An Investigation of Biosecurity Education for Life Scientists in the Asia-Pacific Region

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Abbreviations

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

Asia-Pacific Biosafety Association (APBSA)

Asia-Pacific Biosafety Training Network (APBTN)

Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB)

Asia-Pacific Economic Cooperation (APEC)

Association of South East Asian Nations (ASEAN)

Biosafety and Biosecurity Network of Thailand (BSNT)

Biosafety Level (BSL)

European Economic Research Council (ESRC)

European Union (EU)

Food and Agriculture Organization (FAO)

Implementation Support Unit (ISU) of the BTWC

Indonesian Academy of Sciences (AIPI)

Indonesian Institute of Sciences (LIPI)

International Criminal Police Organization (INTERPOL)

Japan Society for the Promotion of Science (JSPS)

Living Modified Organisms (LMO)

Organization for Economic Cooperation and Development (OECD)

Philippine Biosafety and Biosecurity Association (PHBBA)

Research Institute for Science and Technology for Society (RISTEX), Japan

Severe Acute Respiratory Syndrome (SARS)

Standard Operating Procedure (SOP)

United Nations Department of Disarmament Affairs (DDA)

United Nations Educational, Scientific, and Cultural Organization (UNESCO)

United Nations Office at Geneva (UNOG)

Web of Prevention (WoP)

World Health Organization (WHO)

World Organization for Animal Health (OIE)

Executive Summary

This investigation aims to provide an insight to help support Asia-Pacific countries in the effort to develop their biosecurity education for life scientists in order to prevent the destructive use of science. The investigation develops two stages of analysis. Firstly, the current national policy trends of regional countries on biosecurity, biosafety and bioethics issues are set out. Secondly, the investigation examines the survey results of the current state of biosecurity education at university level life science degree courses in Asia-Pacific. By doing so, the investigation is designed to identify a potential gap between national policy provisions of biosecurity issues and the implementation level of biosecurity education at universities in the region. Finally, the investigation considers potential approaches to promote biosecurity education. Findings of the investigation are summarised as follows:

Concept of Biosecurity

The concept of biosecurity in the Asia-Pacific region has much stronger traditions in relation to agricultural security, biodiversity and public health than in the sense of national security concerning biological weapons or dual-use issues.

National Policy Provisions

Regional countries commonly have national regulations on biosafety to protect biodiversity. In some countries there has been a nascent but certain development in national legislation and institutionalisation of biosecurity, including the establishment of national biosecurity centres or national networking frameworks. Regional countries have well coordinated national networking on bioethics and some have governmental committees.

University Level Education

There has been a clear lack of biosecurity modules on dual-use issues and to a certain extent in biosafety modules. However, there is a growing interest in dual-use issues in the contemporary life sciences, such as in genetic technology. The dual-use issues here are illustrated mostly in relation to the threat of bioterrorism rather than in state-level weapons programmes.

There is a highly prevalent implementation of bioethics modules. On the one hand, the content of bioethics education has a wide range of cultural and religious disciplines based on different social backgrounds. On the other hand, there is an academic trend to develop ethics education for harmonising different values as trans-cultural ethics or regional ethics.

For further Promotion of Biosecurity Education

Te investigation identified a gap between the lack of provisions on dual-use biosecurity education, and to a less extent on biosafety education, at the universities despite the presence of governmental legislation. However, there is little gap between the national policies on bioethics and provisions of university level bioethics education, i.e. there is already a sound basis to teach social topics for life scientists in the current educational environment.

Therefore, the investigation recommends the integration of dual-use issues as part of ethics education with due care to local cultural and religious principles in ethics education. The role of regional ethics associations, such as the Asian Bioethics Association, needs to be considered to help promote this process in cooperation with ethics associations of individual countries.

Biosafety can be another critical intervention point in the Asia-Pacific region. Firstly, there are more educational provisions on the topic compared to biosecurity. Secondly, scientists are more familiar with the topic compared to biosecurity. Moreover, important regional countries have started capacity building for life scientists on laboratory safety issues, such as the safe management of pathogens, and recently such efforts have been expanded to include dual-use biosecurity issues.

1 Introduction

1.1 The Life Sciences and Biosecurity Education

Biotechnology, more broadly, the life sciences and related sciences have been one of the most rapidly growing areas of cutting-edge sciences worldwide in the 21st Century. This has offered great social benefits as a means of public health, agriculture and energy development around the world.

Alongside the benefits, however, this peaceful science and technology also generates risks. The international society has paid careful attention to the potential for adverse effects of biotechnology research to the conservation of biological diversity and the environment, under the concept of biosafety.[3] However, life science research can also give rise to issues of dual-use, whereby peacefully developed scientific research can be applied for destructive purposes, such as biowarfare and bioterrorism.[4]

Therefore, one significant enterprise of the international society is to ensure the progress of life science research exclusively for peaceful purposes. A wide range of international communities in science, economics, public health and security, have underscored the increasing need to develop a responsible culture in life science research concerning dual-use issues.[5]

However, the development of such a responsible culture will depend significantly on building capacity and fostering collaboration between scientists who are cognisant of the concerns of the security community and *vice versa*. In other words, education is increasingly recognised as a prerequisite for coordinated policy decisions in preventing and responding to the advertent and inadvertent misuse of the life sciences against humans, animals and plants.[6]

In this study, efforts to mitigate and respond to the potential of destructive use of the life sciences at national, regional and international levels is broadly conceptualised as biosecurity.[7] Therefore, biosecurity education is also widely envisaged as a process to better inform understanding of how the potential for the misuse of the life sciences can be prevented. Specifically, it includes themes such as, *inter alia*, the history of biological-warfare programmes and biological terrorism; the role of the international prohibition regimes and their national implementation;[8] intersection of public health and national security; dual-use risks and ethical responsibilities of life scientists; and building an effective set of preventative policies to ensure benign development of the life sciences.

1.2 International Landscape of Biosecurity Education and the Asia-Pacific Region

There are several significant regions in the current landscape of awareness-raising of life scientists concerning biosecurity issues. Table 1 shows the global market share of the biotechnology industry. North America holds the largest share followed by Europe and Japan.[9] The size of the industry implies the size of the population who are dealing with cutting edge biotechnology research. That is where the extent of awareness i such populations about dual-use issues is a salient matter.

Table 1. Global Market Share of Biotechnology

Region/State	Annual Worth	Share
North America	**$204 Billion**	**51%**
Europe	**$102 Billion**	**25%**
Japan	**$47 Billion**	**12%**
Asia, Africa, Australia	**$32 Billion**	**8%**
Latin America	**$17 Billion**	**4%**

Reference: National Research Council. (2006) *Globalization, Biosecurity, and the Future of the Life Sciences*. Washington, D.C.: National Academies Press., at p. 85.

Some international surveys investigated the current state of awareness of life scientists about dual-use issues and biosecurity-related degree courses at the higher education level in the United States,[10] Europe[11] and Japan.[12] These surveys in different parts of the world have produced very similar results. There appears to be very little biosecurity educational provision for life scientists. The surveys in Europe and Japan also concluded that the lack of such provisions is a major contributory factor leading to the lack of awareness of biosecurity issues amongst life scientists.[13]

Having recognised the current problems, the surveys made recommendations towards the implementation of biosecurity education. The surveys suggested that bioethics education was the most prevalently implemented topic to inform social issues in the current life science degree courses. Therefore, an expansion of the scope of traditional bioethics education was recommended as a starting point for biosecurity education by integrating the dual-use dimension of the life sciences into ethics education.[14,15]

What those surveys demonstrated was the utility of the identification of current problems in order to provide solutions to promote biosecurity education in different parts of the world. Notably, there have been further reports from the United States, Europe and Japan demonstrating the growing number of educational programmes on biosecurity topics, the national networking of relevant stake-holders in the issue area and the level of awareness of life scientists about dual-use issues.[16]

Table 1 indicates there are some other regions which are the next possibilities for such investigation, as Asia-Pacific is certainly one of the most important cases. While there are some useful illustrations of the current state of laboratory safety and security policies in Asian countries,[17] there has been no in-depth investigation about the specific topic of biosecurity education in this region where there are some strongly growing biotechnology industries in the 21st Century, such as in Australia, China, India, Indonesia, Malaysia, New Zealand, South Korea, Singapore, Thailand and Taiwan.

Therefore, this study aims to provide a regional case study of Asia and Oceania, more broadly framed as Asia-Pacific. Japan and China were excluded from the sample, as those have already been studied by others.[18,19] Countries from the region are geographically closely located and have commonly recognised the importance of regional cooperation to deal with the transnational security challenges they face.[20] Those include the proliferation of weapons, ethnic conflicts, concern over maritime security, and also interlinked challenges relating to the

spread of infectious diseases such as Severe Acute Respiratory Syndrome (SARS), Nipah and Avian Influenza. Moreover, as a case study, it is important to consider how regional policy coordination on the issue of education can be developed without a strict regional framework such as that chosen in the European Union (EU) which has been providing common policy on biosecurity issues including the awareness-raising of scientists.[21]

2 National Policy Trends

This section focuses on some selective national provisions which are related to the capacity building of biosecurity and education (See Table 2). Firstly, this section illustrates the conceptual issues of biosecurity in Asia-Pacific. Secondly, legislative and institutional aspects in biosecurity policies are investigated. Thirdly, biosafety legislation is briefly looked at. Finally, this section illustrates some bioethics-related policy provisions.

Table 2. Policies on Individual Country Basis

Policies	Countries*									
	AU	ID	IN	ML	NZ	PH	RK	SG	TH	TW
Biosecurity Legislation	O	O	O	O	O	O	O	O	O	O
Biosecurity Centre/ Committee	O				O	O			O	
Biosecurity Code			O(b)							
Biosafety Legislation	O	O	O	O	O	O	O	O	O	O
Bioethics Network	O(a)	O(a)	O	O	O	O	O(a)	O	O	O
Bioethics Committee/ Advisory Board	O	O	O	O(b)	O	O	O	O	O	O

Notes: *AU = Australia, ID = India, IN = Indonesia, ML = Malaysia, NZ = New Zealand, PH = the Philippines, RK = Republic of Korea, SG = Singapore, TH = Thailand and TW = Taiwan.
O = Presence of the Element, (a) = Presence of Association, (b) = Being developed.
Reference: Table was created based on the *BWC National Implementation Database* of the United Nations Office at Geneva (UNOG),[22] *Codes Archive* of the Organization for Economic Cooperation and Development (OECD),[23] *Biosafety Clearing-House* of the Convention on Biological Diversity[24] and *Bioethics Database* of the United Nations Educational, Scientific, and Cultural Organization (UNESCO).[25]

2.1 Definitional Issues in Biosecurity

The term biosecurity has been conceptualised differently across different scientific and professional disciplines. One study shows that the term has been used in ecology, agriculture, food supply, arms control and public health albeit with different meanings and conceptualisations.[26] Therefore, when it comes to policy making on biosecurity, this overlaps

with interdisciplinary areas such as biosafety, counter-terrorism, agricultural biosecurity and biodiversity.[27] In addition to these conceptual complications, biosecurity has also experienced linguistic complications. Although biosecurity and biosafety are different terms in English, when translated into Spanish, French and other Romance languages it becomes one word.[28]

In the Asia-Pacific region the concept of biosecurity has a strong tradition in agricultural biosecurity, biodiversity and public health rather than in security concerning dual-use issues (biological warfare or terrorism). A study shows that "75% of all emerging viruses over the past two decades have been zoonotic",[29] and particularly in East Asia, the experience of SARS and Avian Influenza have given critical momentum for the regional governments to prioritise public health as a security issue.[30] Therefore, regional communities, such as the Association of South East Asian Nations (ASEAN) and the Asia-Pacific Economic Cooperation (APEC), have recurrently addressed the importance of coordinated policy making in public health and agricultural biosecurity.[31]

This trend can be clearly found in a case study of New Zealand. Dunworth noted that:

> [I]n New Zealand the terminology of biosecurity is avoided in security discourse [concerning bioterrorism], and explains this is partly due to the importance of biosecurity in the sense of protecting its agricultural sector, and partly due to a resistance to the rhetoric of terrorism.[32]

The author further argued that "[b]iosecurity is fundamental to New Zealand's well-being and for that reason any attempt to use this terminology in the context of bioweapons is likely to continue to be resisted".[33]

In order to better understand the conceptualisation of biosecurity in this region, it is also important to see how local life scientists perceive the potential risk associated with biotechnology research. For this question, a study which investigated the state of laboratory safety and security policies in 16 Asian countries, gives useful insights. The study suggested the risk that most concerned practicing scientists was the scenario of pathogens under research "[a]ccidentally infecting people or animals or contaminating the environment outside laboratory", rather than theft or advertent use of the agents for destructive purposes. [34] The study also showed that although scientists clearly recognise the possible risk of generating novel infectious agents, their concern was in relation to the accidental release.[35] Under the definition of the WHO, such accidental releases are recognised as safety issues rather than dual-use security issues.[36] Therefore, dual-use issues have a low profile in the risk perception of life scientists at least in some Asian countries which include eight countries out of ten in this investigation.

2.2 Legislation

Although dual-use issues are not the highest priority of traditional concepts of biosecurity in the region, dual-use issues are gradually becoming of interest for regional countries.[37] Particularly regional countries have been working on this issue under the Biological and Toxin Weapons Convention (BTWC).[38] Since 2003, the BTWC has conducted in-depth discussions on national implementation measures for the prohibition against biowarfare and bioterrorism. These discussions also included the capacity-building in public health preparedness, in cooperation with the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE).[39]

To pay careful attention to the public health issues under the BWTC is based on the growing understanding that there are policy overlaps in responding to and mitigating the affects of a natural outbreak of disease and also of a deliberately triggered outbreak of disease. To further enhance biosecurity norms and practice on dual-use issues, the BTWC developed specific discussions on education for biological scientists in 2008.[40]

Table 2 indicates the provisions of national legislation to implement the BTWC. [41,42] There are certain types of national legislation in relation to the BTWC, such as where:

1. Existing national regulations are enough to achieve the scope of the BTWC and no further legislation is necessary,
2. Certain amendments of existing laws and regulations are necessary,
3. An act is newly enacted specifically for the BTWC, and
4. Broader legislation is enacted not only for the BTWC but generally for anti-terrorism acts.[43]

A commonly recognised approach of the countries from Asia-Pacific is to use, or make minor amendments of, existing laws and regulations related to hazard substances (toxins and pathogens), export control, criminal codes and public health.

However, at the meeting of the BTWC in 2003 Australia argued that such an approach:

> …may be partly but not entirely effective for the purposes of the BWC. Furthermore, such legislation is often quite narrow in scope - absenting some activities, facilities and materials - with several regulatory functions scattered between many government agencies.[44]

Indeed, some countries such as Australia, New Zealand and the Republic of Korea developed their own national strategies and reported back to the BTWC in 2007.[45]

2.3 Biosecurity Centre

Clearly there has been some development in the institutionalisation of national efforts to enhance biosecurity (Table 2). Due to the differences in definition of biosecurity, Australia has three different types of national biosecurity centres. One of them deals with dual-use issues and provides university level education programmes for life scientists.[46,47] New Zealand has a governmental division of biosecurity on non-dual-use topics, working on the protection of public health and "the welfare of our environment, flora and fauna, marine life and Maori resources".[48]

The Philippines and Thailand assign importance to national networking amongst relevant governmental and academic institutions for building the capacity of technical experts. The Philippines set up a steering committee on *National Laboratory Biosafety and Biosecurity Action Plan Task Force* in 2006.[49] The Plan underlines the technical capacity-building and education for life scientists about public health and bioterrorism issues.[50] Thailand has national networks on the capacity-building of biosafety and biosecurity experts to provide policy recommendations for the government. This effort includes the development of text books on the issue area, which is an important effort.[51] Surveys on biosecurity education in

Europe and Japan indicated that one of the difficulties for university lecturers to promote biosecurity education was the lack of literature which illustrates dual-use issues in the life sciences in a localized research context and in the local language.[52]

2.4 Code of Conduct on Biosecurity

As Table 2 shows, the Indonesian Academy of Sciences (AIPI) has been designing a national code on biosecurity.[53] The rationale for such a code was concisely summarised in the report of the US National Research Council titled *Biotechnology Research in an Age of Terrorism*, in 2004:[54]

> Whether mandatory or voluntary, the adoption of codes of conduct by professional organizations or national academies of science, and the integration of ethics education into the training of students should serve to sensitize 'young scientists to reflect on the wider consequences of their intended field of work.'[55]

The Indonesian's code is planned to be "incorporated into core curriculum for the biological sciences throughout Indonesia", i.e. it is possibly to be made mandatory.[56] If this takes places, it will produce a rapid increase in awareness amongst life scientists about dual-use biosecurity issues.

2.5 Biosafety Legislation

As increasing numbers of regional countries are developing their capacity in genetic research, due care regarding the potential risks and the prevention of possible adverse effects of Living Modified Organisms (LMO) is critical for the conservation and sustainable use of biological diversity. Particularly, in light of *Cartagena Protocol on Biosafety to the Convention on Biological Diversity* adopted in 2000, the national implementation of biosafety regulations has been developed by the regional countries.[57]

As with biosecurity legislation, biosafety legislation processes in this region are also highly country specific. A joint report by the Asia-Pacific Association of Agricultural Research Institutions (APAARI), the Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB) and the FAO, pointed out that some are "developing an entirely new biosafety specific system while others [are] making modifications in the existing regulatory systems to address biosafety issues."[58]

2.6 Bioethics Network

Ethics is an essential intervention point to promote in the education for life scientists.[59] Miller and Selgelid explain that scientific research generates a dual-use dilemma "since it is about promoting good in the context of the potential for also causing harm… [and a] dual-use dilemma is an *ethical* dilemma, and an ethical dilemma for the *researcher* as well as for those (e.g. governments) who have the power or authority to assist or impede the researcher's work".[60] As it was also noted in the introduction of this report, ethics education was recommended as a practical platform to promote dual-use topics for scientists in the current educational environments in Europe, Japan and the United States.

In this view it is important to see the extent of the presence of national networking and academic associations on bioethics in Asia-Pacific. Table 2 also shows that some countries

have institutionalised national advisory boards or committees. Amongst these, the Indonesian National Bioethics Commission is noteworthy as it deals with dual-use topics. Concerning the biosecurity issues, the commission provides policy recommendations to the government, domestic industry and scientific communities and plays the role of a hub for international policy coordination on ethics issues between WHO-Department of Health, FAO –Department of Agriculture and UNESCO-Indonesian Institute of Sciences (LIPI).[61] The necessity for capacity-building of the Commission about the BTWC has also been recognised.[62]

Having looked at the national policy trends of regional countries, this section showed that biosafety regulations were prevalent. Bioethics networking was also well developed in regional countries and there was a development in legislation and institutionalisation on biosecurity policies. However, this section also illustrated the low level of risk perception among practicing scientists about dual-use biosecurity issues. There is a clear gap between the presence of governmental policies and the lack of risk perception among scientists.

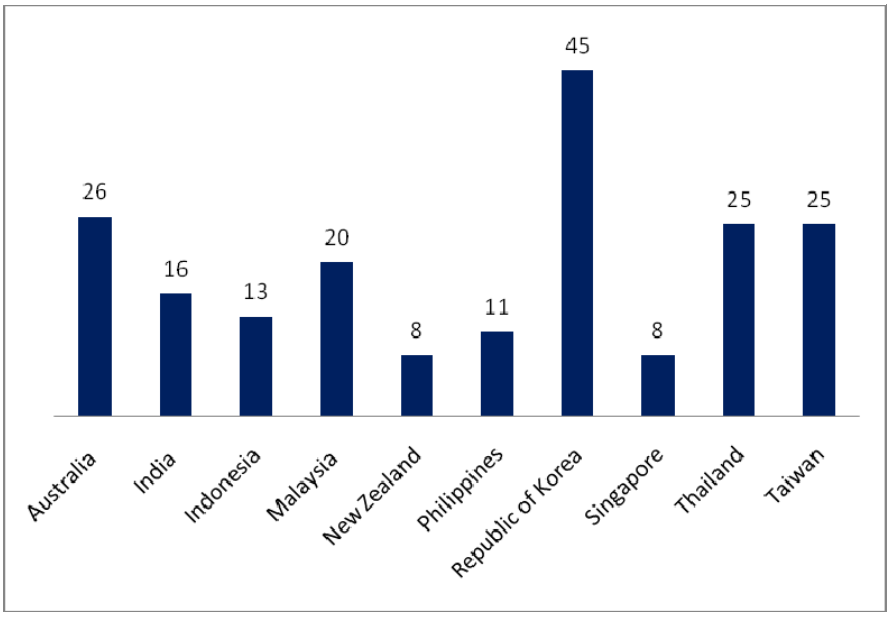
One reasonable explanation for this gap is the lack of education about the issue of biosecurity. Hypothetically, if there is a lack of specific provisions for biosecurity education at university level courses, it is natural that scientists are not aware about possible dual-use risks in their research. To further develop the understanding on this point, the next section focuses on the current state of biosecurity education at university level life science degree courses in Asia-Pacific.

3 Survey

3.1 Sampling

This section provides the results of a survey which specifically focused on life science degree courses in higher education in Asia-Pacific. Leading universities on the subject areas in the life sciences and biomedical sciences were sampled by using a university ranking system.[63] Universities from Japan and China were excluded from the sample, as those have already been studied.[64,65] In total, the investigation looked at 197 lifescience degree courses from 58 universities (Figure 1).

Figure 1. Number of Sampled Degree Courses on Country Basis



3.2 Methods

Employing the same basic structure and methodology from the surveys on biosecurity education in Europe[66] and Japan,[67] the survey in Asia-Pacific consisted of two data-collection methods. The first was an online investigation focusing on publicly available syllabi and other information from the websites of the courses.

Specifically, this investigation looked for following six possible indicators of biosecurity education. The first three indicators were used to identify the 'presence of modules' on respective subjects within the existing curricula. Thus, the survey investigated whether there was evidence of specific modules on 'biosecurity', 'biosafety' and 'bioethics'. The remaining three indicators were used to identify the 'presence of references' to respective topics within existing modules, even though there were no particular modules on such topics. Thus, the survey investigated whether there was evidence of specific references to the following topics within current curricula: dual-use issues; international arms-control or disarmament regimes; and ethical guidelines as well as codes of conduct. As summarised:

- *Biosecurity*: laboratory measures to prevent unauthorised access to pathogens and toxins from outsiders,[68] or in other definitions [as discussed above],
- *Biosafety*: laboratory management to prevent accidental release of pathogens and toxins to the environment/people/animals,[69] or biosafety regulations for the protection of biodiversity such as of the *Cartagena Protocol*,
- *Bioethics*: ethical issues in scientific research, including the Hippocratic Oath and the Declaration of Helsinki of 1964 for medical scientists,[70]
- *Dual-use Issues*: historic illustration of hostile use of different areas of the sciences or specific cases of bioterrorism, biowarfare or biocrimes,
- *International Arms Control Law/Mechanisms*: such as the Biological Weapons Convention, the Chemical Weapons Convention or the Geneva Protocol 1925, and
- *Ethical Guidelines for Scientists or Codes of Conduct*: assuring good research or medical practice.

The second stage was a follow-up questionnaire to clarify the findings of the online investigation by asking more about the presence of the above topics. In the case of such educational topics not being provided, we asked how respondents recognise the rationale of the above topics for the education of life scientists. The questionnaire was circulated to the head of the educational programmes or degree courses. The low level response rate to the questionnaire from 13 out of 58 universities does not permit statistically significant analyses. The quantitative data analysis was conducted largely based on the information collected by the online investigation.

The available information by the data collection was organised into three categories, as follows:

- *Exist:* refers to data where we can say with a degree of certainty that the required information was present,
- *Not Exist:* refers to data where we can say with a degree of certainty that the required information was not present,
- *Unclear:* refers to data where there is some information available but we cannot say with certainty whether the required information exists or not.

3.3 Survey Result

Figure 2 shows that the survey identified five specific biosecurity modules and some other instances of biosecurity-specific teaching. Although there were only 36 cases of biosafety modules, biosafety education has been provided in many universities by means other than a single educational component. Bioethics modules were the most commonly found topic in this survey, with 93 examples existing. In a small number of cases these also dealt with dual-use issues. Some 19 universities included topics of relevance to dual-use issues without using this specific term. References to international prohibition regimes against biological and toxin weapons were highly limited, with only 3 cases found. Finally, references to ethical guides or codes were fairly prevalent, with 62 cases largely included in bioethics modules. The overall result was very similar to those of the surveys in Europe and Japan.

Figure 2. Number of Presence of the Educational Topics

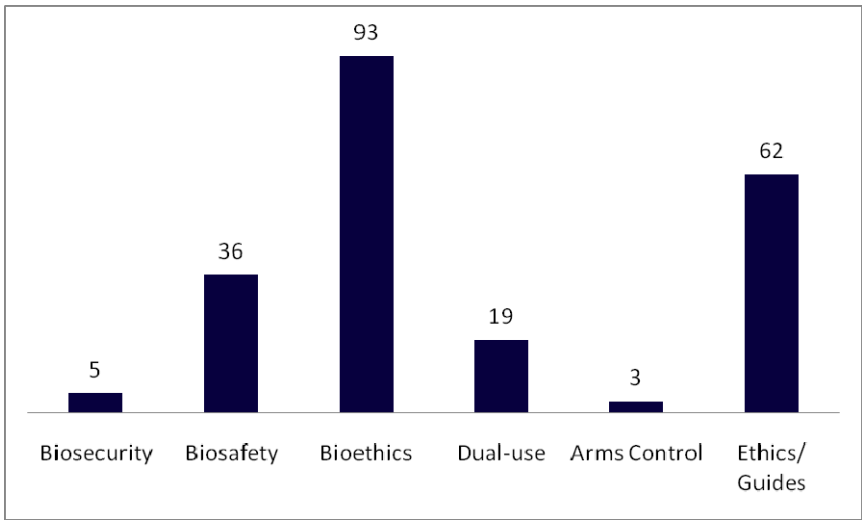
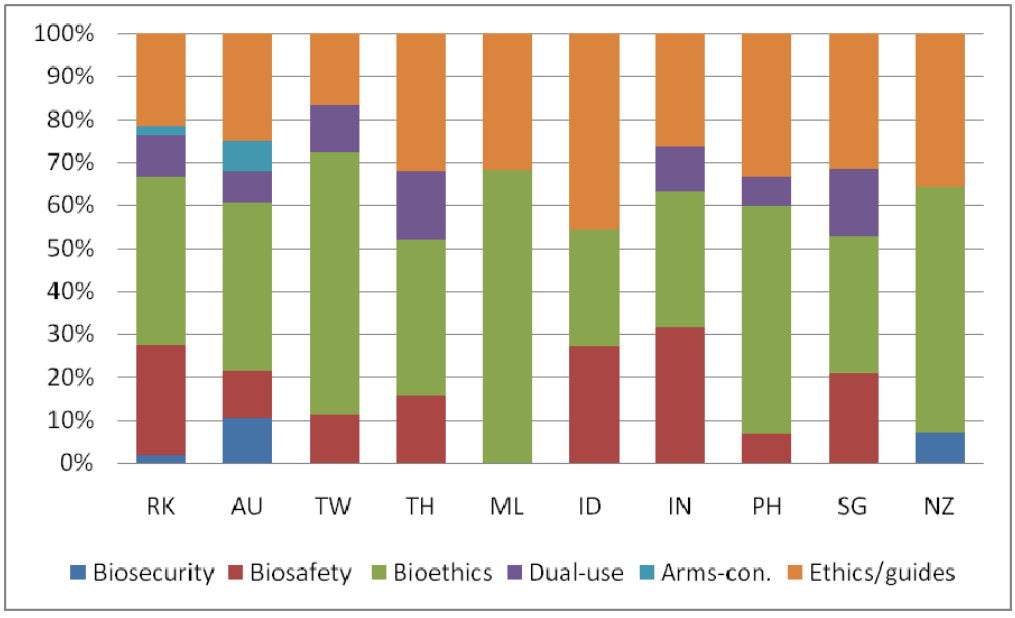


Figure 3 indicates that although there were certain differences in the provisions of biosecurity and biosafety education amongst countries where the investigated degree courses were located, provisions for bioethics education was again prevalent throughout the region. Dual-use topics were also widely spread despite the actual numbers being small.

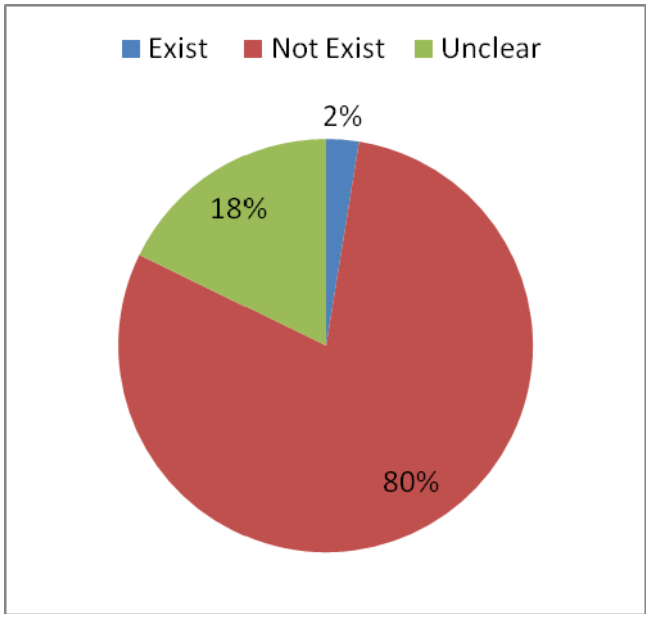
Figure 3. Level of Presence of Investigated Topics on Country Basis



3.3.1 Biosecurity Topics

Figure 4 shows that only a small number of universities had specific modules on biosecurity topics. Due to the differences in definition of the term biosecurity, there are biosecurity modules on dual-use issues (biowarfare and bioterrorism) and agricultural/environmental biosecurity. Regarding the former, modules were commonly provided for the students in public health studies or science policies, and the latter was provided more at the faculties of biological sciences.

Figure 4. Presence of Biosecurity Modules



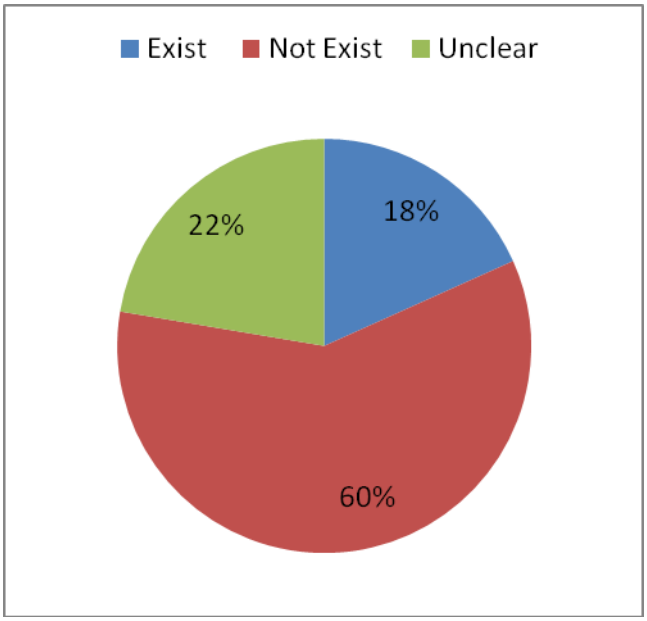
Some modules dealt with broad issues of biosecurity. For example, the course titled – *Disease and Security* (CISS6004) – at the University of Sydney, Australia is an elective module for postgraduate students of security studies, public health and also for commerce. Topics included the history of biological weapons, legal aspects on laboratory biosecurity measures and the dual-use dilemma in the life sciences. Courses provided at the Graduate Program of Science at KAIST, Republic of Korea had clear emphasis on educational topics in science policy which could be directly applied in considering multifaceted biosecurity measures. These included *Governance of Emerging Technologies, National Security and Global Strategy, Biotechnology and Law, The Laboratory and the Clinic* [of life and medical sciences], *Science, Technology, and* [role of NGOs in] *Public Policy Making*, and *State Bureaucracy and Regulations*.[71]

A laboratory level biosecurity course at the University of Indonesia, Faculty of Medicine and Institute of Human Virology and Cancer Biology at the University of Indonesia teaches laboratory management skills for microbiologists. Compared to the above modules, this course was designed for the technical capacity-building of practicing scientists which included a scenario study on the isolation and identification of *Anthrax* in a clinical microbiology laboratory.

Regarding agricultural/environmental biosecurity, for example the School of Biological Sciences at the University of Auckland, New Zealand provides the following compulsory modules: *Biosecurity and Invasion Biology* (BIOSCI 747), *Weed and Pest Management* (BIOSCI 748), *Biodiversity Management and Conservation* (ENVSCI 733). In addition to these, eleven elective courses for environmental biosecurity are also provided by the programme.[72]

3.3.2 Biosafety Modules

Figure 5. Presence of Biosafety Modules



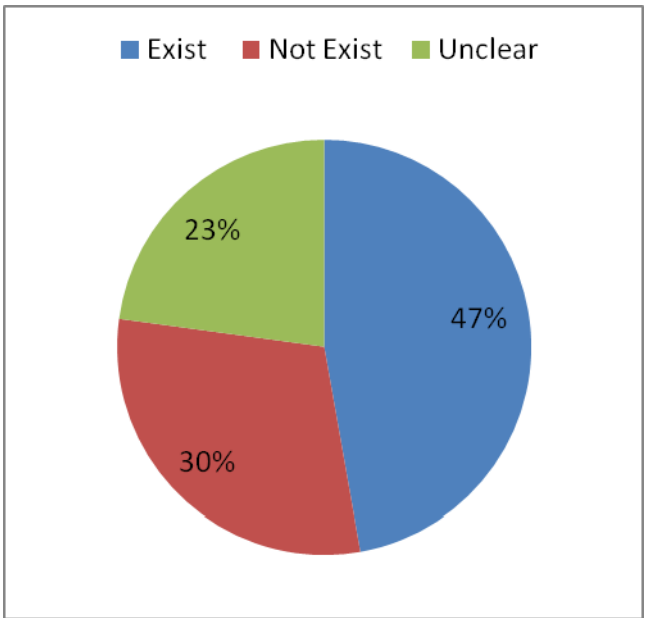
In the previous section, Table 2 showed that all regional countries have provisions for biosafety legislation. However, Figure 5 indicates that the level of implementation for the specific modules on biosafety was not very high - at 18 percent. The presence of biosafety legislation in a country therefore does not mean domestic universities are obliged to provide a specific module on biosafety for the purpose of educating students. Also, some courses are not mandatory but elective. Such lack of provision of education can be a major contributory factor to the lack of awareness.

Indeed it was reported that in Asia "21% of the respondents did not know the biosafety level of their laboratory".[73] The study also pointed out some infectious agents and toxins which are supposed to be treated at Biosafety Level (BSL) 3 laboratories are used for research at lower BSL2 laboratories in some Asian counties,[74] largely including the countries from this investigation.

In this investigation it was found that biosafety modules were commonly provided as the introductory courses for laboratory practice for life scientists. Titles included topics such as: *Bioengineering Fundamentals*; *Biosafety and Regulations*; *Biosafety Challenges for the Microbiology Laboratory*; and *Biotechnology Resource Planning*. Typically course topics included regulations in clinical laboratory control, handling and risk assessment of GMOs, storage and usage of biomaterials, and bioinformation.

3.3.3 Bioethics Modules

Figure 6. Presence of Bioethics Modules



Quantitative results indicated that this was the most prevalently implemented topic in the survey - being provided by 47 percent of investigated degree courses. Also, as Figure 3 suggests, this was a topic which has been implemented at universities in all the countries of this investigation. There are three trends in terms of the content of bioethics education in Asia-Pacific. Firstly, many biomedical faculties are providing traditional medical ethics, such as the Declaration of Geneva of 1948, the Hippocratic Oath and the Declaration of Helsinki of 1964 for medical professionals,[75] as well as contemporary topics such as ethics in stem cell and

human embryo research. However, there was one case where the issue of dual-use was illustrated as part of ethics education, *Bioethics* (PAAE 8007), at the Australian National University.

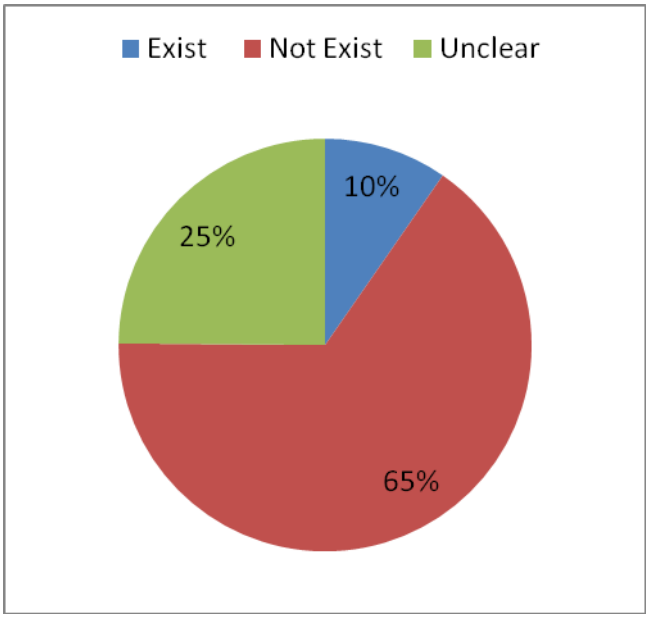
Secondly, what is noteworthy in the ethics education of this region was the diverse range of cultural and religious traditions in ethics education for life scientists. For example, a Department of Biology in the Philippines provide mandatory *Catholic Theology* for the second and fifth year biology students. A Graduate School in Thailand provides *Buddhist Ethics* for the consideration of ethical challenges in medical sciences. Moreover, at a Department of Science and Technology Studies and a faculty of Biomedical and Health Science Engineering in Malaysia the following courses are provided – *Philosophy of Islamic Science, Science Technology in the Contemporary Islamic World, and Islamic and Current Issues*. Finally, at a College of Medicine in Taiwan, *Chinese Medical Ethics* is part of a core teaching strategy.

Thirdly, alongside the highly localised ethical disciplines, there is an ethical and philosophical consideration to harmonise trans-cultural or regional ethics. For example, the course *Bioethics in Asia*, at a School of Medicine in Singapore, is provided for the students in biomedical ethics to develop "critical reflection on ethical concepts from a perspective of cultural differences and universal moral values".[76]

3.3.4 Dual-Use Topics/References

Figure 7 indicates that the implementation of dual-use topics was small with 10 percent, but Figure 3 presented above suggests that universities from seven countries out of ten in this investigation are providing the topics. In terms of specific content on dual-use issues, potential use of genetic engineering in biowarfare and terrorism scenarios was provided at a wide range of courses, such as in a Department of Biological Sciences, a Department of Biobrain Engineering and a Faculty of Medicine. Also, the role of surveillance and capacity-building in disaster medicine, including a bioterrorism scenario, was also illustrated for students in public health studies.

Figure 7. Presence of Dual-Use References



It is noteworthy that these dual-use issues are illustrated in the context of contemporary life science research. In the case of the survey in Japan, the majority of dual-use topics were related to the historic illustrations of nuclear, chemical and biological weapons during the World War periods rather than to dual-use issues in the contemporary life sciences.[77] In such cases, threats of dual-use were illustrated as state-level programmes. Compared with the case of Japan, the main threats were illustrated at the non-state level mainly in the context of terrorism in Asia-Pacific.

3.3.5 Arms Control Topics/References

Figure 8. Presence of Arms Control Topics

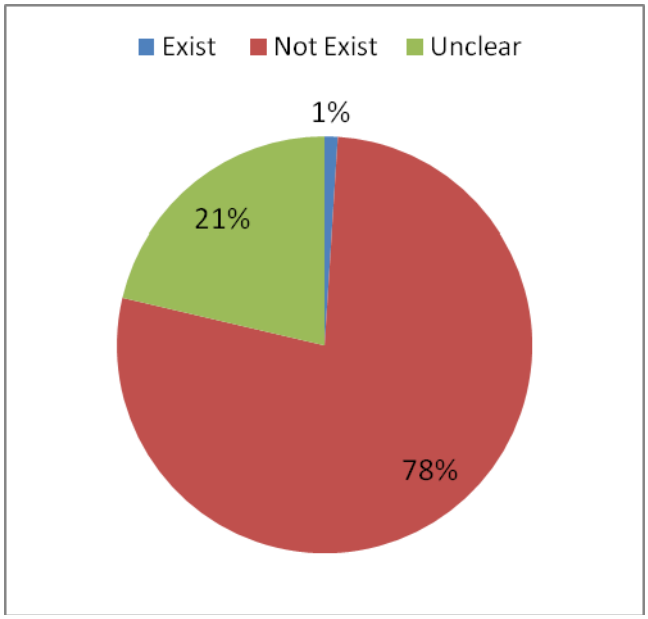


Figure 8 suggests that this topic was the least implemented topic within the current educational environment of life science degree courses in Asia-Pacific. International prohibition regimes against biological weapons, such as the BTWC, are only partially referred to within the biosecurity modules which were illustrated in the above section. A respondent of the questionnaire noted, "We don't think (at this moment) [it] is necessary to give [attention to] the topic of dual-use issues, International Arms control law/mechanisms."

3.3.6 Codes of Conduct/Ethical Guidelines

Figure 9. Presence of Guidelines or Codes

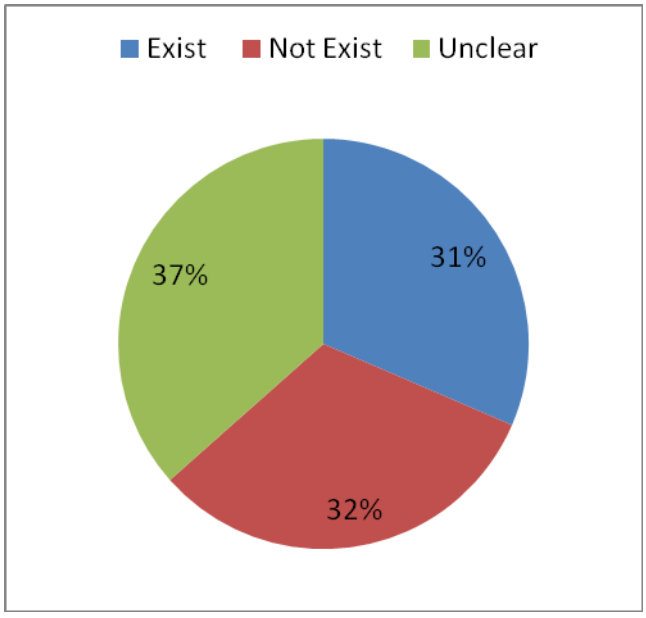


Figure 9 indicates that this is another prevalently implemented topic. This is partly because ethical guidelines and codes of conduct for ensuring good practice in research practice are commonly provided as part of ethics education or biosafety education. Indeed, the level of implementation of bioethics education was high in this survey. An example included a course titled *Quality Assurance for Health Research* for Public Health studies at the Qkhon Kaen University in Thailand. This course educates students for the planning and writing of Standard Operating Procedures (SOP) for public health practice. Regarding a research guideline, for example, a *Laboratory Biorisk Management Manual* from the National University of Singapore is provided to all its university personnel for the safe operation of laboratories and performance of experiments involving materials of biological origin.

The survey results are briefly summarised as follows in Table 3:

Table 3. Brief Summary of the Survey Results

Topic	Quantitative	Qualitative
Biosecurity	Significantly small numbers of implementation: 5 cases across 3 countries out of 10.	Biosecurity issues were illustrated with dual-use and non-dual-use content.
Biosafety	Specific modules were limited: 36 cases across 8 countries.	Modules were usually provided at the introductory education for laboratory training.
Bioethics	The most commonly discovered element in the survey: 93 cases across 10 countries.	Both highly localised content and trans-cultural content were identified.
Dual-Use	Not the most commonly provided topic for scientists: 19 cases across 7 countries.	The topic was commonly illustrated in the context of contemporary life science research.
Arms Control	The least prevalent topic: 3 cases across 3 countries.	The topic was partially referred to as part of biosecurity modules.
Guide/Code	Many references were identified: 62 cases in 10 countries.	The majority of these have not been framed in the context of dual-use.

4 Conclusion

This investigation demonstrated two stages of understanding regarding biosecurity education in Asia-Pacific. The first stage, the section of national policy trends on biosecurity issues, helped identify potential gaps between the governmental regulations and the awareness of scientists about them. There was a growing presence of legislation and institutionalisation of dual-use biosecurity policies while there was a low level of risk perception among scientists about dual-use issues. The section concluded by asking whether this could be derived from the lack of education. At the second stage of the analysis, the survey results suggest that there has been a lack of specific modules on biosecurity and biosafety topics especially on dual-use issues. This was argued as a contributory factor leading to the current lack of awareness and low risk perception among life scientists about dual-use biosecurity issues.

What can be the way forward for promoting a responsible culture among life scientists about dual-use issues in Asia-Pacific? Firstly, the lack of biosecurity education means that it will require an intensive input of human and financial resources to develop comprehensive biosecurity education programmes from scratch for the majority of regional universities. However, this investigation showed that at least regional governments have biosecurity legislation regarding the prohibition of biological weapons. The scope of existing laws and regulations can be expanded so as to help provide the education for life scientists about dual-use issues.

For this purpose, policy coordination among relevant governmental branches as well as the establishment of national networking is important. Through this process, the promotion of biosecurity education needs to be accommodated with the interests of practising scientists and policymakers on security and education, in order to make it possible to strike an appropriate

balance between the freedom of scientific research and oversight of science for national security requirements.

Another intervention point can relate to ethics education. In the case of the surveys carried out in Europe and Japan, there were a lack of biosecurity modules present, but there was a high prevalence of bioethics modules as well as a certain amount of educational topics on dual-use issues. Therefore, dual-use bioethics was suggested in the previous surveys as the best platform for awareness-raising among life scientists. However, the potential of the 'dual-use bioethics' approach needs to be carefully considered in the Asia-Pacific region. As this investigation (section 3.3.3) suggests, there is a highly diverse range of bioethics content based on different cultural and religious principles available. This investigation did not look specifically at whether the concept of dual-use can be effectively illustrated as part of ethics education under such different cultural or religious principles. So, further studies are needed to find answers to this question. However, if it can be illustrated in this way, ethics education will form a strong base for biosecurity education.

Moreover, the survey also suggested that some ethics education is designed to harmonise such cultural diversity at the regional level or even at wider levels. This type of education is important to promote an umbrella concept of 'dual-use bioethics' at the trans-national level. In this sense, it is also important to consider the role of regional associations, such as the Asian Bioethics Association, in order to promote regional dialogue on dual-use issues in biosecurity.

Finally, the expansion of educational content on biosafety topics should be considered for the promotion of biosecurity education. As discussed above (Section 2.1), the majority of life scientists in Asia-Pacific recognised the highest potential risk associated with biotechnology as the safety management of infectious agents, rather than as dual-use issues. While the regional countries had national legislation implemented, what was under-developed were the specific provisions of biosafety modules at university level education. Moreover, such educational provisions need to better inform life scientists about the conjunction of biosafety measures with biosecurity measures by emphasising that both concepts are needed as part of public health preparedness and the prevention of the destructive use of the life sciences.

For this purpose, developments are at an early stage but there are increasing regional efforts taking place. For example, the Asia-Pacific Biosafety Association (APBSA) and the Asia-Pacific Biosafety Training Network (APBTN) have been developing new educational resources, train-the-trainer programmes, and regional workshops/seminars for life scientists on laboratory biosafety topics.[78] Their recent outreach efforts have now been expanded into biosecurity and dual-use topics.[79] It is noteworthy that their approach to awareness-raising for life scientists is developed in relation to bioethics in the effort to enhance the biosecurity capacity.[80] This means that the 'dual-use bioethics' approach is already taking place under the regional biosafety associations. In Asia-Pacific, it can be reasonably argued that either bioethics or biosafety education can be a possible vehicle to advance dual-use biosecurity education.

References

[1] Mancini, G. and Revill, J. (2008) *Fostering the Biosecurity Norm: Biosecurity Education for the Next Generation of Life Scientists*, Como, Italy and Bradford, UK: Landau Network-Centro Volta and the University of Bradford, 2008 Available from http://www.brad.ac.uk/acad/sbtwc/dube/publications/LNVCBDRC_FosteringNorm.pdf;
Minehata, M. and Shinomiya, N. (2009) *Biosecurity Education: Enhancing Ethics, Securing Life and Promoting Science: Dual-Use Education in Life-Science Degree Courses at Universities in Japan*. Saitama and Bradford: National Defense Medical College and University of Bradford. Available from http://www.brad.ac.uk/acad/sbtwc/dube/publications/JapanSurvey.pdf;
Minehata, M. and Friedman, D. (2009) 'Biosecurity Education in Israeli Research Universities: Survey Report', *Research Report for the Wellcome Trust Project on 'Building a Sustainable Capacity in Dual Use Bioethics*. Tel Aviv, Israel: Institute for National Security Studies. Available form http://www.brad.ac.uk/acad/sbtwc/dube/publications/Israel_BioSecReport_Final.pdf

[2] The list of participants are available from http://www.brad.ac.uk/acad/sbtwc/dube/resource/esrc_seminar.html

[3] "The *Cartagena Protocol on Biosafety to the Convention on Biological Diversity* is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs)." See the website of the Convention of Biological Diversity, *Cartagena Protocol on Biosafety to the Convention on Biological Diversity*. Available from http://bch.cbd.int/protocol/

[4] National Research Council.(2004) *Biotechnology Research in an Age of Terrorism*. Washington, D.C.: National Academies Press.

[5] For example, G8 Counter-Terrorism Cooperation has consistently addressed the issue of bio-threats since 2001, Available from http://www.mofa.go.jp/policy/economy/summit/2002/coop_terro.html; Regarding biosecurity education, in 2008 the Biological Weapons Convention (BWC) recognized the value of education for scientists on dual-use issues "including possible mandatory components" at the higher education, and the BTWC's national implementation has been authorised under the United Nations Security Council Resolution 1540 since 2004. See United Nations, *Report of the Meeting of States Parties*, BWC/MSP/2008/5, December 2008; Voluntary awareness-raising for scientists, national legislation on biosecurity and biosafety measures, and oversight of scientific research were underlined by the *Statement on the Consideration of Biodefence and Biosecurity* signed by editors of some 30 major scientific journals, including Science, Nature and PNAS in 2003. Editorial. (2003) "Statement on the Consideration of Biodefence and Biosecurity," *Nature* 421, February, p.771; also InterAcademy Panel (IAP) issuing a statement calling for, amongst other things, the oversight of scientific research and the awareness raising of scientists through education. See IAP. (2005) *Statement on Biosecurity*, Available from http://www.interacademies.net/?id=4909; WHO experts group provided a report by making education the first priority to prevent the misuse of the life sciences. WHO. (2007) Scientific Working Group on Life Science Research and Global Health Security: *Report of the First Meeting*, Geneva: WHO.

[6] Rappert, B. (2009), *Experimental secrets: International Security, Codes, and the Future of Research, New York*: University Press of America.

[7] There have been efforts to conceptualise a multifaceted approach comprising several practical measures through what is termed the Web of Prevention (WoP). For the conceptual evolution of the WoP in literature, see Feaks, D., Rappert, B. and McLeish, C. (2007), 'Introduction: A web of prevention', in Rappert, B. and McLeish, C. (eds), *A Web of Prevention: Biological Weapons, Life Science and the Governance of Research*, London: Earthscan.

[8] Such as BTWC of 1972, Chemical Weapons Convention of 1993 or Geneva Protocol of 1925.

[9] See Chapter 3 of National Research Council. (2006) *Globalization, Biosecurity and the Future of the Life Sciences*, Washington, D.C.: National Academies Press.

[10] National Research Council. (2009) *A survey of Attitudes and Actions on Dual Use Research in the Life Sciences: A Collaborative Effort of the National Research Council and the American Association for the Advancement of Science*, Washington, D.C.: National Academies Press.

[11] Mancini, G. and Revill, J. (2008) *op. cit.*
[12] Minehata, M. and Shinomiya, N. (2009) *op. cit.*
[13] Revill, J., Mancini, G., Minehata, M. and Shinomiya, N. (2009) "Biosecurity Education: Surveys from Europe and Japan," *Background Paper for the International Workshop on Promoting Education on Dual-Use Issues in the Life Sciences*, 16-18 November 2009, Warsaw, Poland: Polish Academy of Sciences, Available from: http://dels.nas.edu/bls/warsaw/background.shtml
[14] National Research Council. (2009) *op. cit.*
[15] Revill, J., Mancini, G., Minehata, M. and Shinomiya, N. (2009) *op. cit.*, at p. 17.
[16] Sta. Ana, J. L., Farnkel, M. S. and Berger, K. M. (2009) 'Educating Scientists about Dual Use', *Science*, 326, p. 1193; Mancini, G. and Revill, J. (2009) *Promoting Sustainable Education and Awareness Raising on Biosecurity and Dual-Use*, Como and Bradford: Landau Network-Centro Volta and University of Bradford; Minehata, M. and Shinomiya, N. (2010) "Japan: Obstacles, Lessons and Future," in Brian Rappert (ed.) *Education and Ethics in the Life Sciences: Strengthening the Prohibition of Biological Weapons*, Canberra: Australian National University E Press, pp. 93-114. Available from: http://epress.anu.edu.au/education_ethics.html
[17] Gaudioso, J. (2006) *A Survey of Asian Life Scientists: The State of Biosciences, Laboratory Biosecurity, and Biosafety in Asia*, California: Sandia National Laboratories. Available from http://prod.sandia.gov/techlib/access-control.cgi/2006/060842.pdf; Gaudioso, J. and Zemlo, T. (2007) 'Survey of Bioscience Research Practices in Asia: Implications for Biosafety and Biosecurity', *Applied Biosafety*, 12(4), pp. 260-267.
[18] Barr, M. (2009) "The Importance of China as a Biosecurity Actor", in Rappert, B. and Gould, C. (eds.) *Biosecurity: Origins, Transformations and Practice*, Hampshire: Palgrave Macmillan, pp. 133-155; Barr, M. (2010) "Bioethics and Biosecurity Education in China: Rise of a Scientific Superpower", in Rappert, B. (ed.) *Education and Ethics in the Life Sciences: Strengthening the Prohibition of Biological Weapons*, Canberra: Australian National University E Press, pp. 115-130.
[19] Minehata, M. and Shinomiya, N. (2010) *op. cit.*
[20] APEC. (2003) *APEC Leaders' Statement on Health Security*, Available from http://www.apec.org/apec/leaders__declarations/2003/2003_StmtHealthSecurity.html; APEC (2003) *Strengthening Security Against Bio-Terrorist Attack and Disease Outbreaks*, Available from http://www.apec.org/apec/news___media/2003_media_releases/211003_strsecagnstbioterrorattackdisease.html; also a series of *ASEAN Regional Forum Annual Security Outlook*, Available from http://www.aseanregionalforum.org/PublicLibrary/Publications/tabid/90/Default.aspx
[21] Commission of the European Communities. (2007) *Green Paper on Bio-Preparedness*, 11 July, COM(2007)399, Brussels, European Union. Available from http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0399en01.pdf
[22] Available from http://www.unog.ch/80256EE600585943/(httpPages)/4ADF8E868AAE82B3C1257578005563E1?OpenDocument
[23] Available from http://www.biosecuritycodes.org/
[24] Available from http://bch.cbd.int/database/laws/
[25] Available from http://databases.unesco.org/bioethics/wwwi32.exe/%5Bin=interro.in%5D/
[26] The term 'biosecurity' has been defined in different concepts in different social and linguistic backgrounds in different countries. See Sunshine Project. (2003) 'Biosafety, Biosecurity, and Biological Weapons', *Background Paper on Three Agreements on Biotechnology, Health, and the Environment, and Their Potential Contribution to Biological Weapons Control*, October, Available from http://www.natwiss.de/publikationen/Biosafety_and_Biosecurity.pdf; Fidler, D. and Gostin, L. L. (2007) *Biosecurity in the Global Age: Biological Weapons, Public Health, and the Rule of Law*, CA: Stanford University Press.
[27] Barletta, M. (2002) *Biosecurity Measures for Preventing Bioterrorism*. CNS Publications, Available from http://cns.miis.edu/research/cbw/biosec/index.htm
[28] Sunshine Project. (2003) *op. cit.*, at p. 2.
[29] Mackenzie, J. (2007) 'Emerging Viral Diseases in South-East Asia and the Western Pacific: the Importance of Biosecurity and the Dilemma of Dual-Use', presentation provided at the *Regional*

Biosecurity Workshop, May, Singapore. Available from http://www.cissm.umd.edu/papers/index.php?docTitle=&author=&docNotes=&docType=&project=The%20Controlling%20Dangerous%20Pathogens%20Project at p. 5.

[30] Enemark, C. (2007) *Disease and Security: Natural Plagues and Biological Weapons in Asia*, London: Routledge.

[31] For example, APEC defined biosecurity "as risk assessment measures and agricultural best practices taken to prevent the incursion of exotic agricultural pest." See APEC. (2005) 'Proposed Report and Recommendations', presented at the *APEC Symposium on Response to Outbreaks of Avian Influenza and Preparedness for a Human Health Emergency*, 28-29 July, California, USA. at p. 2; ASEAN (2010) *Strategic Plan of Action on ASEAN Cooperation in Food, Agriculture and Forestry*, Available from http://www.aseansec.org/6218.htm

[32] Dunworth, T. (2009) "Biosecurity in New Zealand", in Rappert, B. and Gould, C. (eds.) *Biosecurity: Origins, Transformations and Practice*, Hampshire: Palgrave Macmillan, pp. 156-170., at p. 156.

[33] Ibid, at p. 169.

[34] Gaudioso (2006) *op. cit.*, at. P. 25

[35] Ibid.

[36] WHO. (2004) *Laboratory Biosafety Manual*, Geneva: WHO, at p. 47.

[37] APEC. (2002) *Report of the ISTWG Ad Hoc Group Chair: Infectious Diseases and Other Health Issues*, 24 October, AMM/036, Mexico: APEC; More recently, the ASEAN Regional Forum (ARF) has been working on biological threat reduction concerning bioterrorism as a part of public health preparedness in cooperation with the BTWC Implementation Support Unit (ISU) of the UN Department of Disarmament Affairs (DDA), WHO, FAO and International Criminal Police Organization (INTERPOL). See AR. (2009) 'Co-Chair's Summary Report', presented at the *ASEAN Regional Forum Workshop on Biological Threat Reduction*, June 10-11, Manila, Philippines.

[38] Although Taiwan is not a member state of the United Nations, "the authorities on Taiwan state they will continue to abide by the provisions of the convention". Arms Control Association. (2004) *The Biological Weapons Convention (BWC) At A Glance*, Available from http://www.armscontrol.org/factsheets/bwc

[39] United Nations. (2006) *Final Document. Sixth Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction.* BWC/CONF.VI/6, 8 December. Geneva: United Nations. Available from: http://www.opbw.org/

[40] United Nations. (2008) *Report of the Meeting of States Parties*, BWC/MSP/2008/5, 12 December, Geneva: United Nations. Available from http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G09/600/07/PDF/G0960007.pdf?OpenElement at paragraph 26-27.

[41] National legislation is a process to domestically implement the norm of an international treaty within a specific legal system of a state. Since each country possesses a different legal system, it is understood that the implementation of specific regulations are left to the discretion of States Parties. Dunworth et al., explains the different legislative process between common law and civil law traditions in order to nationally implement the BTWC. See Dunworth, T. and Mccormack, T. L, H. (2006) National Implementation of the Biological Weapons Convention. *Journal of Conflict and Security Law*, 11(1), 93-118. at p. 98.

[42] There has national legislation on biosecurity measures introduced by Centers for Disease Control (CDC), Taiwan. See http://www.cdc.gov.tw/ct.asp?xItem=7806&ctNode=935&mp=5; Biosecurity measures are laboratory biosecurity measures. This The WHO definition of laboratory biosecurity refers to 'institutional and personal security measures designed to prevent the loss, theft, misuse, diversion or intentional release of pathogens and toxins'. See World Health Organisation. (2004) *Laboratory Biosafety Manual*, Geneva: WHO, at p. 47.

[43] Republic of Korea. (2003) *National Measures or Legislation to Implement the BTWC: A Conceptual Analysis*, BWC/MSP.2003/MX/WP16, 6 August, Geneva: United Nations. Available from http://www.opbw.org/new_process/mx2003/bwc_msp.2003_mx_wp16.pdf at pp. 3-4.

[44] Australia. (2003) *Model Strategy for Implementing BWC Obligations*, BWC/MSP.2003/MX/WP39, 22 August, Geneva: United Nations. Available from http://www.opbw.org/new_process/mx2003/bwc_msp.2003_mx_wp39.pdf at p. 1-2.
[45] Australia. (2007) *Increasing the Technical Expertise of Law Enforcement Agencies to Assist Counter-Proliferation Initiatives*, BWC/MSP.2007/MX/WP12, 20 August, Geneva: United Nations. Available from http://www.opbw.org/new_process/mx2007/bwc_mx07_WP.12_EN.pdf; New Zealand. (2007) *Biosecurity-Protection from the Risks Posed by Organisms to the Economy, Environment People's Health Through Exclusion, Education and Control*, BWC/MSP.2007/MX/WP15, 21 August, Geneva: United Nations. Available from http://www.opbw.org/new_process/mx2007/bwc_mx07_WP.15_EN.pdf; Republic of Korea. (2007) *National Legislative Measures Adopted by the Republic of Korea to Implement the Biological Weapons Convention*, BWC/MSP.2007/MX/WP6, 14 August, Geneva: United Nations. Available from http://www.opbw.org/new_process/mx2007/bwc_mx07_WP.6_EN.pdf
[46] University of Sydney and the Australian National University. *National Centre for Biosecurity*, Available from http://www.biosecurity.edu.au/
[47] The Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease deals with the protection of people, animals and the environment from infectious disease, pests and other biological threats. The website is available from http://www.abcrc.org.au/pages/About.aspx; the other one is the Cooperative Research Centre for Plant Biosecurity. The website is available from http://www.crcplantbiosecurity.com.au/
[48] The Ministry of Forestry and Agriculture, *Biosecurity New Zealand*. The website is available from http://www.biosecurity.govt.nz/
[49] Republic of the Philippines Department of the Health Office of the Secretary. (2006) *Creation of a Steering Committee and Task Force / Technical Working Group for Health Sector on National Biosafety and Biosecurity Action Plan*, 15 September, Manila: Department of the Public Health. The document is available from the website of the Philippine Biosafety and Biosecurity Association (PHBBA) see http://phbba.org/new2/index.html
[50] Ibid.
[51] Asia-Pacific Biosafety Association. (2009) 'The Biosafety and Biosecurity Network of Thailand (BSNT)', *A-PBA Newsletter*, 2(2), pp. 1-12.
[52] Revill, J., Mancini, G., Minehata, M. and Shinomiya, N. (2009) *op. cit.*
[53] Sudoyo, H. (2010) 'Indonesia and the Global Challenges of Biological Control: From Jakarta to Geneva', presented at the *Workshop on "The Global Challenge of Biological Controls"*, 8-9 April, UNIDIR, Geneva, Switzerland.
[54] National Research Council. (2004) *op. cit.*
[55] Ibid., at p. 55
[56] Sudoyo, H. (2010) *op. cit*., at p. 15
[57] The website of the *Biosafety Clearing-House* of the Convention on Biological Diversity is available from http://bch.cbd.int/database/laws/
[58] Gupta, K., Karihaloo, J. L. and Khetarpal. (2008) *Biosafety Regulations of Asia-Pacific Countries*, Italy : APAARI, Asia-Pacific Consortium on Agricultural Biotechnology and FAO., at p. 28.
[59] Traditionally enhancing the ethical principles "never do any harm" with scientific knowledge has long history in medical science, including the Hippocratic Oath and the Declaration of Helsinki of 1964 for medical professionals. Recently, the WHO study group on dual-use issues and ethical responsibility of life scientists argued that "to do no harm" principle in medical ethics is not enough but what is necessary is to take "a much more proactive role in controlling the hazards associated with the misuse of genomics for biowarfare". WHO. (2005) *Life Science Research: Opportunities and Risks for Public Health Mapping the Issue*, WHO/CDS/CSR/LYO/2005.20, Geneva: WHO. at p, 6; See also WHO. (2002) *Genomics and world health. Report of the Advisory Committee on Health Research*, Geneva: World Health Organization.
[60] Miller, S. and Selgelid, M. J. (2007) "Ethical and Philosophical Consideration of the Dual-use Dilemma in the Biological Science," *Science and Engineering Ethics*, 13(4), pp. 523-580.

[61] Samihardjo, I. (2007) 'Strengthening Oversight Over Dual Use Research In Asia: Indonesian Perspective', presented at the *Regional Biosecurity Workshop*, December, Bangkok, Thailand, Available from http://www.cissm.umd.edu/papers/index.php?docTitle=&author=&docNotes=&docType=&project=The%20Controlling%20Dangerous%20Pathogens%20Project at p. 20.
[62] Ibid.
[63] QS. (2010) *Asian University Ranking: Study Life Sciences and Biomedicine in Asia*, Available from http://www.topuniversities.com/university-rankings/asian-university-rankings/life-sciences-biomedicine
[64] Minehata, M. and Shinomiya, N. (2010) *op. cit*.
[65] Barr, M. (2009) *op. cit.*.; Barr, M. (2010) *op. cit*.
[66] Mancini. G. and Revill, J. (2008) *op. cit.*
[67] Minehata, M. and Shinomiya, N. (2009) op. cit.
[68] The WHO definition of laboratory biosecurity refers to 'institutional and personal security measures designed to prevent the loss, theft, misuse, diversion or intentional release of pathogens and toxins'. See. WHO. (2004) *op. cit*., at p. 47.
[69] Biosafety measures have been taken in laboratories by safely managing pathogens and toxins with a view to preventing accidental release of bioagents into the field and the exposure of people. WHO. (2004), *op. cit*., p. 47.
[70] World Medical Association. (2008) *World Medical Association Declaration of Helsinki*, 59th WMA General Assembly, Seoul, October. Available from http://www.wma.net/en/30publications/10policies/b3/index.html
[71] The course details are available from http://143.248.248.90/eng/education/education2.html
[72] The course details are available from http://www.sbs.auckland.ac.nz/uoa/science/about/departments/sbs/student_information/biosecurity/biosecurity.cfm#Courses
[73] Gaudioso. (2007) *op. cit*., at p. 264.
[74] Ibid.
[75] World Medical Association. (2008). *op. cit*.
[76] The course details are available from http://cbme.nus.edu.sg/edu_postgrad.htm
[77] Minehata, M. and Shinomiya, N. (2009) *op. cit*.
[78] The Asia-Pacific Biosafety Training Network, Available from http://www.apbtn.org/apbtn/
[79] Janardhan, B. S. (2007) Biosafety and Biosecurity of Asia', *Current Science*, 93(3), pp. 285-286; A-PBA. (2008) *A-PBA Newsletter*, 1(1). pp. 1-8.
[80] A-PBA. (2009) 'Up-Coming APBA Events', *A-PBA Newsletter*, 2(1). pp. 1-8., at p. 3; Also at the 4th Asia-Pacific Biosafety Conference, there was a panel on *Biosecurity and Bioethics*.

Executive Summary

This investigation aims to provide an insight to help support Asia-Pacific countries in the effort to develop their biosecurity education for life scientists in order to prevent the destructive use of science. The investigation develops two stages of analysis. Firstly, the current national policy trends of regional countries on biosecurity, biosafety and bioethics issues are set out. Secondly, the investigation examines the survey results of the current state of biosecurity education at university level life science degree courses in Asia-Pacific. By doing so, the investigation is designed to identify a potential gap between national policy provisions of biosecurity issues and the implementation level of biosecurity education at universities in the region. Finally, the investigation considers potential approaches to promote biosecurity education. Findings of the investigation are summarised as follows:

Concept of Biosecurity

The concept of biosecurity in the Asia-Pacific region has much stronger traditions in relation to agricultural security, biodiversity and public health than in the sense of national security concerning biological weapons or dual-use issues.

National Policy Provisions

Regional countries commonly have national regulations on biosafety to protect biodiversity. In some countries there has been a nascent but certain development in national legislation and institutionalisation of biosecurity, including the establishment of national biosecurity centres or national networking frameworks. Regional countries have well coordinated national networking on bioethics and some have governmental committees.

University Level Education

There has been a clear lack of biosecurity modules on dual-use issues and to a certain extent in biosafety modules. However, there is a growing interest in dual-use issues in the contemporary life sciences, such as in genetic technology. The dual-use issues here are illustrated mostly in relation to the threat of bioterrorism rather than in state-level weapons programmes.

There is a highly prevalent implementation of bioethics modules. On the one hand, the content of bioethics education has a wide range of cultural and religious disciplines based on different social backgrounds. On the other hand, there is an academic trend to develop ethics education for harmonising different values as trans-cultural ethics or regional ethics.

For further Promotion of Biosecurity Education

Te investigation identified a gap between the lack of provisions on dual-use biosecurity education, and to a less extent on biosafety education, at the universities despite the presence of governmental legislation. However, there is little gap between the national policies on bioethics and provisions of university level bioethics education, i.e. there is already a sound basis to teach social topics for life scientists in the current educational environment.
Therefore, the investigation recommends the integration of dual-use issues as part of ethics education with due care to local cultural and religious principles in ethics education. The role of regional ethics associations, such as the Asian Bioethics Association, needs to be considered to help promote this process in cooperation with ethics associations of individual countries.

Biosafety can be another critical intervention point in the Asia-Pacific region. Firstly, there are more educational provisions on the topic compared to biosecurity. Secondly, scientists are more familiar with the topic compared to biosecurity. Moreover, important regional countries have started capacity building for life scientists on laboratory safety issues, such as the safe management of pathogens, and recently such efforts have been expanded to include dual-use biosecurity issues.