The control gene expression (AQA A2 Biology) PART 4 of 8 TOPICS

TOPICS: Alternation of the sequence of bases in DNA can alter the structure of proteins Gene expression is controlled by a number of features – most of the cell’s DNA is not translated Gene expression is controlled by a number of features – regulation of transcription and translation Gene expression is controlled by a number of features – gene expression and cancer Using genome projects Gene technologies allow the study and alteration of gene function allowing a better understanding of organism function and the new design of industrial and medical processes – recombinant DNA technology Gene technologies allow the study and alteration of gene function allowing a better understanding of organism function and the new design of industrial and medical processes – differences in DNA between individuals of the same species can be exploited for identification and diagnosis of heritable conditions Gene technologies allow the study and alteration of gene function allowing a better understanding of organism function and the new design of industrial and medical processes – genetic fingerprinting

# Gene expression is controlled by a number of features – gene and cancer:

There are two types of tumours that need to be known; each of them having characteristics to make them different from the other:

* **Malignant:** These tumours are cancerous which grow rapidly and invade to destroy surrounding tissues. These tumours can break into cells which can travel in the blood stream (and lymphatic system) causing the tumour to spread to other parts of the body.
* **Benign:** These tumours are not cancerous which grow slowly compared to malignant tumours. Benign tumours are often covered in fibrous tissue which stops cells invading surrounding tissue. The damage that these tumours can cause are blockages and can put pressure on organs. (Some benign tumours an also become malignant.

Although these tumours are different to one another, they look similar:

* **Shape:** Tumours are irregular compared to normal cells
* **Nucleus:** Their nuclei are dark and large compared to normal cells
* **Proteins:** Not all the proteins are made to function properly
* **Antigens:** These are different where the immune recognises these as non-self
* **Growth:** They do not respond to growth regulating processes
* **Division:** The divide more frequently by mitosis compared to normal cells

In order for any type of tumour to be developed a process should be followed. There are five ways in which a tumour can come about:

* **Tumour suppressor genes:**
* When functioning normally, tumour suppressor genes should slow cell division down by producing a protein that stops cells dividing or cause apoptosis (self-destruction of cells).
* These genes are inactivated when there is a mutation in the DNA base sequence.
* The mutation does not allow the protein to be produced. Therefore tumour suppressor genes will no longer be able to slow division down. The cells divide uncontrollably to produce a tumour.

**NB: You do not need to know the name of the protein which slows cell division down for AQA.**

* **Proto-oncogene:**
* When functioning normally, proto-oncogenes stimulate cell division by producing a protein which allows cells to divide.
* These genes can become over-active when there is a mutation in the DNA base sequence.
* The mutated proto-oncogenes, known as oncogenes, make more proteins than it should do therefore increasing the cell division to produce a tumour.

**NB: You do not need to know the name of the protein which increases cell division for AQA.**

* **Abnormal methylation of tumour suppressor genes:**
* When functioning normally, a methyl group is added (methylation) on to DNA which regulates gene expression, controlling whether a gene is transcribed or translated.
* A mutation causes hypermethylation (too much methylation). Tumour suppressor genes are not transcribed therefore the protein needed to slow cell division is not made.
* The cells continue to divide forming a tumour.
* **Abnormal methylation of proto-oncogenes:**
* When functioning normally, a methyl group is added (methylation) on to DNA which regulates gene expression, controlling whether a gene is transcribed of translated.
* A mutation causes hypomethylation (too little methylation). Proto-oncogenes become mutated to be called oncogenes. There is an increase in production of proteins causing and increase in cell division creating a tumour.
* **Oestrogen:**
* The exact reasoning behind how oestrogen causes an increase in risk in getting some breast cancers is not fully understood however there are few theories.
* Oestrogen can stimulate certain breast cells to divide and replicate. The more cell divisions there are the more likely a mutation may occur causing an increase in chance that the cells will be cancerous.
* Oestrogens’ ability to stimulate cell division can assist with cancerous cells replicating even quicker causing a tumour.
* Other research conducts that oestrogen can introduce new mutations to the DNA directly of certain breast cells which increase the chance of these cells becoming cancerous.

There two factors which increase the risk of cancer:

* **Genetic:** If you inherit the allele that causes cancer you are more likely to get the cancer but it does not mean that you definitely will get the same type of cancer.
* **Environmental:** These are carcinogens such as radiation and lifestyle choices such as smoking, alcohol consumption and a high-fatty diet.

There is no single cure for all cancers, but many can be prevented or treated successfully. Prevention includes minimising exposure to known carcinogens (cancer-causing agents in the environment like radiation with tar in cigarettes being a chemical carcinogen). Effective treatment also depends on early diagnosis of a cancer. Most cancers of the skin, colon, breast and cervix can be cured if there is an early diagnosis. Cancer research is a very active field and new knowledge is gained daily, enabling doctors to establish the causes of the diseases and to design effective treatments. However much remains unknown. Finding cures for cancers will continue to be one of our greatest challenges in the 21st century.

* **Prevention:**
* If a specific cancer-causing mutation is known, then it is possible to screen for the mutation (look for the mutation).

***EXAMPLE:*** BRCA1 and BRCA2 are tumour suppressor genes. Mutation of these genes has been linked to hereditary breast and ovarian cancer.

* Knowing about the increased risk means preventative steps can be taken in order to reduce it.

***EXAMPLE:*** A woman can choose to have a mastectomy (the removal of or both the breasts) to reduce the risk of breast cancer developing. Other women may screen for the signs of breast cancer for an early diagnosis which increases the chance of recovery.

* Knowing the specific mutations also means that more sensitive tests can be developed leading to an earlier more accurate diagnosis.

***EXAMPLE:*** A mutation in the RAS proto-oncogene exists in around half of all bowel cancers. This cancer can be detected early looking for RAS mutations in the DNA of bowel cells.

* **Treatment and cure:**
* The treatment of cancer can vary for different mutations so knowing how specific mutations actually cause cancer can be useful in developing drugs to effectively target them.

***EXAMPLE:*** A mutation of the HER2 proto-oncogene causes breast cancer and it can be treated by Herceptin. The drug binds specifically to the altered HER2 protein receptor and suppresses cell division and growth. If breast cancer was caused by a mutation of another gene, for instance BRCA1 or BRCA2, the drug will not work

* Some cancer-causing mutations require more aggressive treatment compared to others, so understanding how these mutations causes cancer can give us the best treatment scheme.

***EXAMPLE:*** If a mutation is known to cause an aggressive cancer (fast-growing), it may be treated by high doses or radiotherapy or by removing large areas of the tumour and surrounding tissue during surgery.

* Gene therapy (faulty genes are replaced by ones that are working) may also be able to treat cancer caused by certain mutations.

***EXAMPLE:*** If you know that the cancer was caused by an inactivated tumour suppressor gene it is hoped that gene therapy will work in the future to replace faulty alleles.