The University of Reading

Control of Biological Hazards

Safety Guide Number 14 Part 3

Hazard Categorisation of Biological Agents

Safety Guide 14, Part 3:

Hazard Categorisation of Biological Agents

Contents

Malcolm Iosson
University Biological Safety Officer
Health and Safety Services

Ext. 8887

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This Safety Guide forms one part of a series that together provide guidance on the control of Biological Hazards, *Safety Guide 14*. Part 5 sets out management responsibilities and identifies the controls and procedures that must be followed by all who work with, or may be exposed to, biological agents.

1 Hazard Characterisation of Biological Agents

Biological agents may be categorised into one of four Hazard Groups based on their hazards to human health. The categorisation scheme is mainly based on the infection risks that biological agents present to humans, but also takes into account allergenic, toxic or other hazards. The availability of effective treatment or prophylaxis is an essential component of the scheme. The Health & Safety Commission has approved a list of biological agents ("The Approved List") that was prepared and published by the Advisory Committee on Dangerous Pathogens (ACDP) as an adjunct to the Control of Substances Hazardous to Health Regulations. The current Approved List is available on-line at http://www.hse.gov.uk/pubns/misc208.pdf. (Reference 1)
ACDP has also published guidance on the physical and procedural requirements to allow safe working with biological agents, with emphasis on Hazard Categories [Containment levels] 2 and 3 (Reference 2).

1.1 The Hazard categorisation scheme

The main considerations used in preparation of the Approved List were:

- Is the organism pathogenic for humans?
- Is it a hazard to laboratory workers?;
- Is it transmissible to the community at large? and
- Is effective prophylaxis or treatment available?

The categorisation scheme is based on the risks to the health of a "normal" healthy population. It does not take into account the fact that certain individuals may be more at risk, for example, due to a pre-existing medical condition (disease; compromised immunity; the effects of medication, pregnancy, etc.). For this reason, people who may be more at risk are advised to consult their medical practitioner or the University Occupational Health provider on the advisability of starting or continuing with work involving possible exposure to biological agents.

Organisms in the higher hazard categories (Hazard Groups 3 and 4) present a significant hazard to the wider community because of the ease with which the organisms can spread from the original infected individual. This may be a consequence of a low infectious dose, and/or high survival and transmissibility. The availability of effective treatment or prophylaxis can ameliorate the consequences of exposure - thus, most bacterial infections can be effectively treated with antibiotics, and some can be prevented by use of appropriate vaccines. By contrast, there are very few effective antiviral agents, and prior vaccination is normally required to help protect the individual. Vaccination is only available for the more common virus diseases at present. Note that all known Hazard Group 4 agents (Section 3.2) are viruses.

In general, the hazard the organism presents is related to the ability of the organism to infect and colonise the human body, and cause deleterious effects during the process. However, it must not be forgotten that some microorganisms may cause severe deleterious effects without infecting the body, due to the intrinsic properties of one or more components of the organism. For example, fungal spores may be highly allergenic, and may induce asthma and/or other allergenic

responses in sensitised individuals. Responses to exposure include anaphylactic shock, which may be life threatening. When the risk assessment is undertaken, such properties must be taken into account.

Because the nature of allergenicity is not properly understood (either in terms of knowledge of molecular features that render a particular substance allergenic, or those factors that might render a particular individual liable to be sensitised), it is therefore important to **minimise exposure to all microorganisms**, especially by the airborne route.

1.2 Hazard Categories

Full details of the hazard categories (groups) for biological agents are given in References 3/ 3a. A condensed list of the agents in Hazard Groups 2 and 3 is given in tabular form in Appendix 1 to this Guide. Hazard Group 1 agents are not listed, as they are regarded as being "unlikely to cause disease" (by infection - *see below.)*

Definitions, with examples, of each of the hazard categories are as follows:

a) Hazard Group 1

"*a biological agent considered unlikely to cause human disease*" (by infection).
Organisms assigned to hazard Group 1 are not listed in Reference 1, but it should not be assumed that, because an organism is not listed, it automatically falls into Hazard Group 1.

- Containment level 1 required (*See Reference 3/ 3a and Appendix 4 for details.)*
- Example organism: *Lactobacillus spp*. (widely used in food fermentations).

Note that, although biological agents in Hazard Group 1 are defined as those "*unlikely to cause human disease*"[by infection], they should still be regarded as potentially hazardous for reasons of allergenicity, toxicity, etc.

b) Hazard Group 2

"*a biological agent that can cause human disease and may be a hazard to employees; it is unlikely to spread to the community, and there is usually effective prophylaxis or effective treatment available*".

- Containment level 2 required (*See Appendix 4*)
- *Example:* Measles virus,
  where although there may be adverse consequences of infection for an infected individual, an effective vaccine is available.

Any human tissues/ cultures should **always** be regarded as Hazard Group 2, **unless** there is sufficient evidence to warrant a downgrading to Hazard Group 1. This classification is irrespective of the possibility of contamination of the cells by other biological agents, such as *Mycoplasma* or viruses, and is based on the theoretical potential that such cells could establish themselves within the human body. For transformed and immortalised human cell lines, this is a distinct possibility.

c) Hazard Group 2

"A biological agent that can cause severe human disease and presents a serious hazard to

employees; it may present a risk of spreading to the community, but there is usually effective prophylaxis or treatment available".

- Containment level 3 and specific, validated training and approval by the Occupational Health Service is required:

  In the University, no person is allowed to work intentionally with a Hazard Group 3 agent without the prior approval of the Biological Safety Officer (BSO). *See Safety Guide 14, Part 1 for University procedures for this category of work.*

- Example organism: *Mycobacterium tuberculosis*, the causative agent of tuberculosis. Infections can be prevented (in 60 - 70% of cases) by prior vaccination with BCG vaccine, and can normally be treated with a 3-drug regime over a period of several months. However, serious permanent damage may be done to infected individuals even if the infection is cured. Death will follow if the infection is not cured or contained.

- All new projects involving the intentional use of Hazard Category 3 agents must be approved by the Sub Committee for Biological Safety, and notified to the Health and Safety Executive **before work can commence.**

Note that certain types of work may carry the risk of **incidental exposure** to Hazard Group 3 agents. A detailed risk assessment should be undertaken, concentrating on possible risks to health, the likelihood of exposure, and any required control measures. *See Safety Guide 14, Part 6: Incidental Exposure to biological agents.*

d) Hazard Group 4

"*A biological agent that causes severe human disease and presents a serious hazard to employees, it is likely to spread to the community, and there is usually no effective prophylaxis or treatment available*". **This is the highest hazard category**.

- **Maximum (Containment level 4) and specific training required.**

- HSE must approve all facilities, and all proposals to work with hazard group 4 agents. (Individual notification of proposals required.)

- *Example*: Ebola virus (all known Group 4 agents are viruses.)

Containment level 4 facilities do not exist in the University, and no proposal to work with such agents will be entertained in any circumstances.

e) "Scheduled Agents"

Additional requirements apply to named biological agents that are listed in Part V of Schedule 3 to the COSHH Regulations (*See Reference 2*). These agents include **all Hazard Group 3 and Hazard Group 4** agents, plus named organisms in Hazard Group 2 (*Bordetella pertussis*; *Corynebacterium diphtheriae* and *Neisseria meningitidis*.) "First use" of any agent on the list must be notified in advance to the Health and Safety Executive, together with specified details of the notifying organisation and a copy of the risk assessment. Work may not begin until the HSE has acknowledged receipt of the notification; any subsequent changes which render a previous notification invalid must also be notified.

2 Intentional work with Biological Agents: hazard categories and containment facilities

The **minimum requirement** for intentional work with any microorganism is that of "containment facilities" and procedures which are appropriate to the organisms in use, and are sufficient to control the risks of the activities. The higher the hazard category of the organism, the more stringent are the controls – the Containment Level of the laboratory is numerically equal to the hazard category of the organism – thus work with a hazard Category 3 organism may only be undertaken in a Containment Level 3 laboratory.

The **intentional use** of **all** microorganisms in a laboratory should comply with the requirements of the University good practice leaflet "Good Microbiological Laboratory Practice" (GMLP) and "Good Occupational Safety and Hygiene" (GOSH – *see Safety Guide 14 Part 5, Section 5*) as a minimum. GMLP techniques are designed both to protect the worker and to minimise contamination of the work by unwanted microorganisms. GOSH practices are designed to protect the worker and others who may be affected by the work, and to minimise escape of organisms into the workplace.

(The GMLP leaflet may be downloaded from the University Good Practice Leaflets page of the Health & Safety Service website, http://www.rdg.ac.uk/safety/documents/GoodPracticeLeaflets/gmlp.doc) . The leaflet is also available as Appendix 2 to Part 5 of Safety Guide 14. The use of GMLP/ GOSH alone is normally equated to Containment Level 1 (the lowest level).

The majority of work with biological agents within the University is expected to be with agents in the first two categories, *i.e.,* Hazard Groups 1 and 2. All projects involving the intentional use of Hazard Group 2 agents are subject to approval by the Sub Committee for Biological Safety – *see Safety Guide 14, Part 1: University procedures.*

Anyone proposing to undertake work with **any Hazard Group 2 agent** should therefore discuss their proposals with the BSO at the earliest opportunity. An appropriate form of health surveillance will be required for all workers on the project. In some cases, prior notification of new work must be made to the Health & Safety Executive.

Procedural aspects of "Intentional work" are dealt with in Part 1, Section 2; **practical aspects** are dealt with in Part 5.

Note that some Category 2 agents[1] have been shown to present **an enhanced risk to workers, and should always be handled in a microbiological safety cabinet**. In some cases, gloves and/or eye protection should be used routinely. This group of agents includes organisms such as:

Borrelia burgdorferi [causative agent of Lyme disease] and other *Borrelia spp*.;

Neisseria meningitidis [one of the causes of bacterial meningitis];

Leptospira interrogans (causative agent of Weil's disease/ leptospirosis) and

Legionella pneumophila (causative agent of Legionnaire's disease)

***Clostridium botulinum*

Corynebacterium diphtheriae

[1] These agents were referred to as "2+" agents in the 1995 edition of the ACDP guidance, where the "+" sign was used to indicate an enhanced level of infectivity by the aerosol route. This nomenclature was however never incorporated into the Approved List, and only appeared in Appendix 2 to the 1995 Edition of the "*Categorisation of biological agents*" document, which has now been withdrawn.

***Vibrio cholerae*

For agents that are "listed" in Schedule 5 of the Anti-terrorism, Crime and Security Act 2001 (Reference 3) additional restrictions apply, including complying with official recommendations regarding security of the agents [marked **"**"** on the above list]. Any proposals to acquire such listed agents must also be notified to the Home Office. (Note that the Schedule also applies to specified toxins, and to nucleic acid molecules coding for such toxins.)

Anyone wishing to undertake work with any of the scheduled agents should discuss their plans with the BSO **before** submitting a project proposal. (*NB: only those in Hazard Category 2 or 3 would be permitted).*

3 Nomenclature of biological agents and record keeping

The names of microorganisms (especially bacteria) are liable to change as more information is gained about taxonomic relationships, etc. This may result in a particular biological agent being overlooked (and possibly misidentified as Hazard Group 1) because it does not appear in the current lists of biological agents.

- For example, the Hazard Group 2 pathogen *Moraxella catarrhalis* was formerly known as *Branhamella catarrhalis.* This species is not listed by ACDP (and could therefore mistakenly be presumed to be Hazard Group 1).

It is therefore important to check whether there are any synonyms for a particular microorganism when assigning it to a hazard group. Such a check could be done, for example, by checking with the on-line catalogues of the major culture collections such as the National Culture of Industrial Bacteria (NCIB); the American Collection of Type Cultures (ATCC) or the Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ).

The laboratory supervisor should maintain an inventory of all biological agents that are stored or used within his/ her laboratory. (See SG14, Part 1 *University Procedures*) (This requirement also applies to samples liable to be contaminated by biological agents in hazard categories 2 or 3.) Previously, a list of biological agents maintained within the laboratory should have been posted on the door of the laboratory, but this is not now recommended for security reasons. However, anyone who is authorised to enter the laboratory should either be given a copy of the list, or be informed of the risks that the organisms present to personnel. In general, the former would apply to those who work with the agents in the laboratory, and the latter would apply to those such as lab. attendants, cleaners or maintenance personnel who do not work with microorganisms.

3.1 Note on the Categorisation of Poliovirus

Poliovirus is presently categorised as a Hazard Group 2 agent (Reference 1). The World Health Organisation has proposed that Polio be reclassified, initially as a Hazard Group 3, but ultimately as a Hazard Group 4 agent. This has major implications in terms of the containment facilities required. The proposal for reclassification arises from the plan for global eradication of Poliovirus by vaccination. Eradication is now a realistic prospect, with the last (to date) recorded infection from "wild" polio in Europe being reported in 1998. It is likely that, following eradication there would be a general decline in immunity levels worldwide, as the need for (and practise of) vaccination would disappear. In such a situation, the "escape" of the wild-type virus from a laboratory could have a devastating effect. It has therefore been proposed that the wild-type virus should only be maintained in the conditions of highest security, *i.e.,* Containment

level 4. **Consequently, all materials containing, or suspected to contain wild-type poliovirus (at the University) must be destroyed before this re-categorisation is put into effect** (date as yet unknown). Additionally, it is proposed that **vaccine strains** of Poliovirus be designated Hazard Category 3, although they do not fit in with the normal criteria for such a classification.

In addition to actual stocks of poliovirus (whether wild-type or vaccine strains), it is possible that the wild-type virus could be present in "environmental" samples taken and stored for other purposes. Samples liable to be contaminated with poliovirus would include:

- Human faecal samples;
- water and sediments from rivers, especially those collected downstream of a sewage works, or
- other samples liable to have been contaminated by human sewage

from areas/ times when "wild-type" poliovirus was known to be in circulation.

The Public Health Laboratory Service has conducted a survey of laboratories in the UK, with a view to identifying those Institutions and laboratories that may be "harbouring" poliovirus. This includes "intentional storage" (as virus stocks or wild-type genetic sequences, including capsid sequences) or "unintentional storage" as contaminated "environmental" samples. The survey has shown that the University is not holding any Poliovirus, or environmental or samples suspected of harbouring polio-related material. It is **important to maintain this status. This is particularly relevant to any person who is considering importing such material (such as sewage sludge or soil) from areas where Poliovirus is circulating, and thus liable to contamination.** Any laboratory supervisor who requires further advice on these issues should contact the Biological Safety Officer.

3.2 Unclassified agents

No published list of biological agents can ever be complete or exhaustive. All employers are required to assign any unlisted agents to a provisional hazard grouping, according to criteria set out in paragraph 2(2) of Schedule 3 of COSHH (Reference 2). Please contact the Biological Safety Officer for advice and assistance if required.

If any information is obtained which suggests that an "unlisted agent" could be allocated to either Hazard Group 3 or 4, work must be stopped immediately, and this information discussed with the Biological Safety Officer without delay.

If a provisional categorisation is confirmed, details must be notified as soon as possible to the Health and Safety Executive (HSE) via the Health & Safety Services office (extension 8888). Any agent allocated to Hazard Group 4 must be safely destroyed as soon as possible. Agents allocated to Hazard Group 3 must be stored safely in appropriate containment facilities pending a comprehensive review of the proposed work, having regard to the allocated classification. Work may not restart until the BSO has examined the information and given his express permission.

References

1 *The Approved List of Biological Agents.* Health and Safety Executive/Advisory Committee on Dangerous Pathogens. 2004 Edition available via http://www.hse.gov.uk/pubns/misc208.pdf

2 *Control of Substances Hazardous to Health Regulations* 2002 as amended. Approved Code of Practice and Guidance. ref. L5.2005. ISBN 0-7176-2981-3, HSE Books, Sudbury, Suffolk.

3 *The Anti-Terrorism, Crime and Security Act 2001*. Chapter 24, Schedule 5. HMSO 2001.

Appendix 1 Approved List of Biological Agents

The following lists of biological agents are adapted from those given in the ACDP "Approved List" of biological agents (Reference 1 in SG14 Part 3). However the lists given below do not include any Hazard category 4 agents, as no work with such agents is permitted at the University. Any agent not listed here should initially be checked against the official lists, and also take into account possible changes in nomenclature. (The names of biological agents, especially bacteria, are subject to change, and any unlisted agent should not automatically be assumed to be in hazard category 1.) Unlisted agents should be assessed for hazard by reference to any known or suspected pathogenic properties. If in doubt, please contact the Biological Safety Officer on extension 8887.

The following key is used in all the lists:
A: Known allergenic effects.
D: A list of workers exposed to this agent should be kept for 40 years following the last known exposure.
V: an effective vaccine is available.
T: Toxin production.
E: Eye protection should be used.
G: gloves should be used.
S: a safety cabinet should be used.
$: Use of a safety cabinet is not essential.
X: exemption certificate applies.

It should be noted that certain "VTEC[2]" strains of *E. coli* are included in Hazard Category 3, whereas other "wild-type" pathogenic strains of this organism are regarded as Hazard Category 2. There is evidence that *O157H7* presents a **serious hazard to laboratory workers**. The hazard is created in part by the low "infectious dose", and partly by the nature of the toxin secreted by the organism. HSE have included these strains in the Exemption[3] certificate so as to allow a partial derogation from full containment level 3 conditions.

Specific Hazard Category 2 agents which present an enhanced risk of infection by inhalation ("2^{+}" agents) should **always** be used in a safety cabinet, or be otherwise suitably contained; in some cases gloves and/or eye protection should be used routinely. These are indicated by the superscript **"+SGE"** in the lists.

Where the abbreviation "*spp*." is used in a list, one or more species of that genus is listed as a "biological agent" of the relevant category. See Reference 1 in SG14 Part 3 for more details. Where the lists in Reference 1 also use this term, all such species should be regarded as being of the relevant hazard category **unless proved otherwise**.

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[2] "VTEC" strains, ie., Vero (cell) cytotoxic E. coli, produce a Shiga-like protein toxin. Infections can cause serious, life-threatening disease Disease signs include kidney failure and "HUS" - haemolytic uraemic syndrome, characterised by the presence of blood in the urine.

[3] The certificate exempts an employer from the requirement to adopt the minimum containment level (level 3), provided that they comply with the conditions of containment and the recommended control measures specified in HSE guidance documents, especially Reference 1, and *"Protection against blood-borne infection in the workplace – HIV and hepatitis"* (Ref. 2) and *"Precautions for work with animal and human transmissible spongiform encephalopathies"* (Ref. 3). The latter two publications have been partially superseded by Ref. 4, "*Biological Agents: Managing the risks in laboratories and healthcare premises.*"

For example, the group of Hazard Category 2 agents includes the named species of *Clostridium botulinum*; *Cl. perfringens* and *Cl. tetani*. The list also includes the term *"Clostridium spp.",* which means that all species of *Clostridium* not specifically identified must be regarded as being hazard category 2, unless proven otherwise.

All strains of one of the named species of a hazardous organism must always be regarded as being hazardous, unless there is definitive proof that all the genes involved in pathogenesis have been permanently removed or inactivated. For example, most laboratory strains of *Escherichia coli* are generally accepted as being Hazard Category 1 because there is a long history of their safe use in the laboratory, whereas wild-type E. coli is in hazard category 2 (or 3 – see above.)

Note also that the classification refers to the hazard that the agents present to humans: for many microorganisms, the risk to animals or plants may well differ, and the organism may therefore present a high "environmental" hazard that is not reflected by the Biological Agent category. A good example of this is Foot and Mouth Disease Virus, FMD, which is not regarded as a biological agent as it very rarely infects humans, but requires Containment Level 4 conditions as it presents an extreme hazard to cattle, sheep and pigs. Where work is intended with an organism not listed, the project supervisor should check with the Department for Environment, Food and Rural Affairs (DEFRA) regarding any controls exist over the use of the agent. In some cases, especially of non-indigenous pathogens, a licence may be required to acquire the organism, and laboratory facilities will be subject to inspection by a Government Inspector.

References

1. *The Management, Design and operation of microbiological containment laboratories.* Advisory Committee on Dangerous Pathogens [Health & Safety Commission/ Department of Health]. HSE Books, Sudbury, Suffolk, 2001. ISBN 0 7176 2034 4.
2. *"Protection against blood-borne infection in the workplace – HIV and hepatitis"* . Advisory Committee on Dangerous Pathogens. HMSO London, 1995. ISBN 0-110321953-9
3. *BSE (Bovine Spongiform encephalopathy).* Advisory Committee on Dangerous Pathogens. HSE Books, Sudbury, Suffolk, 1996. ISBN 0 7176 1212 0.
4. *"Biological Agents: Managing the risks in Laboratories and Healthcare premises*". Advisory Committee on Dangerous Pathogens [Health & Safety Commission/ Department of Health/ DEFRA] published by HSE – http://www.hse.gov.uk (Web only)

Hazard Category 3

Bacillus anthracis[V]	*Mycobacteria spp.*[V] *inc.*
Brucella abortus [and other Brucella spp.]	*bovis;*
Burkholderia mallei + pseudomallei	*leprae;*
Chlamydia psittaci [avian strains]	*simiae and tuberculosis*
Coxiella burnetii	*Rickettsia spp [including akari.]*
Ehrlichia sennetsu [+ other Ehrlichia spp.]	*Salmonella paratyphi A, B, C*[$ X,] *and S. typhi* [V$X]
Escherichia coli VTEC strains [T$[X]]	*Shigella dysenteriae (type 1)* [T$X]
Francisella tularensis[V]	*Yersinia pestis* [V]
Mycobacterium africanum [V]	

Fungi

Blastomyces dermatitidis	*Paracoccidioides brasiliensis*
Coccidioides immitis	*Penicillium marneffei*
Histoplasma capsulatum [3 varieties]	

Parasites

Echinococcus spp., inc. vogeli[X] *granulosus*[X] *and multilocaris*[X]	*Trypanosoma brucei rhodesiense, and T. cruzi*
Leishmania braziliensis[X]*, and L. donovani*[X]	*Plasmodium falciparum*[X]
Naegleria fowleri	*Taenia solium*[X]

Viruses

Arenaviridae: *LCM*	*Poxviridae: Monkeypox*[V]
Bunyaviridae: Hantaan; Seoul and many other Bunyaviruses including Phleboviruses- Rift Valley fever[V] *Nairoviruses – Bhanja*	*Retroviridae: including H.I.V*[X]*. H.T.L.V*[X]*.*
Caliciviridae: Hepatitis E[X]	*Rhabdoviridae: Rabies*[V]
Hepatitis C group: Hepatitis C[DX]	*Togaviridae - many alphaviruses including: Chikungunya; Eastern equine encephalomyelitis*[V] *Western equine encephalomyelitis*[V]
Hepadnaviridae: Hepatitis B[VDX]	*Herpesviruses: Herpes simiae [Herpes Simian B virus]*
Hepatitis D[VDX] *[Delta agent]*	*"Unconventional" (Prion) Agents associated with: CJD*[DEX]*, BSE*[DEX] *Kuru*[DEX] *and GSS*[DEX]
Flaviviridae: many including Dengue,: Yellow Fever[V] *Japanese B encephalitis*[V] *St. Louis encephalitis West Nile Fever*	

Hazard Category 2

Bacteria

Acinetobacter spp., inc. calcoaceticus	*Haemophilus spp.*
Actinomyces spp.	*Helicobacter pylori*
Aeromonas hydrophila	*Klebsiella spp.*
Alcalagines spp.	*Legionella spp.inc. pneumophila*[+SGE]
Arizona spp.	*Leptospira interrogans*[+SGE]
Bacillus cereus	*Listeria spp*
Bacteroides spp.	*Mycobacterium spp. [except those in Group 3]*
Bartonella spp.	*Mycoplasma spp.*
Bordetella spp., inc. *pertussis*[V]	*Neisseri a spp.*, inc. *meningitidis*[V+SGE]
Borrelia spp.+SGE	*Nocardia spp*
Burkholderia spp.	*Pasteurella spp.*
Campylobacter spp.	*Providencia spp.*
Chlamydia spp.[+SGE]	*Pseudomonas aeruginosa*
Clostridium spp., inc. *tetani*[TV]; *botulinum*[TV+SG]	*Shigella spp. [except Type I dysenteriae.*]
Corynebacterium spp., inc. diphtheriae[TV+SGE]	*Staphylococcus aureus*[T]
Enterobacter spp.	*Streptobacillus moniliformis.+SGE*
Enterococcus spp.	*Streptococcus spp.*
Escherichia coli [with the exception of non-pathogenic or VTEC strains.]	*Treponema .+SGE spp.*
Francisella tularensis [Type B]	*Vibrio spp. inc. cholerae TV+SGE*
Fusobacterium spp.	*Yersinia spp*

Fungi

Aspergillus fumigatus[A]	*Madurella spp*
Candida spp., inc. albicans[A]	*Microsporum spp*[A].
Cryptococcus neoformans[A+SGE]	*Neotestudina rosatii*
Emmonsia parva	*Sporothrix schenkii.+SGE*
Epidermophyton floccosum[A]	*Trichophyton spp.*
Fonsecaea spp.	*Xylohypha bantiana*

Parasites

Acanthamoeba spp.	*Mansonella spp.*
Ancylostoma duodenale	Onchocerca volvulus
Angiostrongylus spp.	*Opisthorchis spp*
Ascaris spp.	*Paragonimus spp.*
Blastocystis hominis	*Plasmodium spp.* [except *falciparum*]
Brugia spp.	*Schistosoma*[G] *spp.*
Capillaria spp.	*Strongyloides spp.*
Cryptosporidium spp.	*Taenia saginata*
Cyclospora spp.	*Toxocara spp.,* inc. *canis*
Entamoeba histolytica	*Toxoplasma gondii*
Enterobius vermicularis	*Trichinella spp.*
Fasciola spp..	*Trichomonas vaginalis*
Giardia spp.	*Trichostrongylus spp.*
Heterophyes spp.	*Trichuris trichiura*
Hymenolepis spp.	*Trypanosoma spp.* including *brucei brucei, brucei gambiense* and

	rangeli.
Leishmania spp.	*Wucheria bancrofti*
Loa loa	

Viruses

Adenoviridae	*Paramyxoviridae:* *Measles* **V** *Mumps* **V** *Newcastle disease* **E** *Parainfluenza [types 1 -4]* *Respiratory syncytial virus*
Arenaviridae [*excluding those in Group 3*]	*Parvoviridae:* *human parvovirus B1*
Astroviridae	*Picornaviridae: including:* *Coxsackie viruses* *ECHO viruses* *[4]Polioviruses* **V** *Rhinoviruses* *Hepatitis A* **V**
Bunyaviridae [*excluding those in Group 3 or 4*]	*Poxviridae: including* *Buffalopox* *Cowpox* *Vaccinia* *Orf* *Yatapox*
Caliciviridae, [*including Norwalk virus*.]	*Reoviridae: including* *Human rotaviruses* *Orbiviruses* *Reoviruses*
Coronaviridae	*Rhabdoviridae: including* *Vesicular stomatitis virus* *Duvenhage*
Flaviviridae [*excluding those in Group 3 or 4*]	*Togaviridae:alphaviruses,* *[excluding those in Group 3], but including:* *Semliki forest virus* *Sindbis* *Ross River*
Herpesviridae - including: *Cytomegalovirus;* *Epstein-Barr virus;* *Herpes simplex I & II;* *Herpes varicella-zoster;* *Human herpes types 6 and 7.*	*Rubiviruses: Rubella*
Orthomyxoviridae, **V** *including:* *Influenza A[5], B, C;* *Tick-borne orthomyxoviruses.*	
Papovaviridae, **D** *including:* *BK and JC viruses, and Human papillomaviruses* **D**	

[4] "Wild-type" Polio virus is currently categorised as hazard group 2. The World Health Organisation (WHO) have proposed that it be recategorised as hazard group 4 if the global eradication programme is successful. Vaccine strains willprobably be categorised as hazard group 3.

[5] Certain highly pathogenic strains of Influenza A are allocated to Hazard Category 4, for example the strain responsible for the 1918/19 pandemic, which probably resulted in more than 50 million deaths.