An Illustrated Review on Penicillin And Cephalosporin : An Instant Study Guide For Pharmacy Students

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An Illustrated Review on Penicillin And Cephalosporin : An Instant Study Guide For Pharmacy Students

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Abstract

Study material can be presented in an instant study guide to help pharmacy students read through and understand quickly rather than digesting facts in long essay form. The review is done for instant use by pharmacy students for an overall revision or rapid review on the topic of Penicillin and Cephalosporin. The approaches used in this instant study guide are illustrations like diagrams, pictures, flowchart, tables, structures and coloured texts. Flow chart simplifies the complex explanation of words. Colors stimulate our visual senses and help in memorizing as it improves attention. The table helps the students to see the whole picture of the facts clearly and guide them on the important points that they have to know. We also apply the concept of 'a picture worth a thousand words'. Pictures can stimulate brain to analyze faster rather than seeing thousands of words. Each part of the structures is fitted with important points so that students can read and straight away gain understanding. The study guide helps the pharmacy students to gain essential information and understand the concept better and faster.

Introduction

Penicillin and cephalosporin are the two antibiotics that have been used in the treatment towards bacteria invasion. These two drugs are the one of the early antibiotics that has been found. Penicillin was discovered by Alexander Fleming in September 1928 while he was working at St. Mary’s Hospital London. He left for holidays and left the culture of the microbe at the window of his lab. After he came back from the holidays, he found an unusual phenomenon of the culture of microbe that he had left. It was found that the absence of fully developed colonies of a common microbe, Staphylococcus aureus and a round a large colony of a common mould, Penicillium notatum [1]. The discovery of his findings led to the use of penicillin as an antibiotic in the present days.

Cephalosporin was discovered by Giuseppe Brotzu in 1945. He was a Professor from University of Cagliari and also a Superintendent of the Public Health of the Sardinian Regional Government which campaigned to eradicate malaria from Sardinia. The discovery of cephalosporin originated from the spread of typhoid fever in Cagliari. Despite of the sewage water, many of the young people there who swim in the water usually do not get ill [2]. From that, he discovered the cultures of Cephalosporium acremonium which inhibited the growth of the bacteria.

Discussion
University students often experience an undue amount of stress, which leads to negative academic, emotional, or health outcomes.\[4\] In a study comparing the stress level of different healthcare professions students, it is shown that pharmacy students were found to suffer from more stress and distress than medical and dental students. \[5\] Stress occurs when pharmacy students are loaded with assignments, digest huge volumes of information due to wide spectrum curriculum and limited time, packed lecture hours and examinations and have to be consistently active in sports and co-curriculum activities. Moreover, additional stress due to fairly competitive environment and enduring the loss of sleep for some students negatively affect the quality of life.

Therefore, studying smart is important to avoid unnecessary stress. To ease understanding and remembrance of information, good study materials are vital. Most books related to the course of pharmacy are presented in long detailed explanations which require students to process the information themselves. According to cognitive theories, human brain cannot notice everything that is given to us; we orientate our attention selectively and organize what we observe into a structured framework of ideas. \[6\] Other than that, if study material can be presented in an instant study guide, it would be like a catalyst in a chemical reaction: speed up the rate with less energy required and produce the wanted outcome.

Understanding this as a way of learning and remembering ideas, we presented the topic on penicillin and cephalosporin, two major groups of antibiotics learned by the pharmacy students in an organized and illustrated summary as an instant study guide to help pharmacy students read through and understand quickly rather than digesting facts in long essay form. To do so, we extract the main idea and the important details linked to the main ideas to support it. We provide updated essential information assimilated from large amount of complex information. We focus more on drug classes rather than doing very detail into individual classes while maintaining emphasis on the Structure Activity Relationship (SAR) of the drugs. The review is done for instant use by pharmacy students for an overall revision or rapid absorb faster with less eye strain. \[7\]

We classify penicillin antibiotic group according to its structure and function, from there the examples, spectrum of activity and indications are listed in table form. By doing so, comparison of the different classes of penicillin can be done. The same goes for cephalosporins in which we classify them according to different generations. By presenting penicillin and cephalosporin in one table, not only we can compare between classes within each group of antibiotics, we can also compare and contrast between penicillin and cephalosporin. This table helps the students to see the whole picture of the facts clearly and guide them on the important points that they have to know. A meaningful learning can help students to remember things faster and longer. To apply the meaningful learning, students need to be able to relate the point or linking words and represent it in an understandable way. \[8\] Therefore, we chose this method in presenting our facts.

We also apply the concept of ‘a picture worth a thousand words’. Visual images can stimulate brain to analyze faster rather than seeing thousands of words. According to this theory, "words and sentences are usually processed and encoded only in the verbal system, whereas pictures are processed and encoded both in the imagery system and in the verbal system". \[9\] Vision concerns both processes of memory and the nature of the stored representation, thus what they see is what the brain will interpret and store it.\[10\] We encode the concepts of the structure activity relationship (SAR) of penicillin and cephalosporin in such illustrated form. We put the important points fitted into each parts of the structure so that they can read and straight away gain understanding. If structures were to be drawn separately from its explanation, students need to read all those explanation about the structure first and digest all the information presented in bulk, they then have to refer back to the structure, this has to be done repetitively for each point of explanation. This might lead to confusion for some students and find it hard to understand. Other than SAR, we also illustrate the mechanism of action and resistance of penicillin, because it involves a process thus it is much better to be understand through illustrations and images. By doing so, students are able to recall an illustrated mindmap of the SAR of penicillin and cephalosporin after reading the material.

All structures are drawn using ChemSketch freeware version.
To explain the pharmacokinetics and adverse effects of both groups of antibiotics, we illustrate them by using visual image of human body. By doing so, the absorption, distribution, metabolism and excretion are explained instantly with minimum words. We also use flow chart to explain the drug-drug interaction of these antibiotics. We use this method because it can simplify the complex explanation of words, sometimes provide more information than can be explained in. This might help to illustrate and interpret text content that is hard to comprehend [11]. According to Biedermann (1981), the general meaning of structure can be grasped in as little as 300 milliseconds because the elements of a visual resource can usually be processed simultaneously, whereas a text must be processed sequentially [12,13].

Other than that, one of the most important elements to be included in effective reading material is colour. Research has shown that colours stimulate our visual senses especially arousing colours such as red and orange. Arousing events can lead to hormonal changes in the brain which leads to enhanced memory. Coloured text can help in memorizing as it improves attention compared to black and white text, coloured structure and text can be part of long term memory [14, 15]. Therefore, our information is presented in colours. For instance, the part of SAR, different colours is used for different substituent explanation, it helps to leave a more vivid memory of the information.

Overall, we focus on illustrations like diagrams, pictures, flowchart, tables, and structures. This method is most suitable for visual learner. We minimize the usage of words so that students will be able to see the key words and understand the topic better and faster, with the hope that the instant study guide can be a catalyst in the process of learning.

Conclusion

Penicillin and cephalosporin are the two essential antibiotics needed to be known by the pharmacy students. Pharmacy students should be able to classify and differentiate between these two drugs. The illustrated review on penicillin and cephalosporin is made to provide an instant study guide for pharmacy students. The study guide helps them to gain essential information and understand the concept better and faster. Drug classes and Structure Activity Relationship (SAR) of the drugs are focused. Illustrations like diagrams, pictures, flowchart, tables, and structures are used. The classification of penicillin and cephalosporin were made such a way to make them see clearly their similarities and differences. The structures for both drugs are drawn and every position of the substituent was shown with explanation on their properties. The mechanism of action and resistance are made into figures that can make them visualize it well and lead to better memory with the picture included.

References

10. Brady TF, Konkle T, Alvarez GA, Oliva A. Visual long-term memory has a massive storage capacity for


Illustrations

Illustration 1

Penicillin and Cephalosporin

![Image of Penicillin and Cephalosporin comparison](image)

**TABLE 1:** A description and comparison between Penicillin and Cephalosporin

Illustration 2

Pharmacokinetic and Adverse Effect of Penicillin

![Image of Pharmacokinetic and Adverse Effects of Penicillin](image)
Illustration 3

Pharmacokinetic and Adverse Effect of Cephalosporin

Illustration 4

Drug-drug interaction of Penicillin & Cephalosporin
Illustration 5

Structure Activity Relationship of Penicillin

Illustration 6

Acid Sensitivity of Penicillin

Acid Sensitivity of Penicillin

Ring strain

Reactive β-lactam carbonyl group

Influence of acyl side chain

Acid-catalyzed ring opening relieves ring strains by breaking open the more highly strained β-lactam.
Illustration 7

Penicillin Analogues

![Penicillin Analogues](image)

<table>
<thead>
<tr>
<th>Acid resistant</th>
<th>Electron withdrawing group in the side chain draws electrons away from the carbonyl oxygen and reduces its tendency to form a monooxide.</th>
<th>Penicillin V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillinase resistant</td>
<td>bulky group on side chain shields penicillin from penicillinase binding site.</td>
<td>Methicillin, Nafcillin</td>
</tr>
<tr>
<td>Broad spectrum</td>
<td>Hydrophobic groups (CH3, CO2H) on side chain increase activity against Gram -- bacteria.</td>
<td>Amoxicillin, ampicillin, amoxicillin, Carbenicillin, cephaloridine, Teicoplanin</td>
</tr>
</tbody>
</table>

Table 2: Penicillin analogues

Illustration 8

Structure Activity Relationship of Cephalosporin

![Structure Activity Relationship of Cephalosporin](image)
Illustration 9

Variations of substituent of Cephalosporins

<table>
<thead>
<tr>
<th>Variation at 3-position substituent</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = alcohol (OH) - block metabolism and protein synthesis (poisoning group)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Variation at 7-position substituent</td>
</tr>
<tr>
<td>------------------------------------</td>
</tr>
<tr>
<td>R = NH₂ or OH, DCDEO - minimal resistance against β-lactamase. More acidic substances and have higher activity against gram positive bacteria</td>
</tr>
</tbody>
</table>

Table 2: Variations of substituent of Cephalosporins

Illustration 10

Mechanism of Action and Resistance of Penicillin

**Mechanism of Action of Penicillin**

Arrests transcription of peptidoglycan cross-link in the bacterial cell wall. Diacetoxy amino (D-Ako-D-Ala) nearly binds to transpeptidase but not β-lactamase molecule or bacteria.

**Mechanism of Resistance to Penicillin**

Bacteria resists β-lactamase, which is similar in structure to transpeptidase, has penicillin resistance active site, if opens up β-lactam ring of penicillin to form side link to the structure. Penicillin is inactivated before reaches cell membrane.

*This mechanism of Action and Resistance also applies to Cephalosporin*
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