Cyanocobalamin and Chemotherapy Medicine: A Light Responsive Reaction

Brandi Zizza and Thomas Shell
Department of Chemistry
Saint Anselm College, Manchester, NH

Introduction

- Phototherapeutic methods (light therapy) reduce exposure to disease, reduce reliance on anesthesia, are more accurate, and have a faster recovery time. It also reduces side effects.
- Photochemotherapeutics localize drug activity, and potentially allow for compounds that are too toxic to be used to treat cancer.
- The optical window of tissue is between 600-900 nm. Below 600 nm, the short wavelengths cannot penetrate the epidermis. Beyond 900 nm, the long wavelengths are absorbed by water.
- Alkylcobalamins have a weak C-Co bond that undergoes cleavage when exposed to wavelengths of light that can penetrate epidermis and are not absorbed by water.
- Akylcobalamins, which are structurally related to Vitamin B_{12}, have derivatives that act as “antennas” which capture wavelengths for the corrin ring system. The general concept involves coordinating a drug to the cobalamin, introducing the cobalamin-drug conjugate into the body, and then exposing specific areas of interest to light.

Porphyrins

- Porphyrins are water soluble, nitrogenous derivatives of hemoproteins. They are heterocyclic macrocycle organic compounds interconnected at the α carbon via methane bridges.
- Porphyrins have a tendency to localize in malignant tumors.
- Since porphyrins absorb light around 410 nm, they are activated by red light, become toxic and destroy their surroundings.
- Porphyrins produce singlet oxygen, which is a radical, and this is what causes the toxicity.
- Porphyrins are unable to release medicine, and are only destructive.

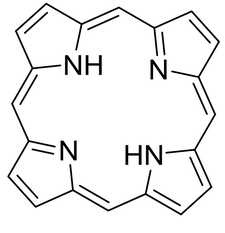


Figure 1: Structure of a Porphyrin

Chemotherapeutics

Taxol

- Taxol is used for the treatment of breast, ovarian, lung, bladder, prostate, melanoma, and other solid tumor cancers.
- The side effects of taxol include low blood count, arthralgias and myalgias, peripheral neuropathy, liver toxicity, and ovarian damage, which can lead to infertility.

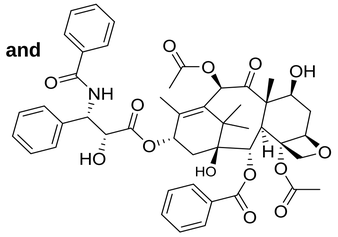


Figure 2: Structure of Taxol

Tamoxifen

- Tamoxifen acts as an estrogen antagonist in breast tissue and is used to treat estrogen receptor positive breast cancer.
- Side effects of tamoxifen include uterine cancer, strokes, and blood clots in the lungs.

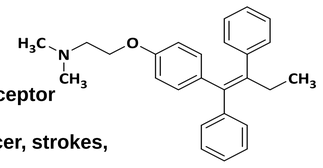


Figure 3: Structure of Tamoxifen

Doxorubicin

- Doxorubicin is used to treat ALL, AML, bone sarcoma, breast cancer, ,gastric cancer, Hodgkin and non-Hodgkin lymphoma, liver cancer, kidney cancer, ovarian cancer, sarcoma, neuroblastoma, etc.
- Side effects of doxorubicin include pain, low blood counts, problems with fertility, and cardiomyopathy, which can be terminal. Treatment can also cause blood cancers such as leukemia.

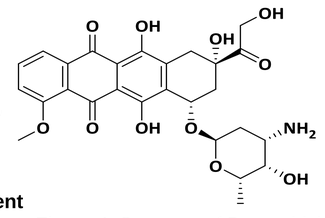


Figure 4: Structure of Doxorubicin

Methotrexate

- Methotrexate is used to treat cancer that begin in the tissues that form around a fertilized egg in the uterus, breast cancer, lung cancer, leukemia, lymphoma, and cancers of the head and neck.
- Side effects of methotrexate include a decrease in the number of blood-cells made by the bone marrow, liver damage, lung damage, and damage to the lining of the mouth, stomach, and intestines. It also increases the chance of developing lymphoma.

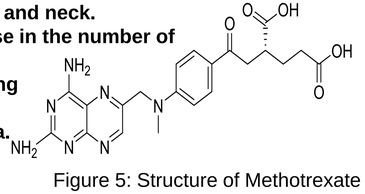


Figure 5: Structure of Methotrexate

Colchicine

- Colchicine cannot actually be used to as an agent to kill cancerous cells because it is too toxic, and it will kill the patient before it treats the cancer. However, colchicine could potentially be used if it was only active in cancer cells.
- The current side effect of colchicine is death from toxicity.

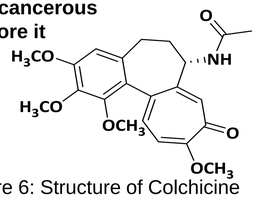
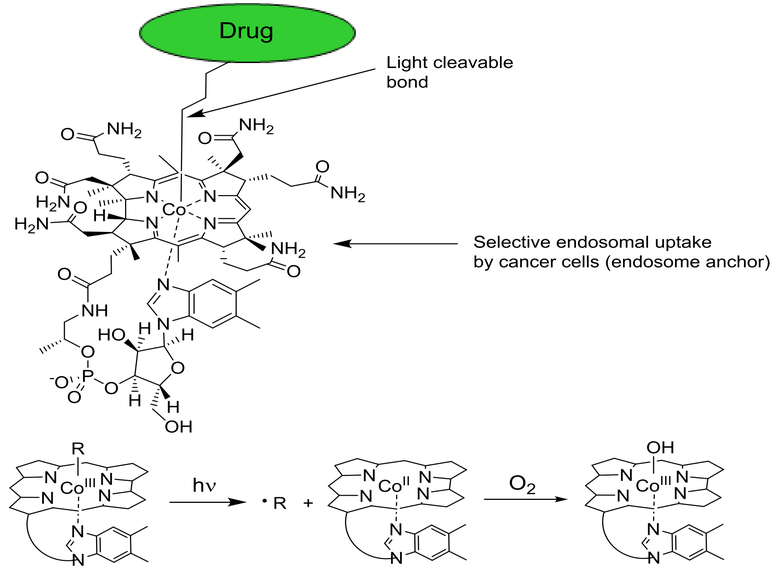


Figure 6: Structure of Colchicine

Alkylcobalamin Strategy and Drug-Conjugate Structure



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