

# CPD 2 Contextualised biology teaching through storylines

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## Module introduction

This module consists of an introduction and two activities. It is intended for use with teachers to develop ideas about contextualised biology teaching through storylines. The activities could be delivered in about 1 hour. Teachers should be asked to undertake the suggested pre-reading for each activity in advance since reading stories in a CPD session will increase the length of time required.

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## The structure of this module

### Preparatory tasks

- Pre-reading for Activity 1 – Student Activity 1.1 Mark's and Peter's stories.
- Pre-reading for Activity 2 – The two articles in Appendix 1, p. 7 and Appendix, pp. 7–9.

### Introduction

This module has an interactive introductory presentation with commentary – 'Why teach contextualised biology through storylines?'. This could be looked at by teachers individually before the session, or in a group at the start of the staff development session.

A more detailed introduction to the CPD is provided in these Facilitator notes to give you further background.

### Activity 1 Getting to grips with storylines

Facilitator notes and Activity sheet are provided. See pp. 3–5 of the Facilitator notes for more details.

Access to the SNAB AS Student book and Student Activity 1.1 is required.

Estimated delivery time: 30 minutes
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### Activity 2 Using additional stories within topics

Facilitator notes and Activity sheet are provided. See pp. 5–6 of the Facilitator notes for more details.

Access to the two articles in Appendix 1 and Appendix 2 is required. They can be found on pp. 7–9 of these Facilitator notes.

Estimated delivery time: 20 minutes
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## Introducing the activities

Many students see science in schools and colleges as not being very exciting or relevant. In 2002, when the Science and Technology Committee's report on Science Education from 14 to 19 was published, Dr Ian Gibson (2002), Chairman of the Committee, said 'Science should be the most exciting subject on the school curriculum: scientific controversies and breakthroughs hit the headlines every day. But school science can be so boring it puts young people off science for life.'

In a web-based survey conducted by Planet Science, the majority of the 2000 students, mostly aged 16–19, who responded agreed that the lack of relevance to the real world made school science less attractive to them.

## Why use contexts?

Salters-Nuffield Advanced Biology adopts a context-led approach. Each topic introduces either a storyline or a contemporary issue and this is followed by the biology that is needed to understand the story or issue. For example, the storyline in Topic 4 relates to the difficulties plants face in being stuck in one place; it investigates the methods plants have developed to overcome these problems and looks at how people have exploited them. Within a topic, additional contexts may also be provided to illustrate particular ideas.

## To engage and motivate students

Inspired students have a zest for learning. These are the ones who read around the subject, subscribe to magazines, visit websites, attend lessons regularly and punctually, and, above all, spend time studying. So, how do we inspire students? Firstly, by our own behaviour: clearly, to learn, students must communicate with the teacher, and a storyline makes communication much easier. Secondly, we stimulate students' interest by using 'real' biology and a learning context relevant to the students' lives. If we have students' interest, their learning is quicker and easier.

## As a pathway

It is said that:

Experts notice features and meaningful patterns of information that are not noticed by novices. Experts have acquired a great deal of content

knowledge that is organised in ways that reflect a deep understanding of the subject matter.

Bransford, J. D., Brown, A. L. and Cocking, R. R. (eds) (1999) *How People Learn: Brain, Mind, Experience, and School*

Teachers are the experts in their subjects and may have organised the subject matter in such a way that they can teach with little reference to notes. However, we may not present the material in a way that helps students to see the patterns. Teachers and lecturers can, over time, forget what it's like to be a learner.

Students, lacking an overview, may have an uphill struggle with the subject matter; and a storyline can provide a framework for their learning, often an anchor point to which they can return. In some SNAB topics, such as the cystic fibrosis dilemma story of Topic 2, this is very evident. In other topics, storylines are less apparent, but it is, nevertheless, useful to remind students of the thread.

At their simplest, storylines are flowcharts that set out an order in which lessons can be taught. At their best, storylines introduce individual stories which allow students to identify with biological concepts: the flowchart turns into a concept map. It may require the skill of the teacher to help the student to make the connections between storyline and concepts.

Professor Peter Fensham (2002), in 'Science as Story: Science Education by Story': said:

Good stories have characters, events and a plot that is woven by the way the characters interact with each other and with the events. It is the quality of this interweaving of the human flow of time and space that makes stories so attractive and so memorable. This is the very opposite of the abstract and conceptual way we have been presenting the central content of school science for most of the last thirty years. For most students this approach seems rootless, suspended beyond time and space, and not surprisingly, is hard for learners to comprehend and build into their long-term memories.

## As opportunities for class discussion

Teaching biology in context should assist the development of higher-level skills in students. For example, with a context-led approach different areas of biology are linked together so students should not see them as separate entities. The

introduction of one aspect of biology in one topic and the addition of more breadth and/or depth in later topics further develops the linking of biological ideas.

Science is often presented as having 'right' and 'wrong' answers, with little scope for students to express their own opinions. It is hoped that SNAB goes some way towards rectifying the situation as there is ample opportunity for debate. In particular, the storyline approach invites discussion which should help to fulfil our aim of educating students to make them biologically literate citizens. This should enable them to evaluate scientific arguments and make appropriate decisions affecting their own lives and the wellbeing of society.

### **Building in more contextualisation**

The storylines selected for use in Salters-Nuffield Advanced Biology had to be 'long-lived'. At the time of developing the course foot and mouth

disease was very topical and prominent in the media, but its use as a context would have made the course date very quickly. The contexts selected will, we hope, remain topical for years to come.

To make the material more topical or relevant to particular groups of students, teachers can introduce additional contexts. For example, the most recent doping scandal to hit the headlines is, for most students, a meaningful introduction to the problems of drugs in sport. Any SNAB activities can be adapted or replaced with ones that use new or topical, or different contexts.

Inviting 'real-life' scientists into your schools or colleges (for example, a molecular biologist, the warden of a wildlife reserve or a hospital doctor) provides you with more opportunities to link principles to real-life situations. The visit or issue coursework report for SNAB gives further opportunities to study biological principles in real-life contexts.

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## **Delivering the activities**

### **Activity 1 Getting to grips with storylines**

The aim of this activity is to get teachers/lecturers to think about the use of storylines in a context-led approach and to reflect on the advantages of their use as described in the introduction. Most teachers have developed ways of delivering content with notes and techniques developed over the years, and may regard storylines with scepticism. This activity also aims to help teachers become aware that familiarity with the storyline from the outset can enhance its value and overcome potential problems with its use.

### ***Suggested delivery method***

The activity requires teachers to look through Topic 1 and in particular Student Activity 1.1, so access to the SNAB AS Student book and the Student Activity sheet is required. Guidance notes on outcomes for each task are provided below.

Estimated delivery time: 30 minutes

### ***Task 1***

Mark's and Peter's stories provide the introductory story. The storyline is about the risk of developing cardiovascular disease, both in the case of Mark and Peter and for any one of us.

### ***Task 2***

Topic 1 could be presented without reference to Mark and Peter and any consideration of their particular risk factors.

### ***Task 3***

Activity 1.1 presents detailed accounts of Mark's and Peter's experiences. It is hoped that it will capture student interest, provide an overview of some of the material that will be covered in the topic, and provide a structure for the teaching of the subsequent material.

#### **Task 4**

Mark's and Peter's stories are real, but both are unusual cases with neither appearing to be obviously at risk. This can be used to highlight the fact that there may be no early signs or symptoms of cardiovascular disease and lifestyle choices should not be delayed until there is a problem. In fact Mark did not have a stroke as a result of atherosclerosis; he probably had a genetic predisposition for thin walls in arteries. This provides a link with genetic inheritance in Topic 2.

#### **Task 5**

**1 Use of teaching time** If the introduction of a storyline is very rushed, the message that it is peripheral will be conveyed to the students: they will perceive the storyline as an unnecessary impediment to their obtaining the 'real facts'.

Feedback from the pilot course suggested that teachers and students do feel storylines are worth the time. Presentation of the storyline needs to be planned and given time. There is a big temptation to regard the lesson as planned: the student just does Activity 1.1 and then sits back to enjoy the story. While enjoyment may be a laudable aim, students will not benefit as much as they could from the story unless certain actions are taken as listed below:

- Ensure that you, as the teacher, know some of the background to the story.
- Decide what you want students to accomplish through the lesson in which the story is introduced. Set objectives for the lesson. For instance, you could: list what the students should know and understand from the story; identify any skills that could be developed by reading the story; identify any issues that students should be aware of, or that may require analysis. It is particularly important that these objectives are as specific as possible and that they are shared with the students.
- Whatever strategy is chosen, the teacher will need to discuss the story with students.
- Summarise findings or the results of discussion on the board or OHP. Surprisingly, teachers often forget to do this.

Some students may think that a story is silly and irrelevant. Positive presentation of the story combined with developing a positive and collaborative working atmosphere should dispel this impression among students. There were feedback comments from students that Mark's story was unbelievable and was made up. This is not the case. Some students thought Activity 2.1 was not realistic and of course it is not. It is very unlikely that any group of people would have a conversation that gave a complete summary in the way this script does. If students raise these sorts of comments, it is worth explaining that it's an activity with the purpose of providing an overview of the topic and so is, of course, a bit contrived. But that does not mean it is not a valuable exercise to get them thinking about the topic. Listen to students and value their views. Remember that humour nearly always helps.

**2 Getting sidetracked** Students may become sidetracked and fail to see the biological concepts or the 'big picture' through the storylines.

Mark's story, for example, can awaken student interest and empathy. As one goes through the topic, having a storyline to refer to provides opportunities for discussion, reasoning and evaluation. With Mark's and Peter's stories, the student may be discussing what has happened to Mark and Peter, what the causes of their CVD were, and how they might have reduced their risk. It should certainly deepen their thinking about probability, and clarify their notions of risk. However, once into the sections looking at the separate risk factors there is a need to link back to the storyline to maintain coherence.

It is also worth noting that where social and ethical issues are involved, weaker students may get sidetracked concentrating too much on these and not on biological principles.

**3 Losing the storyline** Some stories are not as obvious as they are not built around personal human stories and some do not continue throughout a topic.

In the pilot some students asked if the later topics could be introduced with stories in much the same way as Topics 1 and 2 are. However, there are disadvantages in starting every topic with a human interest story (suppose we had started Topic 3 with a story about a child with FOP, Topic 4 with a story of islanders surrounded by rising sea levels, Topic 5 with a story of an Australian farmer ruined by an explosion in rabbit numbers, and so on). It was decided that a variety of styles would give better balance to the course and hopefully satisfy different students' preferred approaches.

In some cases, reference to the original story may be fairly light through the topic. Later in Topic 2, for example, there is little reference to Claire and Nathan, but it is recommended in the route through that the story is returned to at the end with a short discussion to decide what the couple should do about their dilemma. In this way the story is completed and students do not feel that they are left with unfinished business.

Sometimes a story is used to introduce a topic, but as the topic progresses there is widening out to encompass related issues. This is more noticeable in the topics with issues as the context rather than a personal story. For example the development story of Topic 3 – a single egg to a complex multicellular organism – widens to include the influence of genes and the environment on this development. It also includes cancer and what happens when development goes wrong. All these areas are related to the core storyline of the topic.

### **Task 6**

The story is the development of a single egg into a complex multicellular organism. Storylines include the influence of genes and the environment on this development, the story of cancer and what happens when development goes wrong.

### **Activity 2 Using additional stories within topics**

The aim of this activity is to encourage teachers to think about the use of stories. The introduction of an additional story into Topic 2 is considered.

### **Suggested delivery method**

Teachers should read the resource articles individually and highlight the biology before discussing the questions in small groups. Guidance notes on outcomes for each task are provided below.

Estimated delivery time: 20 minutes (not including time for reading the articles)

### **Task 1**

A few suggestions for biological ideas that could be introduced include:

- Hunter disease is an inherited disorder, caused by a recessive allele.
- It is sex-linked, so sons inherit the alleles from their mother.
- Possession of the recessive allele means that an enzyme that breaks down polymucosaccharides is missing; these sugars then accumulate, causing distressing symptoms.
- Expression of the defective gene results in symptoms that impair body function.
- The effect of reduced enzyme concentration on rate of reaction.
- Gene therapy and an appreciation that there are ethical arguments for and against the use of gene therapy for Hunter's patients.
- Genetic screening, in particular the issue of pre-implantation sex determination.

**Task 2**

Students could read the story and identify the biological ideas covered by it. These could then be presented in subsequent lessons. Alternatively, a more problem-solving approach towards learning could be used: this is commonly used in medical school. The class, or groups within the class, read the story and identify the biology they need to learn to understand the story. Individuals could then each research one aspect that they then present to the rest of the group. The amount of guidance on what aspects to study and additional teaching will be dependent on the ability of the group members.

In a group discussion it may be necessary to guide the students. This may be a non-directive, 'Well what do you think?', approach, a directive extraction of wisdom from your students, or a middle-ground approach. The first is a more open approach where the discussion will be less structured. The second will be more focused on achieving the answers to some specific questions. The third might be a combination of the first two approaches.

Again, remember that weaker students usually concentrate on opinion issues (as they do in exams), so it may be necessary to keep the students moving towards science, evidence and analysis.

**Task 3**

This story could be used in addition to the main cystic fibrosis story presented in Topic 2. It could be introduced briefly and used when looking at inheritance in terms of the expression of recessive alleles rather than dominant alleles. However, it deals with sex-linkage that is not on the specification so with weaker students it could cause confusion. Protein synthesis, protein structure and enzymes could also be presented in this context, as could gene therapy.

It does provide some attributes of a good story. These include:

- being real
- arousing interest and empathy
- being current / recent
- having a pedagogic value
- including direct or reported speech
- developing higher-level reasoning skills and possibly requiring a decision to be made.

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## Appendix 1: Pre-reading for Activity 2

### Hunter disease

[A] rare hereditary disorder characterised by dwarfism, a coarse \*facies, . . . and mental retardation and deafness.

Speech and mental development are delayed, the child has frequent respiratory infections, and as the disease progresses a typical constellation of physical signs becomes evident: protuberant abdomen, claw hands, excessive hair growth, coarsening of the face with grotesque facial features; retarded growth, and behaviour problems.

The mental and physical defects are caused by a defect in the chemical breakdown of the mucopolysaccharides, carbohydrates essential in the development of the connective tissues, and the consequent accumulation of mucopolysaccharides in the body.

The disease affects almost exclusively males; cases in females are very rare but not unknown. It makes its first appearance during the first three years of life. An affected child may appear normal up to about 1 year of life. The visceral\* involvement is progressive and death by early adulthood is usual. Most patients die before age 15. Inheritance is autosomal X-linked, about 33% of cases represent a new mutation. Occurrence is 1:40,000.

In past literature [it was] referred to as mild Hunter's gargoylism, or Hurler–Hunter. A mild form and a severe form [are] distinguished; however, the severe one is less severe than Hurler's syndrome.

From the 'whonamedit' website – Hunter's syndrome (Charles A. Hunter). The website can be found in the weblinks section for this topic.

\*facies – the general form and appearance of an individual.

\*viscera – the large internal organs of the body collectively, especially those in the abdominal cavity.

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## Appendix 2: Pre-reading for Activity 2

### Hunter disease cruelly robs my children of health: one man's story

Our little boys have Hunter disease, a genetic disorder so rare that there are fewer than 100 sufferers on Great Ormond Street Hospital's register. Jamie is five and Jack is two. We were a normal everyday couple; I ran a computer software business and Rebecca was a part-time junior teacher. We married in 1994 and both wanted children so Rebecca was thrilled to find herself pregnant with Jamie two months later.

Both lads started life as normal, healthy babies, but Hunter's is gradually attacking every organ in their bodies. We clutch at straws despite knowing that children with this particular Hunter's rarely survive to adulthood. Jamie is on constant medication and has had several operations. Jack's so active and healthy we can't believe he will go the same way. He's so lively it's sometimes hard to believe that anything's wrong with him, let alone anything so serious. Life is pretty much scheduled out for us. This week, for instance, Jamie has a pulmonary clinic visit, series of x-rays, and an MRI under general anaesthetic. (A tiny baby's breathing tube for a baby is all they can use, for this, as a normal tube would kill him.) Jack has an ophthalmology visit and blood tests.

Hunter's weakens cartilage and damages the airways, so nights are bad: when they lie down the boys can scarcely breathe. If they get to sleep, they snore loudly. We lie awake listening. Being older, Jamie's the worst, though removing his tonsils and adenoids has helped a bit.

When they wake up, like arthritic old men, the lads creak and groan as Hunter's gradually shortens all their tendons. Jamie's in real trouble: he has to wear night-time leg braces; he can't raise his arms up above his head and he's had surgery to stretch the

tendons in his legs and to stop his fingers from clenching together. I tell myself he's OK, but I know he's not when I see him trying to run around with other kids. He can't keep up, his growth is stunted and the nerves in his ears are damaged so he can't hear or speak clearly. We miss about 60% of the words he speaks. That apart, he seems so quick, so alert. I know Hunter's attacks the brain, but specialists are kind – they won't tell us if Jamie's mentally affected.

Some days pass as a blur; I'm so tired from lack of sleep. Rebecca's fantastic: she copes far better than me and keeps me going when I feel overwhelmed. We don't consider what the boys will be when they grow up. We simply wonder if they will get the chance to grow up.

Like many men, I wanted boys so that I could do the normal things that dads do with sons, like kicking a ball about with them. If we'd had girls, they would have been healthy. Hunter's only affects boys. Rebecca would like another child – we've been told we'd be able to select a girl, but I don't know whether I've got the energy for another child.

When Jamie was born, there were a few complications and he spent two weeks in intensive care. He appeared a normal cheerful little chap and gave us so much pleasure we decided to have another child straight away. Jack was born, again, we thought, happy and healthy. By now Jamie had been diagnosed as having a heart murmur. This is not uncommon so we weren't unduly worried. However, he began to get one cold after another and the doctor began to do tests. When he gently broke the news, time instantly stopped for me. I asked how long Jamie would live and, in the worst moment of my life, I got a straight answer. We were told that Jamie was born with a defective gene, a gene that produces an enzyme vital for breaking down special sugars called mucopolysaccharides. Without it, the sugars build up in the body and ultimately damage all the organs.

I looked up 'Hunter disease' on the Internet and found that this is a deadly and terminal disease with no cure. Jamie had the worst type of Hunter's. I learnt it has physical and mental effects, causing heart disease, liver disease and brain damage, eventually affecting almost every cell and organ in the body. I found that the condition was inherited, so there was a chance Jack could have it, too. We looked at our beautiful baby, and begged for him to be tested at just 6 months: if there was a problem, we had to know.

Jack's diagnosis came through quickly: he too had Hunter's. Rebecca learnt that Hunter disease is passed from mother to son. She was a carrier, but Rebecca and everyone in her family is healthy, so she had had no idea. She thought it was her fault, and didn't need to listen to the Great Ormond Street specialist's list of future problems we'd face – breathing problems, mental retardation, dwarfism, deafness, distorted limbs and facial features, heart attacks, to name a few. Rebecca took it very badly and her mother immediately took the boys in and we went off together for a weekend in a hotel to sort our lives out.

My boys are adorable, and they adore each other. Currently they have no idea that they are different in any way and play with each other all the time. Jack with his little swollen tummy (caused by the enlarged liver trying to break down the sugars in the body) worships Jamie. Heaven knows what we'll all do if Jamie dies. They are incredibly brave. Jamie, especially, has been through so much – injections, operations and pain. Strangely, a visit to the dentist seems to be the worst experience for him. Only then does he scream the place down, and that's just for the hygienist! We're glad he's tough; he's certainly going to need all the strength that God gives.

Rebecca works two days a week. It provides an element of normality that helps her to cope with the boys. Her mother is a diamond; she looks after the boys for us on those days. We couldn't manage without her. Like others in the same boat, we try ensure the

boys stay as comfortable as possible and cram as much fun as we can into our lives. I guess we spoil them – our garden's a kids' playground, but we have to make the most of the limited time we have with them. We go off to theme parks and on as many family trips as we can manage. This summer we're off to Disneyland, Paris for 5 days. We've had the boys' medical notes translated into French and we will worry about illness, but we're determined to do it.

Life can be so unkind, but I tell myself that it is worse for the children and that my role in life is to try to make their short lives as happy and fulfilling as possible. In our darkest moments it seems that the bottom has fallen out of our world. Then we hug each other and cry. We try not to be bitter and avoid thinking about what might have been. We don't think much about the long term. Despite everything, the boys are so happy, we love them so much and they've brought us so much joy that I couldn't manage without them. I know that Rebecca is stronger person for the experience and hope I am too.

I still search the Internet. I know that enzyme replacement therapy in which the child is given a transfusion of the missing enzyme once a week, is a future option. It can't cure but it can halt the damage, especially to the heart. This is what usually causes the eventual death of Hunter's boys. We're praying it will be available in the next two years. There'll be a tremendous cost, and if it's not available on the NHS, what will we do? The ultimate solution may be gene therapy. I read all I can about this and understand that when you inject the child with a good copy of the defective gene, the child then makes the missing enzyme. My Jamie is so badly affected that I wonder how many genes they can inject. I know we're years off from this, so try not to build up hope. We don't think about next week, let alone next year. We take each day as it comes, and are thankful for the smallest mercies.