



Transition metals and anticancer drugs – answers

Education in Chemistry

Sustainability in chemistry 2021

Goal 3: ensure healthy lives and promote well-being for all at all ages

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This activity will check your students' knowledge on shapes of complexes, their understanding of anticancer drugs and provide them with some history behind cisplatin.

Task 1: knowledge retrieval

Carry out as a Do Now activity to help recall prior knowledge. You could have students self-assess their answers.

1. List four characteristic properties of transition metals.

- They form coloured ions
- They have variable oxidation states
- The metal/their compounds are used as catalysts
- They form complexes

2. Complete the table.

Name of shape	Number of coordinate bonds	Bond angle
<i>Linear</i>	<i>2</i>	<i>180°</i>
Tetrahedral	<i>4</i>	<i>109.5°</i>
<i>Square planar</i>	<i>4</i>	<i>90°</i>
<i>Octahedral</i>	<i>6</i>	<i>90° and 180°</i>

3. Which shape of complex ion can show both optical isomerism and cis-trans isomerism?

Octahedral

4. Define the term ligand.

A ligand is a molecule or ion that forms a coordinate bond with a transition metal by donating a pair of electrons.

5. State the name of the effect which favours multidentate ligands replacing monodentate ligands.

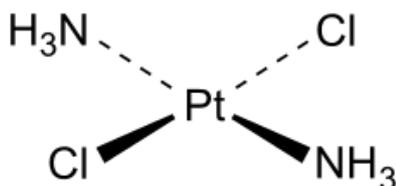
Chelate effect

Task 2: cisplatin and other platinum anticancer drugs

This could be delivered as a whole class activity or as a worksheet after / during the teaching of cisplatin. Students could self-assess their answers or you could model answers under a visualiser and have a class discussion.

1. Cisplatin is a *four*-coordinate, *square planar* complex of *platinum*(II). It has bond angles of *90°*. Cisplatin has two *chloride* ions and two *ammonia* molecules as ligands. The overall charge on cisplatin is *zero*, this is because the charge on the *platinum* ion is 2+ which is cancelled out by the two *chloride* ions. Cisplatin is used as an *anticancer* drug. However, its *isomer* transplatin is inactive against cancer.

2. Draw the structure of transplatin.



3. Cisplatin prevents DNA replication in cancer cells by a ligand replacement reaction with DNA. A chloride ion in cisplatin is replaced by a nitrogen atom on a guanine base, which forms a bond with the platinum ion in cisplatin.

Oxaliplatin is another platinum based anticancer drug. Using your knowledge of cisplatin, suggest and explain how oxaliplatin may prevent cancer cells from replicating.

Coordinate bonds form between the platinum ion in oxaliplatin and the nitrogen atoms on the guanine bases of DNA in the cancer cells, with the oxalate anion being the ligand that is replaced. This results in a kink in the DNA molecule, DNA replication is prevented and therefore the cancer cells cannot divide.

4. Suggest why using oxaliplatin as a treatment for cancer often has adverse side-effects.

Oxaliplatin also binds to DNA and prevents replication of healthy cells (that replicate quickly) as well as cancer cells. This can damage healthy tissues.

Task 3: cisplatin comprehension/quiz

This task can be used either as an extension task or as wider reading for students to appreciate the history behind cisplatin. The quiz could be done as a comprehension activity or you could quiz students using the questions as a starter after setting the text as wider reading for homework.

1. When was cisplatin first synthesised? *1845*
2. When was the structure of cisplatin known by? *1893*
3. Who deduced the structure? *Alfred Werner*
4. In which decade were cisplatin's anticancer properties discovered? *1960s*
5. Who discovered cisplatin's anticancer properties? *Barnett Rosenberg*
6. What caused the growth of the unusually long *E. coli*? *Cisplatin forming at the platinum electrodes*
7. When was cisplatin licensed for use in the UK? *1979*
8. How many years did it take for cisplatin to be licensed in the UK from the first clinical trials in humans? *Eight years*
9. How are patients normally given cisplatin? *As a solution, intravenously*
10. Name three types of cancer cisplatin is used on. *Any three from: testicular, ovarian, lung, bladder, colorectal*