



The Biology of HIV

HIV is on all A level specifications. Exam questions are common and relatively straightforward. You simply need to learn a few facts and then practice applying this knowledge to the type of questions which keep coming up. This Factsheet summarises:

- The structure of the human immunodeficiency virus (HIV) and its replication.
- the roles of social, economic and biological factors in the prevention and control of AIDS

KEY FACTS

- **Acquired Immune Deficiency Syndrome (AIDS)** is caused by the Human Immunodeficiency Virus (HIV).
- HIV is a retrovirus
- The HIV virus binds to special receptors, called CD4 receptors, which are on the surfaces of specific white blood cells known as helper T-cells
- There are millions of different families of T-cells and each family is designed to fight a specific type of pathogen
- When HIV reduces the number of T-cells, some of these families can be totally wiped out, thus the ability to fight off these pathogens is lost
- Thus, the immune response is weakened
- This **immunodeficiency** exposes the infected person to infection by other pathogenic (disease-causing) organisms
- These pathogens cause **opportunistic infections** - so called because they usually only affect people whose immune system is weakened.
- These infections eventually result in death
- **AIDS (acquired immune deficiency syndrome)** is the name given to this **collection** of unusual, opportunistic diseases
- The virus can remain latent for many years before it is activated

Typical Exam Question

Explain how infection by HIV could increase the risk of a person developing a disease such as tuberculosis. (1 mark)

Markscheme

HIV affects cells of immunological system / white blood cells / helper T- cells/lack of functional white blood cells / means a person is more susceptible);

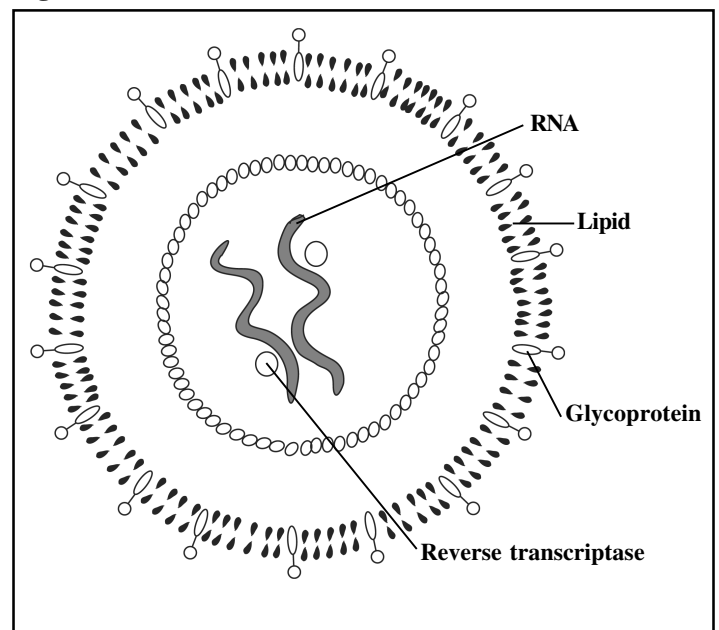
Reject "affects immune system"

Note: general responses such as "affects immune system" are specifically rejected. Be precise, or you will not get the mark.

Here is an extract from the Chief Examiner's Report on this question: "Candidates failed to state clearly that HIV affects white blood cells, or specifically T-lymphocytes, and hence reduces the ability to combat infection. Most candidates made blanket statements about weakening the immune system, for which no mark was given".

Fig 1. below shows the structure of a human immunodeficiency virus (HIV).

Fig 1 HIV Virus

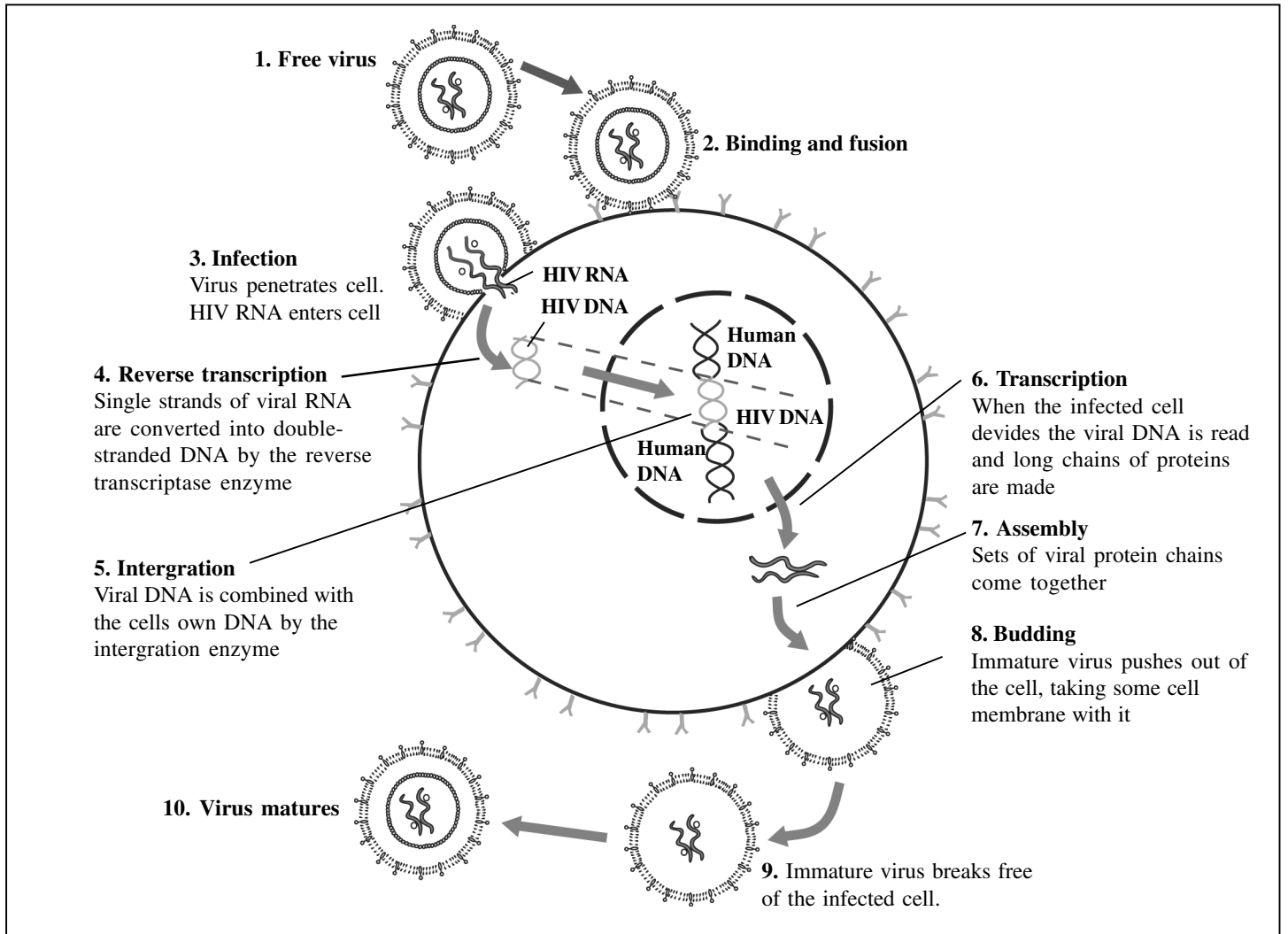


How HIV replicates and causes AIDS

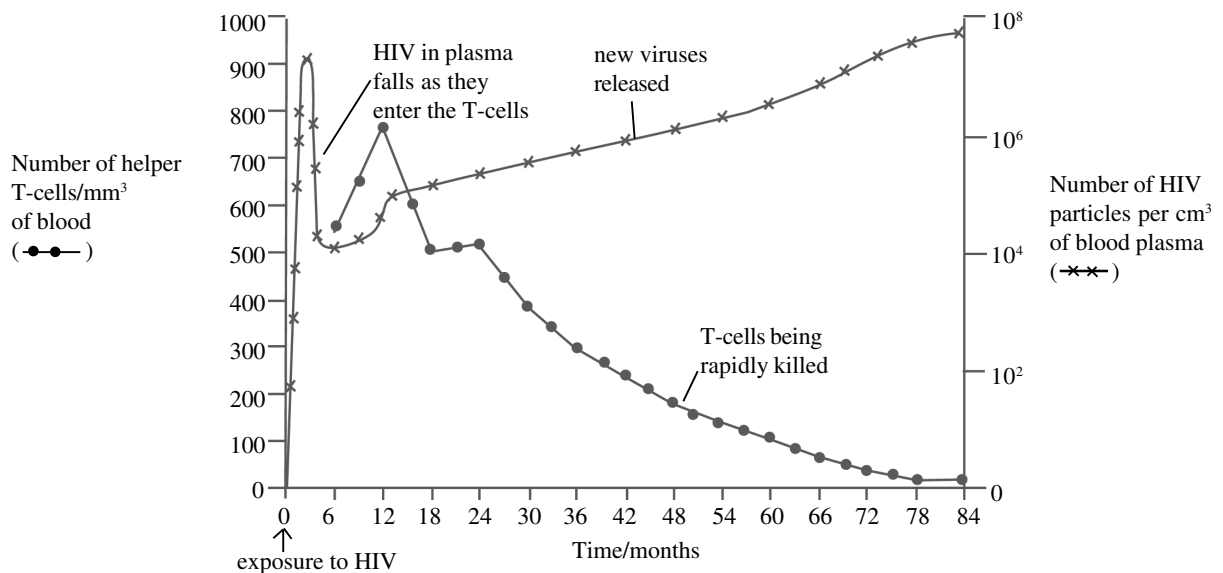
- The glycoprotein on the outer surface of the virus attaches to receptors on the host cell
- The lipid bilayer of the virus then **fuses** with the host cell's membrane and the virus enters the host cell
- The viral enzyme **reverse transcriptase** stimulates the cell to make viral DNA from the viral RNA template
- This viral DNA is then inserted into the host cell's chromosomes
- The viral DNA then codes for the production of thousands of new viruses
- Eventually, these burst out of the cell, killing it
- These viruses then infect other cells
- These include helper T – cells. These are part of the immune system. The immune system is weakened and opportunistic infections result
- Thus, AIDS is not a single disease, but a descriptive term for the opportunistic infections
- People who develop AIDS often die from Kaposi's sarcoma, a rare cancer itself caused by a virus.

Fig 2 summarises the life cycle of HIV.

Fig 2. Life cycle of HIV



The graph shows some of the changes in the blood of an AIDS patient after infection with HIV.



How HIV is transmitted between people**Transmission is by transfer of body fluids:**

- semen
- blood transfusions
- transplants
- contaminated needles
- across placenta
- in mother's milk

Exam Hint :- Many candidates believe that HIV enters the body through cuts or wounds and fail to explain that contaminated blood needs to be present.

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Tackling AIDS

The virus enters cells throughout the body – intestines, brain, skin, retina, liver and, of course, T lymphocytes. Every time one of these cells replicates, the viral DNA is replicated also.

People suffering from HIV infection need to take a cocktail of antiviral drugs

The arrangement of proteins on the outer coat of the virus keep changing – making it extremely difficult to develop a vaccine. There are now many different strains of AIDS virus around the world and the virus is still mutating to form even more.

The first class of anti-HIV drugs was the nucleoside reverse transcriptase inhibitors, also called “nukes”. These drugs work by blocking the action of reverse transcriptase (step 4 in Fig 2), where the HIV genetic material is converted from RNA into DNA. AZT is an example of this type of drug.

However, one type of drug is unlikely to be effective against HIV. When HIV multiplies, most of the new copies are mutations: they are slightly different from the original virus. Some of these mutations will be resistant to the drug.

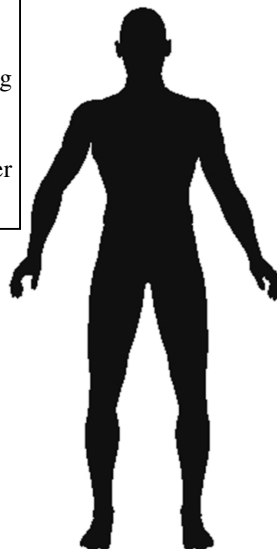
Thus the strategy is to use several drugs which attack HIV at different points in its life cycle, reducing the chance of resistance.

Tackling aids requires an understanding of:

- the biology of HIV
- economic factors affecting its transmission
- social factors affecting its transmission

Biological factors

HIV is slow –acting, there can be a very long incubation period eg 10 years –with no outward signs anything is wrong
There is no cure
There are multiple transmission methods, all involving body fluids
Maternal transmission to foetus impossible to stop
HIV makes people more susceptible to many other infections eg TB

**Social factors**

Some sections of society are intolerant of pre-marriage sex/ homosexuality/casual sex
Successful sex education will mean greater abstinence/greater use of condoms
Birth control not supported by Catholic Church
Providing sterile needles may make drug-taking seen as acceptable
Only accurate detection method is to check blood sample –difficult in rural areas/difficult to persuade people to come forward for what they see as no reason/can be seen as infringing civil liberties
Some members of certain groups of individuals have been/continue to be promiscuous eg prostitutes/tourists/long-distance lorry drivers
People may be ignorant of symptoms or be in denial
HIV+ individuals may feel stigmatised and not come forward for treatment
Deliberately infecting others may lead to prosecution thus individuals are reluctant to come forward

Economic factors

HIV infection is widespread
Tracing people's contact with HIV+ individuals can be extremely difficult
Checking and tracking extremely expensive