

# Development of an educational resource on microbes, hygiene and prudent antibiotic use for junior and senior school children

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Health promotion interventions aimed at children and young people have the potential to lay the foundations for healthy lifestyles. One such intervention, e-Bug, aims to provide schoolchildren with knowledge of prudent antibiotic use and how to reduce the spread of infection. Many children and schools approach learning in different ways; therefore, it is essential to research school needs and the variety of learning styles when creating any school resources. This article outlines the process involved during the development of a pan-European educational resource, and identifies the final pack layout, based on feedback from teacher focus groups, student questionnaires and European partner discussions.

**Keywords:** antibiotic resistance, learning styles, health

## Introduction

e-Bug is a European Directorate General for Health and Consumer Protection (DG SANCO)-sponsored project that has been developed to disseminate a school education resource across Europe. The aim of the Project is that all children will leave school with knowledge of prudent antibiotic use, and of how to reduce the spread of infections for themselves and their future young children, which is where much of the antibiotic misuse occurs. To achieve these aims, we have developed a school pack and accompanying web site to encourage a better understanding of infections and how they spread, and of antibiotic resistance. The resource comprises a series of pupil activities. It has been created for different age groups linking in with each country's national curriculum, in close collaboration with the government departments responsible for health in each country.

The Ottawa Charter signalled the emergence of a new public health movement, highlighting that health promotion should be facilitated in schools, and that action is required through

educational, professional, commercial and voluntary bodies.<sup>1</sup> The WHO has drawn attention to the importance of health education for all children,<sup>2,3</sup> including: the creation of schools as health promoting institutions; the planning of health education in the environment of the families of schoolchildren and the wider community; and for teachers to be instrumental in promoting the health of people in their school and community. These sentiments were mirrored at a WHO conference in 1991<sup>4</sup> and in the

UK White Paper 'Choosing Health—Making Healthier Choices Easier'.<sup>5</sup>

Health promotion interventions that target children and young people have the potential to lay the foundations for a healthy lifestyle that may be sustained into adulthood and passed on to future generations. Through the acquisition of knowledge, understanding and decision-making skills relating to specific health issues, schoolchildren feel empowered to make healthy choices, thereby enhancing their health in the long term. Therefore, schools are an important source of

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health promotion, as they reach a large proportion of the population from early childhood through to adolescence.

### *Learning styles*

All children are different and, as such, they approach learning in different ways. Psychologists and educationalists have developed numerous theories regarding learning styles,<sup>6</sup> some of which should be considered when creating an educational resource.

- (i) Conversation Theory.<sup>7</sup> Learning occurs through topic discussion and this suggests topics should be presented in a structured manner (learning objectives, introduction, plenary etc.).
- (ii) Visual, Audio and Kinaesthetic Learning (VAK). This emphasizes that there are three broad styles of learning and people tend to favour at least one. Therefore, it is essential that all three are utilized in the classroom.
  - (a) *Visual* learners tend to think in pictures and learn best from visual displays, taking detailed notes to absorb the information. The quality of the visual material used will have an effect on the quality of learning of visual learners.
  - (b) *Auditory* learners learn best through discussions, talking things through and listening to what others have to say. Written information may have little meaning until it is heard. Shared or paired reading and writing are essential for schoolchildren deemed auditory learners.
  - (c) *Kinaesthetic* learners prefer a hands-on approach, needing to 'do' in order to understand. They may find it hard to sit still for long periods and may become easily distracted. A three-part lesson plan with an interactive activity would be of real benefit to these schoolchildren.

It is accepted that learning styles will change as a child develops<sup>8</sup> and that learning styles are not mutually exclusive. In order to create a successful educational resource, it is important to take these learning styles, as well as teacher and student advice, into consideration. This paper outlines the process involved in the development of the e-Bug pack, which facilitates learning through all of these methods.

## Pack structure and layout

### *Teachers' needs*

At the onset of the Project, it was deemed essential to have teacher and student involvement in the development of the resource. Focus groups of both primary and secondary school teachers were established in the UK and France, in order to gain a comprehensive insight into the details of microbiology and health issues taught to 9–11- and 12–15-year-old age groups, and to establish teaching requirements for e-Bug.

In the UK, a total of five secondary school teachers and one junior school teacher took part in the focus groups. Junior and senior school focus groups were carried out on two separate days at either Gloucestershire Royal Hospital or at the Science Learning Centre, Bristol.

Prior to the focus groups, teachers were asked to complete a short questionnaire identifying:

- (i) Where they find educational resources.
- (ii) What makes a good educational resource.
- (iii) What makes a bad educational resource.
- (iv) Five things that are important in a resource.
- (v) Five teaching techniques that they routinely use with their class.

Throughout these focus groups, teachers were asked to review various educational resources currently in use around the world under the following headings:

- (i) Pack content—likes and dislikes.
- (ii) Pack design—likes and dislikes.
- (iii) How the resource could be improved.

In France, the coordinating team at Nice University Hospital asked junior and senior science school inspectors from Nice Local School Authority (Académie de Nice) to help select and contact teachers of different ages and genders, with different teaching experience, and from different socioeconomic areas of Nice. A total of five junior school teachers and five senior science teachers from four senior schools were recruited. Two different groups were organized, one with junior schools and one with senior schools, at the Department of Public Health at Nice University Hospital. Each discussion group was led by a moderator from the e-Bug Project, and an observer who took notes and recorded the discussions, making it possible to complete notes when necessary. The discussion followed the English questionnaire and French educational resources were reviewed. The observer and the moderator debriefed their observations directly following each focus group. A summary of the results, made by the moderator, was sent to all participating teachers by e-mail asking them for validation and comments.

### *Pack structure and layout (Table 1)*

All teachers emphasized that the terminology must be relevant for each age group. In junior schools it is appropriate to use words such as 'bugs' and 'germs' when introducing the topic; however, correct terminology ('microorganisms' or 'microbes') is preferred for the remainder of the syllabus. In senior schools, however, the teachers preferred to use accurate terminology, such as 'microbes', 'bacteria', 'viruses', 'fungi' etc., from the onset of the syllabus, as accurate terminology is required in examinations.

The overall teacher consensus was that large blocks of text should be avoided, as the attention span of some school children is short. Instead, the text should be split up into distinguishable boxes or bullet points, where appropriate. It was also highlighted that activity sheets in Microsoft<sup>™</sup> Word<sup>™</sup> format as opposed to PDF documents would be extremely beneficial, as teachers can then modify lessons to suit their student needs and learning abilities.

Because of the range of student learning abilities in a class, it was suggested that differentiating the resource to provide more support for less-able school children and extension activities for more-able school children would also increase the appeal to teachers.

Teachers in both France and the UK highlighted the need for a 'teacher refresher' section, in order to overcome the lack of scientific education for primary or cover/substitute teachers.

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Table 1. Summary of teacher requirements ascertained from focus groups

Resource section	Teacher requirements
General pack content	<p>† The pack will be individualized for each country with regards to curriculum links, cross-curricular capabilities etc.</p> <ul style="list-style-type: none"> <li>• Each section of the pack will highlight areas of differentiation for children of different learning abilities</li> <li>• Everything in the pack will also be available on the web at <a href="http://www.e-bug.eu">www.e-bug.eu</a>, so that teachers can modify the activities if and when necessary to suit their needs</li> <li>• All classroom activities, worksheets and fact sheets will be available in Microsoft Word format</li> </ul>
General web site content	<ul style="list-style-type: none"> <li>• Downloadable clip art for use in projects etc.</li> <li>• Competitive quizzes for student home use or teacher classroom use</li> <li>• Interactive games that reinforce the key learning objectives for home or classroom use that will last ~10 min</li> <li>• Certificates of achievement</li> <li>• An element of evaluation throughout the games</li> <li>• Games with multiplayer capabilities are very appealing</li> </ul>
Teacher sections	<p>The teacher section of the pack will contain detailed lesson plans and background information for teaching each individual topic and should also contain:</p> <ul style="list-style-type: none"> <li>• Text in large individual boxes for ease of use and manoeuvrability around the pack</li> <li>• Learning outcomes—highlighting what children will and should know at the end of the lesson</li> <li>• Links to the national curriculum and other subjects</li> <li>• Preparation section—what teachers will have to prepare in advance</li> <li>• Materials section</li> <li>• Health and Safety section</li> <li>• Introduction section—how teachers should potentially introduce the topic to students, e.g. questions they should ask etc.</li> <li>• Activity section—describing the activity in detail</li> <li>• Plenary section—describing how teachers could assess children’s knowledge at the end of the session</li> <li>• Suggested time frames</li> <li>• Background information on each section in the event that the topic is being covered by either a substitute teacher or a teacher with limited microbiology knowledge</li> <li>• Alternative methods—for when the suggested activity may not be suitable/possible in a given situation</li> <li>• Extension activities</li> </ul>
Student sections	<p>† Classroom resource material</p> <ul style="list-style-type: none"> <li>• Information sections</li> <li>• ‘Did you know?’ sections</li> <li>• Games for home and school use</li> <li>• Revision guides</li> <li>• Links to other informative sites suitable for home study</li> </ul>

### Classroom activities (Table 1)

Activities should have a ‘fun’ element, even if it is small, and not rely too much on reading comprehension. The use of a variety of media (photographs, slides, Microsoft<sup>W</sup> PowerPoint<sup>W</sup>, animation) is beneficial to help keep lessons interesting. Both junior and senior school teachers agree that stories are a useful and interesting way to provide context, with ‘disgusting’ or ‘gory’ details appealing to school children. Each group made reference to the ‘Horrible Histories’ books.

### Web site content

Teachers also provided useful information for the design of online content. Suggestions made, which were taken forward onto the web site, were that quizzes and online competitions would be popular. These could be used either as a classroom activity or as a home revision exercise.

It was agreed that, where relevant, printable (customizable) certificates should be included and that online activities should include some kind of ‘formal’ evaluation. For example, a game could include a ‘question and answer’ session at the end, so that the teacher could observe how much knowledge had been gained.

For teacher use, video clips and animations demonstrating difficult concepts would make teaching the subject easier as many children learn better through visual stimulation. Taking this concept a step further, it was also suggested that all characters and relevant animations should be available as downloadable clip art for student and teacher classroom use.

### The draft layout

Draft layouts of the junior and senior e-Bug packs were developed after taking into consideration the key points from the teacher focus groups and results from the research into the national curricula in each partner country (Table 1).<sup>9</sup>

Table 2. Draft e-Bug junior pack layout and key messages

Pack sections	Junior pack	Key messages
Introduction to Microbes	An Introduction	(1) There are three different types of microbes: viruses, bacteria and fungi (2) They are found everywhere, even though you can't see them
	Good Microbes	(1) Most microbes are good for us (2) Good bacteria help keep us healthy (3) They can be put to good use
	Bad Microbes	(1) Sometimes microbes can make us sick
Spread of Infection (1) Prevention, when possible, is better than cure (treatment) (2) Keep your bad microbes to yourself (3) Our body helps defend against microbes	Hand Hygiene	(1) Wash your hands (once, twice) (a) How and when to wash your hands
	Respiratory Hygiene	(1) Cover your coughs and sneezes (2) (Sneeze in your sleeve or equivalent)
	Food Hygiene	(1) Microbes can spread via raw meat
Treatment of Infection	Antibiotic Use	(1) Most common infections get better on their own (2) Sometimes your doctor needs to give you an antibiotic (3) If you take antibiotics, finish the course
Prevention of Infection	Vaccines	(1) Vaccines are important to prevent a range of infections (2) There aren't vaccines for all infections

It was decided that e-Bug should be a teacher resource, with lesson plans and interactive activities for school children. Each section of the pack would contain key student learning outcomes and teacher sections with background or refresher information to familiarize teachers with the topic and keywords. Each section would also contain detailed information on how teachers should prepare to teach the lesson in advance, including the materials required, and health and safety information. This would be followed by a detailed lesson plan with pointers on how to introduce the topic, carry out the activity and run a follow-up plenary session. There would then be a final homework section with a smaller take-home activity, where the key messages from that section could be taken home to the family environment. Student sections would include fact sheets, fascinating facts and worksheets suitable to each topic.

Through research into other educational resources available at the time and teacher's suggestions, a range of interactive activities were selected for each pack section and taken to project partners for suggestions.

#### Partner country views

A research dissemination meeting in Prague, attended by 36 health and education representatives from e-Bug partner countries, formed a focus group session. Breakout groups of three to five people discussed each pack section under the following headings:

- (i) Are the key messages appropriate?
- (ii) Does this activity cover one of the key messages?

- (iii) Is the lesson plan at the correct level for each age group?
- (iv) Is this activity practical for classroom use?
- (v) How can the lesson plan and activity be improved?
- (vi) Suggest another activity to cover the key messages.

At the end of each pack section breakout, the discussion points from all groups were collected, and the main points were collated for consideration during pack and web site development.

The meeting provided a unique opportunity to address both the associate and collaborating partners on this proposed pack and web site structure. It was agreed that the general pack structure and layout (Table 2) was appropriate to suit each country's needs. Based on this structure, partners then agreed on key learning outcomes (Table 3) for each pack section. The main points highlighted that the pack and web site should focus on health and the human body, and not venture into other areas of the science microbiology curriculum, such as composting. This discussion also led to a clearer idea of what each country needed from their educational resource and highlighted the necessity for slight country variation/adaptation in pack content. Discussions on various interactive activity ideas shed light on what countries expected from a resource of this type.

#### Student artwork questionnaires

Both teacher and partner focus groups agreed that it was essential for school children to relate to pack topics, and considered it necessary to involve this target audience in the development of the pack and web site artwork. In order to achieve this outcome,

Table 3. Draft e-Bug senior pack layout and key messages

Pack section	Senior pack	Key messages
Introduction to Microbes	An Introduction	(1) There are three different types of microbes: viruses, bacteria and fungi (2) They are found everywhere, even though you can't see them (3) They are all different shapes and sizes
	Good Microbes	(1) Most microbes are good for us (a) Good bacteria help keep us healthy (b) They can be put to good use  (2) We need bacterial colonization to live a healthy life (normal flora) (3) Protect your normal flora
	Bad Microbes	(1) Sometimes microbes can make us sick
Spread of Infection (1) Prevention, when possible, is better than cure (treatment) (2) Keep your bad microbes to yourself (3) Our body helps defend against microbes	Hand Hygiene	(1) Wash your hands  (a) How (warm water/soap), when and why to wash your hands
	Respiratory Hygiene	(1) Cover your coughs and sneezes  (a) sneeze in your sleeve or on a tissue (country dependent)
	Sexually Transmitted Infections	(1) Microbes can spread via unprotected sexual activity
Treatment of Infection	Antibiotic Use	(1) Most common infections get better on their own (a) Sometimes your doctor needs to give you an antibiotic  (2) If you take antibiotics, finish the course (3) Do not use leftover antibiotics or other people's antibiotics (4) Antibiotics are special medicines designed to cure bacterial infections but not viral infections (5) Overuse of antibiotics can lead to antibiotic resistance in bacteria and affect our normal flora (6) Bacteria are becoming resistant to many antibiotics due to antibiotic overuse and misuse
Prevention of Infection	Vaccines	(1) Vaccines are important to prevent a range of viral and bacterial infections (2) There aren't vaccines for all infections

junior and senior school children took part in a series of artwork development questionnaires in order to assess the most appropriate style of pack artwork.

#### Questionnaire 1(a)

To determine the style of the junior pack human characters, e-Bug artists drew sketches of various human character styles (Figure 1), and asked school children to choose which they preferred and why. The class teachers summarized the comments and returned the questionnaires to the artists. School children preferred the characters in Group 4 (Figure 1), as they were more realistic and mischievous looking, with comments including: '... a devil in disguise, look at his grin;' and '... looks like she gets up to a lot of mischief.' However, unfavourable

comments included: '... looks like he tries to be funny but isn't;' and '... she thinks she's cool but isn't.'

On closer questioning of school children it was realized that these comments referred to facial structure, which they thought 'looked like rubber' in the male character and referred to what the school children perceived as the 'old-fashioned' style clothing of the female character. The school children also did not like the fact that the characters looked like brother and sister.

#### Questionnaire 1(b)

Based on the feedback from Questionnaire 1(a), the selected characters were drawn and school children were asked to comment on the characters' clothing, facial features and hair-styles (Figure 2). The class teachers summarized the comments



Figure 1. Questionnaire 1: character sketches.

and returned the questionnaires to the artists. School children preferred the female character in a denim skirt rather than trousers. Nineteen school children also preferred hairstyle (c) (Figure 2), stating that the other styles were for 'older girls'. Various facial structures, hair and clothing were trialled for the male character. Most school children (22/30) preferred facial structure (a), as this was more realistic, and clothing option (b), because it 'looked cool'; option (c) was for an older boy (Figure 2). The final characters are shown in Figure 3(a).

#### Questionnaire 2(a)

To determine the style of the junior pack microbes, e-Bug artists sketched from electron microscope photographs of various microbes and asked school children to comment on whether or not they liked the images, if they thought the microbes were good or bad, and to describe the pictures. Two images of different styles of good and bad microbes were drawn based on scanning electron microscope photographs. School children preferred image (b) for the good microbes, because it looked friendly, while the more muscular looking character in image (a) was unappealing. For the bad microbes, school children preferred image (a), because it was scary and they did not like what they perceived to be a 'stupid' look as in image (b).

The images were then further developed by the artists so that harmful microbes were instantly recognizable by their bold bushy eyebrows, menacing eyes and dark green colour. In contrast, useful microbes had happy faces and eyes, and were light green in colour (Figure 3b).

The senior school artwork was developed in the same way by school children. The school children preferred the characters in the senior school pack to be dressed casually and to be of the appropriate weight, with the senior female character being redrawn three times because school children thought she was too thin. Senior school children preferred more realistic 'three-dimensional' microbes (Figure 3d).

Artists and graphic designers were essential members of the e-Bug team, and ensured that the e-Bug pack covers and the

layout of lesson pages had a very professional finish. This was particularly important when showing the resources to stakeholders during the marketing and implementation of the product.

## Conclusions

Teacher focus groups provided an in-depth perspective of what the main stakeholders (the schools) require. Their advice and insight proved invaluable in the design of pack and web site activities. Aside from providing guidance in suitable pack content for classroom use, the teacher focus groups provided valuable advice on favourable pack design.

### Suggested resource layout

#### General pack content

The pack will be individualized for each country with regards to curriculum links, cross curricular capabilities and some key health messages. For example, the health departments of some countries promote sneezing into a tissue, whereas some follow the extended US CDC message of 'sneeze on your sleeve'.<sup>9</sup> Each pack section will have extension activities suitable for children of different learning abilities. All pack content will also be available on the e-Bug web site in Microsoft Word format, which will allow teachers to modify the activities if and when necessary to suit the needs of their school.

#### Teacher section

Although all teachers across Europe must undergo professional training and specialize in a specific subject area for both junior and senior schools,<sup>10</sup> this subject may not necessarily be science. Teacher focus groups highlighted that, particularly in primary schools, many of the teachers do not have a science background and, as such, may feel uncomfortable teaching

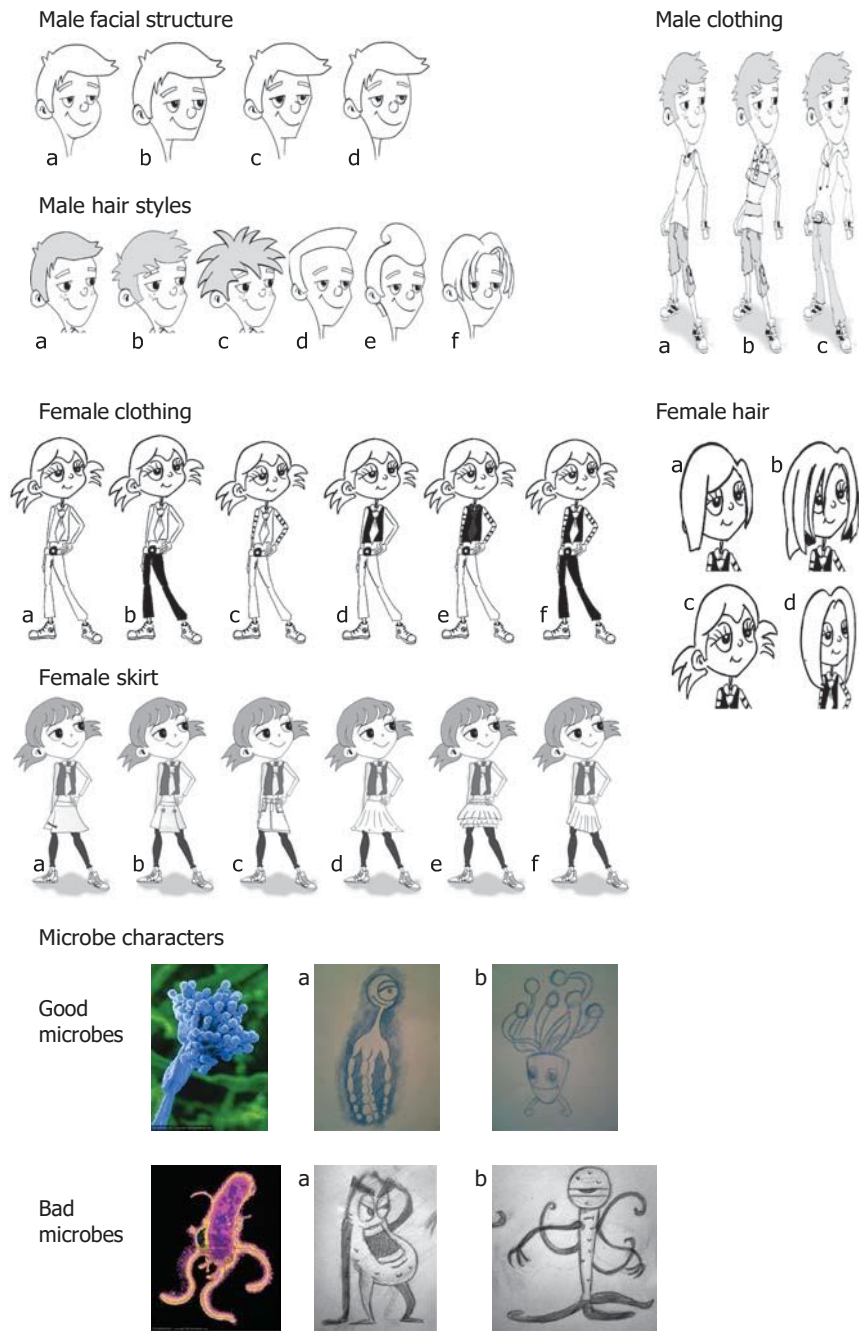


Figure 2. Questionnaires 1(b) and 2(a): human and microbe character development. This figure appears in colour in the online version of *JAC* and in black and white in the print version of *JAC*.

this difficult topic. Taking this into consideration, the teacher section of the pack will contain detailed lesson plans and refresher background information on each section, in the event that the topic is being covered by either a substitute teacher or a teacher with limited microbiology knowledge. Moreover, it will:

- (i) Contain text in large individual boxes for ease of use and manoeuvrability around the pack.
- (ii) Highlight the main learning outcomes (what children actually and should know at the end of the lesson).
- (iii) Have clear links to local national curricula and other relevant subjects.
- (iv) Have a preparation section on what teachers will have to prepare in advance, listing all the materials required to carry out the activity, and also health and safety information.



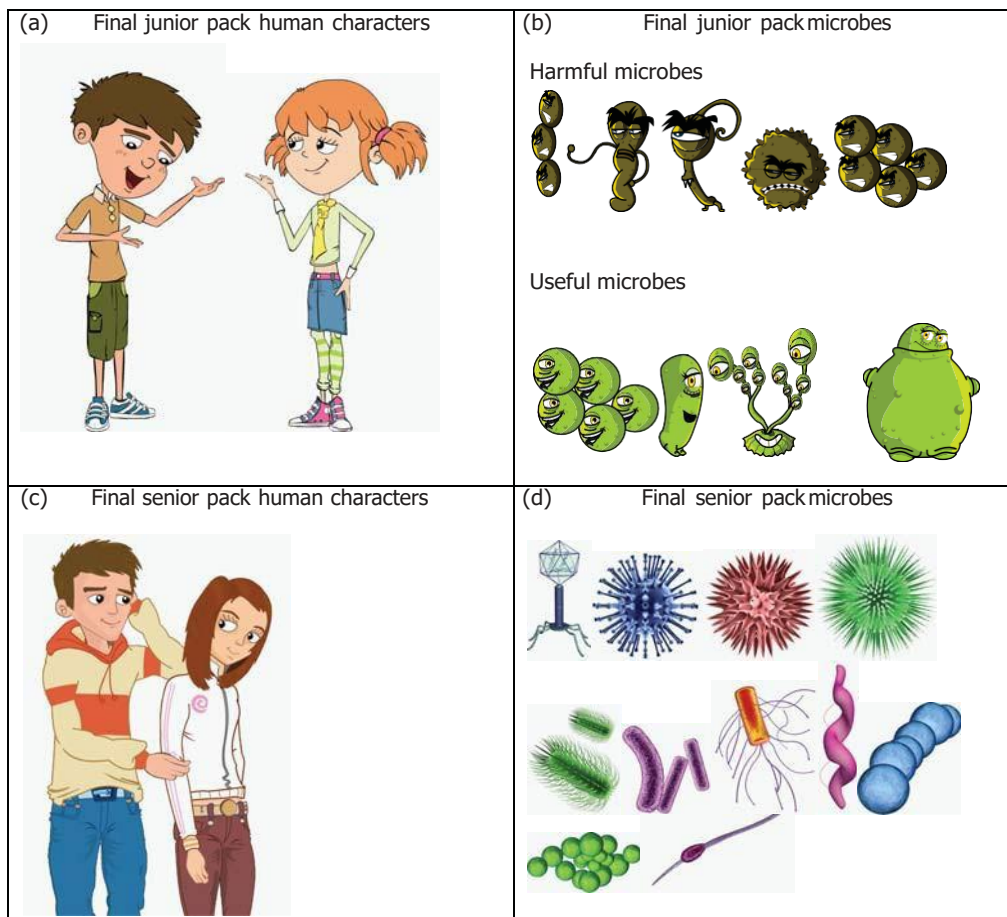


Figure 3. Final e-Bug human and microbe characters. This figure appears in colour in the online version of *JAC* and in black and white in the print version of *JAC*.

### Lesson plan

In accordance with the Pask theory of conversation learning,<sup>7</sup> each lesson plan has been developed in a structured manner with an opening introductory section suggesting how teachers may introduce the topic to the school children and the questions they should ask. This is then followed by an interactive activity, all of which have been designed taking into consideration VAK learning. The artwork developed for the packs and each section has all been developed with student input, and, as such, is suitable for visual learners. The background information provided for teachers allows fuller teacher understanding of each topic, so that they can have the in-depth discussions required by auditory learners. All the activities, including the reading comprehension, have a 'hands on' approach suitable for kinaesthetic learners. Lastly, the lesson plan ends with a plenary session describing how the teachers could assess what school children have learned at the end of the session.

All activities have been developed to be as budget-friendly as possible, using resources that are normally found in a school or are easy to acquire. In some cases, alternative resources have been suggested for those that are more difficult to acquire in the main activity. For example, glitter and oil have been

suggested for use in the junior schools' hand hygiene activity as an alternative to a glow-under-UV-light gel. In other cases, such as the antibiotic section in senior schools, a complete alternative activity has been developed for when the suggested activity may not be suitable or possible in a given school environment (e.g. some schools may not have a water bath or incubator to make yogurt in the section on good microbes). Extension activities have also been created in each of the topic areas and designed as either supplementary lessons for more-able school children or as homework activities.

### Student section

Each section of the pack also contains student classroom materials in the form of information sheets and worksheets. As required by the teacher focus groups, these worksheets contain blocks of information in language that is easy to understand rather than continuous prose. 'Did you know?' sections relevant to each topic have been included to make the worksheets interesting for the school children, and the human and microbe characters have also been added where appropriate. The colour scheme of these sheets has also been developed to allow clear photocopying.

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