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Review Article

The importance of transition metals as drug

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ABSTRACT

The last few decades have seen enormous advances in the area of bioinorganic chemistry, attracting scientists from various disciplines including chemistry, biology, agriculture and medicine. Metals are very important constituents preferred by nature that function in bio-chemical method for living organisms. Metal complexes are essential in the area of catalysis, material science, photochemistry and bio systems. Medicinal chemistry may exploit the unique feature of metal ions in concern with design of new drugs. The recent advancement in emerging field of inorganic chemistry, the act of transition metal complexes as therapeutic compound has becoming increasingly important. From the survey of literature inorganic chemistry have made possible formation that leads to number of transition metal complexes having organic ligand and can be used as therapeutic agent. The present review paper focus the scope and recent progress in the area of bioinorganic chemistry with new opportunities to the synthesis of metal-based drugs.

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1. Introduction

The biological systems and its role of metal ions have been recognized for a long period. Certain metals are needed urgently and others are considered as toxic. As a matter of fact, iron (Fe²⁺/Fe³⁺) is the most important metal ion in transition metals.^{1–6} Without iron, there is no life existence. Copper, an essential trace metal available in nature as Cu²⁺ which is involved in metallo proteins including cytochrome oxidase, superoxide dismutase and ascorbate oxidase. Also, we aware the role of Mn involves in photosynthesis, the function of Co in Vitamin B12 and the role of Ni in urease. Chromium (III) can have a role as glucose metabolism. But the toxic effect of Cr (VI) is considered as carcinogenic. Metal ions play major functions in human being. The lack of deficiency of

some metal ions can result to disease like anemia due to iron deficiency, growth retardation arising from insufficient dietary of zinc and heart disease in infants owing to copper deficiency. Metal ions are required in pharmaceuticals and also diagnostic agents.^{7–12} Metals are endowed with unique features which include redox activity, coordination site and reactivity towards organic group. The presence of excess of metal ion concentrations are associated with many pathological side effects leading to cancer. For these reasons, coordination metal complexes, as drugs become very attractive and interesting areas in medicinal chemistry.^{13–15} In nature, many biological systems apply extensive use of metal ions, such as zinc and copper which play crucial role in normal functioning of organisms.^{1–15} Research report has significant progress in utilization of transition metal complexes as drugs to treat several human diseases. The advances in bioinorganic chemistry provide

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better opportunities to use metal complexes as therapeutic agents.



Fig. 1: Transition metal complexes

2. Significance of Transition Metals

Bioinorganic chemistry is a fast growing emerging field of science bridging inorganic chemistry and biology. Since long the importance of metal ions in biological systems has been known, though systematic study of their chemical and biochemical roles has started only in recent times. Metal ions such as sodium, magnesium, potassium, calcium etc., are present in living organisms in relatively large quantities and many other metal ions such as iron, copper, zinc, manganese, molybdenum, chromium, vanadium etc., occur in trace amounts. Though the total metal ion content in an adult man is nearly 2.5% of the body weight, (several of these are present in 'mg' quantities only) yet without these, life cannot sustain. So, the role of metal ions and metal complexes in biological processes has become very important. Since human body contains various metal ions as nutrients and micronutrients, it is important to study the coordinating ability of various metals. Most of the metals that are necessary in trace amount but essential for various body functions. Proteins containing transition metals are important to the living organisms due to their biological action. The transition metals have great importance in our lives. The transition metals and some of their alloys shaped the Bronze Age and Iron Age. Now due to the advancement of technology and aerospace industry, metals with high conductivity and greater strength are at top demand. Without these valuable metals, life simply would not exist. Transition metals are found everywhere on this Earth in various quantities. Most are not occur in a pure substance in the Earth's crust. Some metals that are rare can be sold at extremely high prices, like gold. Other metals are seen right in front of us. The computer is made up of transition metals. It has metals to send electrical currents. The chair we use, has metal ball-bearings in the wheels. The pictures hanging on the wall, they are hanging by nails, which are made up of metal alloys. Almost everything around us have been made from transition metals. Titanium is a relatively new transition metal which is in high demand due to its light weight, good strength, high temperature and corrosion

resistance. It is used to make airplane bodies and engines.

Metals in today's society have the highest demand. Metals are used to make bicycles, electrical toothbrushes, wires and refrigerators. Steel is used to make bridges and buildings. Anything that needs electricity has metal components because metals are electrical conductors. Transition metals are used as catalysts in many ways. Many times transition metals can be used to simply speed up a reaction. This is used because it is often economically quite cheaper to add some metal rather than waste time waiting for the reaction to occur. An example of this would be the use of a vanadium oxidizing catalyst in the process the making sulfuric acid. Metals are also the key ingredient in automobiles because of their strength, durability and extreme resistance to heat and fire. The main problem with transition metals is their easy way of oxidation. Due to oxidation the metals get corroded and become brittle. This can be overcome by making alloys. For example, alloys of chromium, has a higher corrosion resistance. Transition metals are also found in our bodies. They are key elements in life and evolution. The bronze, iron and steel ages would never have happened leaving us in the Stone Age. Research has shown significant progress in utilization of transition metal complexes as drugs to treat several human diseases. Transition metals exhibit different oxidation states and can interact with a number of negatively charged molecules. Humans excrete about 1 mg of iron every day and must constantly have 3 gm of iron in their bodies. The iron is mostly used as hemoglobin that transports oxygen to the brain and muscles. Iron deficiency or anemia, occurs when our body don't have enough iron and causes to become chronically tired. Cobalt is another transition metal our bodies need. It is a component of vitamin B₁₂ which human need in their diet. Without iron, oxygen would not make it to the brain and life would not exist. Transition metals have become of utmost importance due to our every growing population and economy. Their demand will continue as long as life as we know it continues.

3. Conclusions

Coordination chemistry being an important branch of inorganic chemistry, is undergoing an unprecedented pace of development both experimentally and theoretically. Since metals are endowed with unique properties the positive aspects in drug discovery can be continued for the design of new drugs. The therapeutic application of metal complexes is still to be explored in the area of research and useful to develop novel therapeutic agents. The exploration of transition metal complexes and their activation strategies, should continue further for future generations of drugs which may overcome some of the disadvantages associated with present drug therapies, including the unwanted side-effects. Therefore metal based drugs will surely take a key part of drug development to improve the quality of life of

patients.

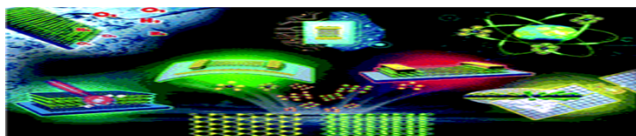


Fig. 2: Transition metals as novel drugs

4. Source of Funding

None.

5. Conflict of Interest

The authors declare no conflict of interest.

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