We will inform centres about any changes to the specification. We will also publish changes on our website. The latest version of our specification will always be the one on our website (www.ocr.org.uk) and this may differ from printed versions.

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Registered office: 1 Hills Road
Cambridge
CB1 2EU

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Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- **Content:** a clear outline of the content covered by the delivery guide;
- **Thinking Conceptually:** expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- **Thinking Contextually:** a range of suggested teaching activities using a variety of themes so that different activities can be selected that best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk.
### The cellular basis of cancer and treatment 3.3.1

| (a) | the factors that may increase the risk of developing non-communicable disease | Factors to include heredity, ageing, types of radiation, carcinogen, viruses and air pollution and diseases to include cancers and asthma AND to include an evaluation of epidemiological and other evidence to identify correlations. |
| (b) | the cellular basis of cancer | To include an outline of cell cycle control and the changes in control which lead to the formation of tumours and metastases. |
| (c) | how mutations to proto-oncogenes can lead to cancer | To include Ras and Myc proto-oncogenes. |
| (d) | how mutations to tumour suppressor genes can lead to cancer | To include the p53 gene. |
| (e) | the evaluation of epidemiological evidence linking potential risk factors with particular forms of cancer | To include smoking and lung cancer, diet and bowel cancer, BRCA1 gene mutations and breast cancer.  
M1.3, M1.5, M1.7, M3.1  
HSW5, HSW6 |
| (f) | the methods used to detect cancers | To include references to MRI, X-rays, mammography, CT scans, ultrasound, PET scans, biopsies and blood tests. |
| (g) | the ethical and economic considerations when screening and conducting genetic tests for cancer | To include evaluation of screening for particular cancers e.g. the potential harm, accuracy and cost of the screening procedure AND discussion of the ethics of genetic tests e.g. for BRCA and HNPCC genes.  
HSW9, HSW10 |
| (h) | the methods used to treat patients with cancer. | To include surgery, chemotherapy, radiotherapy, immunotherapy (monoclonal antibodies), complementary therapies and hormone-related treatment. |
Thinking Conceptually

Approaches to teaching the content
Due to the nature of the development of cancer and the link between this and the cell cycle, it is vital that candidates have a secure understanding of the cell cycle and its processes covered in 3.1.1(a). Once this has been established, 3.3.1(b), (c) and (d) can be explored.

Common misconceptions or difficulties students may have
The most common mistake that students make with this section of the specification is to confuse the roles of the Ras, Myc and p53 genes. They often discuss the mechanisms of tumour suppressor genes when they are asked to describe proto-oncogenes. When teaching these aspects of the specification, it is important that the roles of these genes are explicit and their roles clearly defined so that the chances of confusion are minimised. Time should be taken to teach the mechanisms involved in their expression to facilitate understanding.

There is also often confusion over the methods of detection, with candidates often confusing MRI, CT and PET scans.

The random nature of mutations can cause confusion here, just as it does, on a rather different timescale, when considering evolution by natural selection (studied in 3.1.3(g) and at GCSE). The concept of risk factors increasing the rate of mutation, rather than deterministically causing mutations, is a tricky one. Anecdotes about aged relatives who have smoked all their lives can lead to interesting discussions taking in this concept of randomness and mutation rates but also touching on the idea that an individual’s genetics could make him or her less (or more) prone to cancer.

Finally there can be a misconception that cancer is something that happens suddenly (even when the student understands that it is a random event). For example, someone who repeatedly crosses the road without looking will eventually get hit by a bus, but until that happens he or she is completely intact. Cancer, however, is a cumulative process of many mutational events most of which are individually innocuous but which have catastrophic consequences when they occur together.

Conceptual links to other areas of the specification – useful ways to approach this topic to set students up for topics later in the course
This unit links to 3.3.2(a) and (b) Respiratory diseases and treatment, when studying the epidemiological evidence for cancer and lung cancer. In 3.3.1(e) the work of Richard Doll can be examined and linked to the development of lung cancer. Students should be able to apply knowledge from this unit to the development of lung cancer in 3.3.2.

The cell cycle and apoptosis should be understood fully before tackling this unit and reference can be made to these areas of the specification 3.1.1(a) and 3.1.1(d).

For A Level students only, the scanning technology becomes relevant again when considering the use of brain scans in 5.2.1(g).
### Activities

**Activity 1 – Factors that increase the risk of developing cancer**  
This is a web-based resource from the National Institute of Health designed for teachers to use with students.  
This activity introduces some of the factors that increase the risk of developing cancer by using four 'news report' clips. These clips, acted out from historical discoveries, tackle soot (carcinogen), retinoblastoma (family history), x-rays and UV light as causes of cancer. There are worksheets to download from the site that can be used with the videos, or they can simply be used as a starting point for discussion of evidence for the causes of cancer.

**Activity 2 – Cancer and the cell cycle**  
This is from the same resource site as Activity 1. This activity focuses on cancer and the cell cycle through five animations of uncontrolled division of body cells, regulation of the cell cycle, the involvement of tumour suppressor and proto-oncogenes. Students can note observations and explanations on downloadable worksheets available at  

**Activity 3 – The role of the p53 gene in cancer**  
This activity is provided by the Howard Hughes Medical Institute.  
This is a short, eight-slide explanation of the role of p53 in cancer. It outlines the function of p53 and how mutations can lead to cancer. It does this using the analogy of a car. There is a video of Dr Volgelstein (from the institute) describing this analogy. The information goes slightly beyond the spec as detail of the domains on the p53 gene.  
This is a very short animation (26 seconds) from the same site, which shows how p53 regulates gene expression. An animation on the function of p53 and the cell cycle can also be found at:  
This animation explains the role of p53 in the cell cycle and consequences of mutations.
### Thinking Conceptually

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<th>Activities</th>
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| **Activity 4 – Ras genes and cancer**  
http://www.dnalc.org/view/958-Causes-Smoking-Smoking-gun-html | **Click here**  
This animation illustrates how benzopyrene was discovered to cause mutations in the ras gene. |
| **Activity 5 – Diagnosing cancer**  
http://www.cancer.gov/cancertopics/screening | **Click here**  
The National Cancer Institute provides information on the screening methods used to diagnose a wide variety of cancers. This website could be used by students to research a particular screening method (as many as time allows for) and to summarise how the screening method works, the advantages and the disadvantages of the method. For each type of cancer, the screening methods are described accordingly either for the patient or for a medical professional. Students must click on the desired explanation. Simple explanations are found on the patient section, with more in-depth descriptions and benefits and risks outlined in the health professional section. Once the students have researched their assigned technique, they should share their findings with the class, who should make notes based on their classmate's presentation. |
| **Activity 6 – Treatments for cancer (p53)**  
http://www.hhmi.org/biointeractive/using-p53-fight-cancer | **Click here**  
Again, from the Howard Hughes Medical Institute website.  
This one minute animated video demonstrates how mutations in p53 can be used to target cells for destruction using modified viruses. |
This unit lends itself to many contextual scenarios. With students able to consider genetic testing from the point of view of the patient (Activity 4) or that of the healthcare provider. They may consider the level of risk a patient may have of developing cancer and act as a healthcare provider in diagnosis (Activity 1). There is also the opportunity to consider the discovery of genes involved in cancer from the position of a scientific researcher (Activity 2).

### Activities

<table>
<thead>
<tr>
<th>Activity 1 – Case studies of cancer patients</th>
<th>Resources</th>
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<tr>
<td><a href="https://science.education.nih.gov/supplements/nih1/cancer/guide/pdfs/ACT1M.PDF">https://science.education.nih.gov/supplements/nih1/cancer/guide/pdfs/ACT1M.PDF</a></td>
<td><img src="https://science.education.nih.gov/supplements/nih1/cancer/guide/activity1-1.htm" alt="Click here" /></td>
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Instructions can be found here:


From the resource provided by the National Institute for Health. This role-play activity centres on several case studies of patients with lifestyle factors and family histories. Students are assigned a patient identity according to a number randomly assigned to them and they receive the information about that individual’s case. The students should work together to establish how many individuals had a family history of cancer, the ages at which the cancer developed and the risk factors that lead to the development of cancer. There are worksheets provided for groups to summarise the data and make conclusions.

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<tr>
<th>Activity 2 – p53 gene</th>
<th>Resources</th>
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This is a link to an article in 'Scitable’ on the ‘Nature’ site by Dr Vogelstein from the Howard Hughes Medical Institute. It covers the history of how p53 was discovered, how its function was discovered, its effects and future research. This article gives students an insight into how the function of this gene was discovered by scientists within the context of research.
### Thinking Contextually

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| **Activity 3 – designing an experiment to investigate the effectiveness of a sunscreen**
Students can carry out an investigation into the effectiveness of sunscreen products. This will help them to develop their practical skills and identify variables to control and interpret their results. Resources and method for carrying out this experiment can be found at:
The website provided by the National Institute of Health.
Please note that this site is American so UK suppliers will have to be used and, due to variability in sunlight, different exposure times may be required, or the use of a UV lamp, if it is available to the centre.
1.1.1(a) (b) 1.1.2(c) |
| **Activity 4 – celebrities and the BRCA genes (HSW10)**
Students should be introduced to the cases of Angelina Jolie and Michelle Heaton who tested positive for the BRCA genes when they were tested in the light of a strong family history of breast and ovarian cancers. They should research these cases, and any others they can find, and discuss the motivations behind getting tested, the ethics of testing specific individuals in a family and the decisions faced if you do test positive for these genes.
They may also consider whether these tests should be offered as a matter of course to anyone with a family history and the financial implications of such a scheme. | |
### Activity 5 – Epidemiology, smoking and lung cancer

The work of Professor Sir Richard Doll and other epidemiologists in discovering the link between smoking and lung cancer can be investigated. There are many articles giving an overview of the work of Doll, Hill and Peto that can show students how research was carried out to establish this ground-breaking discovery. This links to HSW12.

The National Centre for Biotechnology Information has a very accessible obituary about Doll's work at:

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1181278/

There is also a video, lasting just under 10 minutes, on YouTube that summarises the work of Doll, with footage of him speaking about his findings at:

http://www.youtube.com/watch?v=VBWGM630zG0

An original article from the Journal of Epidemiology and Community Health by Doll and Peto from 1978 can be found on the BMJ site at:

http://jech.bmj.com/content/32/4/303.full.pdf+html

This could be used to show students original published research, and could be used to develop maths skills around the subject as it includes tables of data graphs (M1.3 M1.7) There is also good statistical analysis to show students, and links to HSW5.

These sources could be used to form a basis for discussion on analysis and interpretation of data, linking to 3.2.1(g) or ethics.
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