Case Study: Mystery of the 7 Deaths

Part 1: The Symptoms

Review the police report notes and answer the following questions:

1. Are any similarities or connects between these seven individuals?

2. What questions would you want to ask the families to answer the previous question?

3. In your opinion, are these seven deaths connected? Why or why not?

Part 2: Autopsy Reports

Obtain and review the five autopsy reports and answer the following questions:

1. Recalling your knowledge of the function of organelles, what function of the cells was interrupted in these victims?

2. Could this loss of function lead to the death of these individuals? Why or why not?

3. Given the data in the autopsy, were there any reports that seemed inconsistent with the immediate cause of death?
Part 3: Subcellular Metabolite Analysis

Obtain and review the Metabolite Evidence Analysis and answer the following questions:

1. For each metabolite listed in the table, describe its role in cellular respiration. Are they substrates or products? What is their main function?

2. Are there any abnormalities in the levels of these metabolites in the victims? Develop a hypothesis about which part of cellular respiration may be affected based on these abnormalities.

3. Explain your reasoning for your hypothesis.
Part 4: Toxins

Obtain the Toxin Analysis Report and answer the following questions based off that information.

1. What affect would cyanide have on the electron transport chain and the production of ATP? Explain your answer.

2. Given what you now know about the action of cyanide on cellular respiration, explain why the patients died of lack of oxygen while their blood oxygen levels were normal.

3. Would artificial respiration or oxygenation have saved these people? Why or why not?

4. Looking back at the information you have about the people before they got sick, can you suggest the source of the cyanide poisoning. How should public health officials and police respond to this tragedy?

“The Mystery of the Seven Deaths” by Michaela A. Gazdik
Case Study: Mystery of the 7 Deaths

You and your colleagues are new interns at the medical examiner’s office for a major metropolitan city. The chief medical examiner will give you all of the tools necessary to investigate the suspicious deaths and provide toxicology services for the county.

Unfortunately it’s been a busy week. In the past 5 days, seven people have died, all with similar symptoms. It is your responsibility to examine the data and determine the cause of death for these victims.

All seven victims were reported all in the same neighborhood, all with similar symptoms. Below are notes on the 5 of the 7 victims pulled from the police reports.

Victim 1:
- 12 yr old girl
- Parents said that she awoke late Friday night complaining of a runny nose and sore throat. They administered extra strength Tylenol and sent her back to bed.
- At 7am Saturday morning her parents discovered the girl collapsed on the bathroom floor.
- Ambulance rushed girl to the hospital where she was pronounced dead.

Victim 2:
- 47 yr old male
- 9 am Saturday morning, paramedics found victim unconscious on kitchen floor
- Suspected heart attack

Victim 3:
- 31 yr old male (brother of Victim 2)
- 8 pm Saturday evening victim was found collapsed on the floor at Victim #2’s house after taking Tylenol for headache.
- Victim 3 had gathered at Victim 2’s house to mourn his passing.

Victim 4:
- 28 yr old female (fiancé of Victim 3)
- 8 pm Saturday evening victim was found collapsed on the floor at Victim #2’s house after taking Tylenol for trying to cope with their loss.
- Victim 4 had gathered at Victim 2’s house to mourn his passing.

Victim 5:
- 17 yr old male
- 7 pm Sunday evening victim was found collapsed on floor of bedroom.
- Parents said he had taken Tylenol for severe muscle cramps in his legs after track practice.

Symptoms exhibited by most patients:
- Dizziness
- Confusion
- Headache
- Shortness of breath
- Vomiting

**Most deaths were very rapid, occurring within a few hours of symptoms.**
Subcellular Metabolite Evidence Analysis

Detailed analysis of the damaged cells showed that ATP levels in the mitochondria were very low. Levels of pyruvate and acetyl coenzyme A (CoA) were normal. You begin to suspect a malfunction of a specific cellular metabolic pathway and so you request a more detailed analysis of the subcellular components of the affected cells from the autopsy. The levels of key metabolites are reported below:

<table>
<thead>
<tr>
<th>Metabolite</th>
<th>Average Victim Levels</th>
<th>Normal Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>99 µM</td>
<td>100 µM</td>
</tr>
<tr>
<td>Pyruvate</td>
<td>27 µM</td>
<td>25 µM</td>
</tr>
<tr>
<td>NAD⁺</td>
<td>10 µM</td>
<td>75 µM</td>
</tr>
<tr>
<td>NADH</td>
<td>400 µM</td>
<td>50 µM</td>
</tr>
</tbody>
</table>

Toxin Analysis Report

You are now convinced that you know the cause of death for these victims and quickly report it back to the police as this is a very dangerous situation. After realizing that the electron transport chain was no longer functioning, you started to suspect poisoning and ran the blood test for various poisons that you knew affected the ETC. The test of all seven patients came back positive for cyanide. Cyanide irreversibly binds to cytochrome c oxidase (CcOX) of the ETC and prevents the transfer of electrons to oxygen, the final electron acceptor.