**Name:**

|  |  |
| --- | --- |
| **3.5 Responses to Stimuli** | **Learning objectives** |
| 3.5.4 Viruses | 1. Explain the problem of defining what a virus is - living or non-living? 2. Show you are aware of their huge variety of shapes 3. Explain their basic structure 4. Describe viral replication 5. Explain why viruses are referred to as obligate parasites 6. Explain the economic and medical importance of viruses to humans, plants, animals 7. Include reference to two harmful examples and one beneficial example |

Viruses

Structure

They are tiny, consisting of nucleic acid (DNA or RNA) surrounded by a protein coat (capsid).

**Living and non-living features of viruses**

|  |  |
| --- | --- |
| **Living** | **Non-living** |
| 1. Possess genetic material (DNA or RNA) | Only have one type of nucleic acid (living things have both DNA and RNA) |
| 1. Possess a protein coat | Non-cellular. Do not possess organelles – ribosomes, mitochondria etc. |
| 1. Can replicate (inside a living coat) | Cannot reproduce by themselves |
|  |  |

Viruses are not included in the 5 main kingdoms as they are non-cellular and do not carry out any metabolic reactions on their own.

**Shapes –**

* **Rod-shaped** e.g. tobacco mosaic virus.
* **Round** e.g. polio, herpes, and influenza viruses.
* **Complex** e.g. bacteriophage, HIV, rabies, smallpox viruses.

**Replication**

Viruses are intracellular obligate parasites - can only live and reproduce in the host cell.

Bacteriophage – a virus that infects bacteria.

**Stages in viral replication**

* **Attachment**

A virus attaches to the host cell. Proteins on the virus match up with receptor sites on the host wall or membrane. This is why viruses are often specific to one host cell.

* **Entry**

The virus forms a hole in the host cell and the viral nucleic acid is squeezed out of its protein coat into the host cell. Protein coat is left outside cell. In animal cells the protein coats also enter, but are digested.

* **Synthesis**

The host nucleic acid is made inactive. The viral nucleic acid uses the host’s organelles to produce new viral nucleic acid and protein coats.

* **Assembly**

New viruses are assembled inside the host cell.

* **Release**

The new viruses are released when the host cell bursts - lysis.



**Retroviruses** contain RNA and the enzyme reverse transcriptase that converts the virus RNA to DNA. This DNA then makes new copies of the virus RNA and new viruses inside host e.g. HIV virus.

Some viruses do not destroy the host DNA. Instead the viral DNA may be inserted into the host DNA and then passed on from one cell to the next when replication takes place. The viral DNA may remain dormant in these lysogenic cells or become active again, making more copies of itself and lysing the host cell e.g. diphtheria, scarlet fever and botulism. The virus, once integrated, causes the bacterium to release toxins, which cause the disease.

# Economic effects of viruses

### *Study two harmful and one beneficial.*

### Disadvantages

Cause disease/death to humans or damaging food crops or animals. Ill people cannot work and need to be cared for.

**Diseases caused by viruses:**

* **Human:**

Chicken pox, shingles, warts, verrucas, cold sores, hepatitis, Common cold, influenza, mumps, measles, polio, German measles, rabies, Ebola, AIDS and some cancers.

* **Plant**: tobacco mosaic virus (gives tobacco plant a spotted, mosaic appearance), potato mosaic virus and sugar beet virus

Most plant viruses are transmitted by insects (vectors) e.g. greenfly, which suck sap.

* **Animal**: cowpox, foot and mouth (in cattle and sheep), rabies (affects nervous system of dogs mainly), distemper (dogs, fatal for puppies unless immunised), myxomatosis.

**AIDS - Acquired Immune Deficiency Syndrome**

**Virus nature**

HIV (human immunodeficiency virus) causes AIDS – a disorder in which the person cannot make antibodies.

## Effects

HIV virus attacks helper T-lymphocytes upon which results in not being able to produce antibodies against opportunistic infections such as pneumonia.

**Transmission** - by body fluids e.g. blood, semen. It can also be passed from mother to child across placenta or in breast milk.

**High-risk groups** = Receivers of blood transfusions, intravenous drug users (via contaminated needles), haemophiliacs receiving blood products and those with multiple sexual partners.

## Diagnosis

Blood tests of HIV positive people will reveal the presence of antibodies. Some HIV+ will get rid of the virus and so are immune but for others the virus is dormant and may turn into full-blown AIDS at any stage.

About 6000 people in Ireland have AIDS, 34 million worldwide – growing by 2.5 million each year.

**Control and prevention:**

At present no cure and no vaccine due to rapid mutation of virus.

Methods of prevention:

1. Avoid unknown or multiple sexual partners.
2. Do not share needles, toothbrushes, razors etc.
3. Only use screened blood products.
4. Use condoms if partner’s status unknown.
5. Avoid contact (use gloves) with blood/body fluids/wounds.
6. Don’t donate blood, semen or body organs if have AIDS or tested positive for the antibodies.

Dallas Buyers Club – have you seen the movie?

Evacuate earth (National Geographic channel) - rabies

### Benefits of viruses

1. **Control of bacterial infections**
   * Bacteriophages can be used to kill harmful bacteria. In this way they may help reduce infections by antibiotic resistance bacteria.
2. **Genetic engineering**
   * Used as **vectors** in to transfer genes from one organism to another.
   * Retroviruses produce the enzyme reverse transcriptase, which is used for the cutting of DNA molecules in genetic engineering and the production of DNA profiles.
3. Myxomatosis (biological control) virus was used to control rabbit population in Australia (but now rabbit population increasing due to resistance to virus).

**Immunity against viruses**

1. **Natural**
   * **Body’s general defense system** e.g. skin, mucus, stomach acid, phagocytes.
   * **Specific defense system** - body produces antibodies to antigen (found in protein coat of virus).
2. **Artificial**

* **Vaccination:**
* Using an attenuated (weakened) form of virus e.g. yellow fever virus or a similar but harmless strain e.g. smallpox vaccine.
* **Injecting antibodies.**

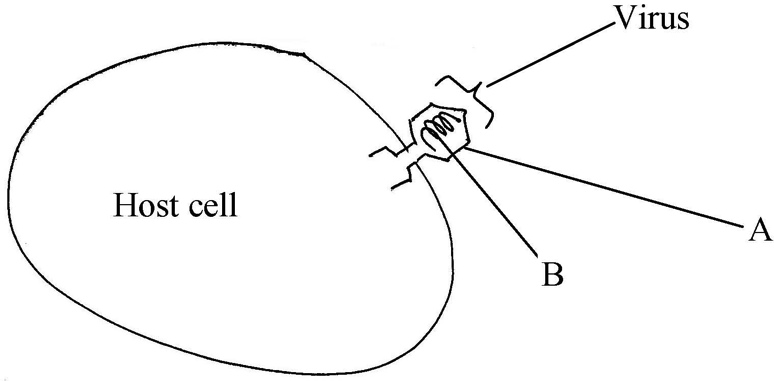
1. Viruses do not respond to antibiotics. Some **antiviral drugs** exist.

* **Interferon:** is a range of substances produced by virus-infected cells to protect healthy cells. It can be made artificially and can help to treat colds and viral hepatitis B.
* **ACV (Acyclovir)** helps to treat herpes (cold sore) virus – interferes with viral replication.
* **AZT** (Azidothymidine) has had some success in slowing the development of AIDS.

##### Section A

**2010 HL**

**6.** The diagram shows a virus attached to a host cell.



(a) (i) What is part A made of ? ………………………………………………………………………..

(ii) What is part B made of ? ………………………………………………………………………..

(b) Briefly describe how viruses reproduce ………………………………………………………………. ….……………………………………………………………………………………………………… …………………………………………………………………………………………………………. …………………………………………………………………………………………………………. ………………………………………………………………………………………………………….

(c) During 2009 swine flu spread through the population of many countries. Younger people

were more at risk of becoming ill with swine flu than older people. Using your

knowledge of the immune system, suggest a reason for this.

…………………………………………………………………………………………………......……

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Section C

**SEC Sample Paper HL**

**15.** Answer any two of (a), (b), (c). **(30,30)**

(c) (i) Comment on the difficulty of describing a virus as a living organism.

(ii) Name the two main chemical components of a virus.

(iii) Describe how virus reproduction takes place in a host cell.

(iv) Name a virus whose activity poses a major threat to human health. In the case of this virus explain the following:

1. How it is transmitted

2. How it affects the human body

3. How its spread is controlled.

**15.** Answer any two of (a), (b), (c). **(30,30)**

(a) (i) Comment briefly on the difficulty in classifying viruses as living organisms.

(ii) Name two diseases of humans caused by viruses.

**2007 HL**

**14.** Answer any **two** of (a), (b) and (c). (30, 30)

(b) (i) Comment on the difficulty of defining viruses as living organisms.   
(ii) What are the two main biochemical components of a virus particle?

(iii) Name two diseases caused by viruses.

(iv) Give an example of a beneficial application of a virus.

(v) What is an antibiotic?

(vi) Antibiotics should not be prescribed for a person suffering from a viral infection.

Suggest a reason for this.

[**Answer**](#_2007_HL_Q14(b))

**2008 HL**

**15.** (b) Just over fifty years ago the myxoma virus was brought to Ireland. The disease for which it is

responsible in rabbits, myxomatosis, quickly decimated the wild population. Now, however, the disease is much less common and is responsible for far fewer deaths.

(i) Why do you think that the rabbit population was decimated when the myxoma virus was first brought to Ireland?

(ii) Suggest a reason why myxomatosis is no longer a major threat to the Irish rabbit population.

(iii) The use of one species to control the population of another species is called biological control. Suggest **one** advantage and **one** disadvantage of biological control.

(iv) The human immunodeficiency virus (HIV) is responsible for AIDS in the human population. Would you expect a similar trend to that shown by myxomatosis as time passes? Explain your answer.

(v) Outline briefly how a virus replicates (reproduces).

**2009 HL**

**15.** (c)Write notes on three of the following topics:

(v) The economic and medical importance of viruses.

**2010 HL**

**12.** (c) **In your answer book**, say whether **each** of the following statements is true or false **and** give a reason

for your choice in each case:

**(24)**

**2013 HL**

**12.** (a) (i) A virus has been described as a piece of genetic material that has escaped from a cell.

Give one piece of evidence that supports this description.

(ii) Viruses are examples of obligate parasites. Explain why this is the case.

(iii) Give an example of how a virus might be beneficial to mankind.

**2009 OL**

**12.** (c) (i) Explain why it is difficult to classify viruses as living organisms.

(ii) Give the **two** main chemical components of a virus.

(iii) Briefly describe how viruses reproduce.

(iv) Give **one** way in which viruses are beneficial and **one** way in which they are harmful.

**(24)**

**2011 OL**

**15.** Answer any **two** of (a), (b0, (c) **(30,30)**

(c) The diagram shows the structure of a type of virus.



(i) Name the parts labelled A and B.

(ii) State two harmful effects of viruses.

(iii) What is meant by the term *immunity*?

(iv) The skin is an important part of our immune system.

Outline **two** ways in which the skin provides immunity.

(v) To help the immune system, many people receive vaccinations during their lifetime.

What is meant by the term *vaccination*?

(vi) Antibiotics are usually not given to a person suffering from a viral infection.

Suggest a reason for this.

Marking schemes

## 2010 HL Q6

|  |  |  |  |
| --- | --- | --- | --- |
| **6.** | (a) | A = protein;  B = Nucleic acid or DNA or RNA | **3**  **3** |
|  | (b) | Attachment / (viral) nucleic acid into (host) cell / uses host structures (or described) / part(s) replicated / virus assembly / release (or lysis)  ***Any three*** | **3(3)** |
|  | (c) | (Older people) previous exposure / antibodies (or active immunity or memory cells) | **3 + 2** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2004 HL Sample Q15 (c) | | | | |
| **15.** | (c) | (i) | Viruses are non-cellular/ no organelles/ only one type of nucleic acid/ no metabolism | **2(3)** |
|  |  | (ii) | Protein and nucleic acid ( either DNA or RNA) | **2(3)** |
|  |  | (iii) | Attachment/ (viral) nucleic acid into (host) cell/ uses host structures (or described)/ part(s) replicated/ virus assembly/ release (or lysis) | **3(3)** |
|  |  | (iv) | Swine Flu or any other appropriate, e.g. HIV, rabies, yellow fever   1. Droplet infection (or explained)/ contact with infected surfaces 2. Attacs the respiratory membranes/ high temperature 3. Good hand hygiene/ ‘catch it, kill it , bin it’/ antiviral drugs | **3**  **2**  **2**  **2** |

## 2005 HL Q15(a)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **15.** | | Answer any **two** of (a), (b) (c) | | | | | | | | |  | | | |
|  | | **(a)** | | | **(i)** | | | | non-cellular / one nucleic acid / can reproduce in host cell only or obligate parasite / do not possess organelles or named organelle  **any two** | | **2(3)** | | | |
|  | |  | | | **(ii)** | | | | Cold / ‘flu / polio / rabies / mumps / measles / AIDS (HIV) **any two** | | **2(3)** | | | |
|  | |  | | | **(iii)** | | | | B-cells/ T-cells or two named T cells e.g. helper / killer / suppressor / memory **any two**  ***B-cells***– produce antibodies/agglutination or lysis / memory  ***T-cells***– recognise / destroy infected or damaged cells / memory / activation / suppress immune system  **Helper T** – stimulate B cells or stimulate killer T cells/ recognise antigens /  **Killer T** – Destroy infected or damaged cells /  **Suppressor T** – Switch off immune system or explained /  **Memory T** – memorise antigen  **any two** | | **2(3)**  **2(3)** | | | |
| 2007 HL Q14(b) | | | | | | | | | | | | | | | |
|  | **(b)** | | | | **(i)** | | | obligate parasite or explained / non-cellular / can be crystallised / no  metabolism / one nucleic acid | | | | **2(3)** | | | |
|  |  | | | | **(ii)** | | | DNA or RNA or nucleic acid / protein | | | | **2(3)** | | | |
|  |  | | | | **(iii)** | | | smallpox / chicken pox / measles / polio / ‘flu / common cold / leaf  mosaic / others [*allow* AIDS or HIV] | | | | **2(3)** | | | |
|  |  | | | | **(iv)** | | | bacteriophage or used in genetic engineering or vaccine production or  vector (in disease treatment) | | | | **3** | | | |
|  |  | | | | **(v)** | | | substance produced by micro-organisms / that kills (some) microorganisms or bacteria or fungi | | | | **2(3)** | | | |
|  |  | | | | **(vi)** | | | (antibiotics) have no effect (on viruses) **or** promote resistant bacteria | | | | **3** | | | |
| 2008 HL Q15(b) | | | | | | | | | | | | | | | | |
|  | (b) | | | (i) | | | no immunity in population / suitable vectors (e.g. fleas) / rapid spread  **or** high population | | | | | | 2(3) | | | |
|  |  | | | (ii) | | | natural immunity **or** Natural Selection **or** virus mutated | | | | | | 3 | | | |
|  |  | | | (iii) | | | **advantage:**  environmentally friendly **or** specific **or** (may be) inexpensive  **disadvantage:**  upsets balance of nature (or described e.g. predator population will  fall when prey becomes scarce allowing prey to increase again **or**  introduced species may become a pest **or** predator may change to a  different prey) **or** (may be) expensive.  [Note: *allow* only one cost point] | | | | | | 3  3 | | | |
|  |  | | | (iv) | | | Yes + plausible answer **or** No + plausible answer | | | | | | 6 | | | |
|  |  | | | (v) | | | attaches to (host) cell / introduces nucleic acid (DNA **or** RNA) /  (host) DNA inactivated / viral DNA **or** RNA replicated / using  resources of host cell / protein coat formed / assembly (of virus) | | | | | | 3(3) | | | |
| 2009 HL Q15(c) | | | | | | | | | | | | | |  | | | |
| **15.** | | | (c) | | |  | | | | | | | | ***Any three* 3(4+3+3)** | | | |
|  | | |  | | | (v) | | | | ***At least one from each category:***  *Economic importance*: Crop damage / example of viral crop  disease / animal disease / example of viral animal disease / human medical costs  *Medical importance*: Human diseases / examples of viral human  diseases / used in medical research / | | | |  | | | |

## 2010 HL Q12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **12** | (c) | (iv) | True  Premature death of parents **or** poor living conditions  **or** poor health care **(**or example) **or** poor education  **or** an example of a cultural reason | **3**  **3** |

## 2013 HL Q12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **12.** | (a) | (i) | Composed of nucleic acid (or DNA or RNA) | **3** |
|  |  | (ii) | Can only replicate (or reproduce) inside a cell (or host) | **3** |
|  |  | (iii) | Genetic engineering **or** vaccine (production) **or** cancer treatment **or** pest control **or** disease control | **3** |

## 2009 OL Q12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 12 | (c) | (i) | Non-cellular / Only one type of Nucleic Acid / Don’t show characteristics of living things **Any one** | **3** |
|  |  | (ii) | Protein (coat) / DNA or RNA | **2(3)** |
|  |  | (iii) | Entry / Use cell’s components / Synthesis / Assembly / Release  **Any three**  Replication (using) / host – allow 2(3) only | **3(3)** |
|  |  | (iv) | Beneficial – Disease control / specific example **Any two**  Harmful – Cause diseases / specific example | **3**  **3** |

## 2011 OL Q15(c)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **15.** | (c) | (i) | A = nucleic acid (or DNA or RNA);  B = protein/coat | **2(7) + 8(2) 2(Pts)** | |
|  |  | (ii) | Two harmful effects (Any two viral diseases) | | **2(Pts)** |
|  |  | (iii) | Defence against disease | | **1(Pt)** |
|  |  | (iv) | Barrier / sweat / scabs | | **2(Pts)** |
|  |  | (v) | ‘Safe dose’ of a pathogen / causing antibody production **or** causing an immune response | | **2(Pts)** |
|  |  | (vi) | Antibiotics have no effect on viruses | |  |