introduction.aspx

www.who.int/topics/hepatitis/en