

# COPPER AND MANGANESE CONTENT IN EXPERIMENTAL ANIMAL TUMORS AND HUMAN BONE SARCOMAS

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The content of copper and manganese in human and animal (rabbit, rat) bone tumors, when expressed per weight of ash, is higher than that in unchanged bones. The copper: manganese ratio is greatly increased in tumors.

Metabolism of trace elements in tumors, especially in the skeleton of animals and man, has been inadequately studied, and there are no references as yet in the literature to the relative proportions of these elements or their interdependence.

The object of the present investigation was to study the content of copper and manganese, trace elements with a broad spectrum of action, in human malignant tumors and in experimental tumors of animals.

## EXPERIMENTAL METHOD AND RESULTS

The content of the metals was determined by emission spectral analysis.

Altogether 26 specimens of human bone tumors (sarcomas) removed during operations, 10 specimens of transplantable osteogenic sarcoma of rabbits (strain LOI), and 10 specimens of bone fibrosarcoma of rats induced by dimethylbenzanthracene (DMBA) were studied. Copper and manganese were estimated in the tumor tissue, in the cortical layer of bone adjacent (or subjacent) to the tumor, in bone of the affected segment at a point not macroscopically involved in the tumor, and in a remote segment of bone.

The results showed that the tissues of bone tumors, whether spontaneous or experimental, accumulate copper and manganese when expressed per weight of ash. However, the cortical layer of bone adjacent to the tumor and bone from a distant segment have almost the same content of the trace elements as unchanged bone.

This fact indicates changes in the character of metabolism of these metals in the tumor tissue. This is confirmed by the fact that the ratio between the content of the metals is altered in bone neoplasms. In unchanged bone, for instance, the copper: manganese ratio ranges between 0.4 and 0.6, whereas in human sarcoma tissue it varies from 2.2 to 2.9, in tissues of the transplantable rabbit tumors from 15 to 17, and in the induced rat tumors from 32 to 36. This increase in the accumulation of copper relative to that of manganese can be attributed to the biochemical character of the respiration of tumor tissue, which is predominantly anaerobic, associated with predominance of copper-containing enzymes.

The tissue of recurrent human bone sarcomas was found to accumulate copper and manganese in much larger amounts than primary tumors.

The manganese content in tumor tissues depended on how the result was expressed: per weight of ash or of the dry substance. When expressed relative to ash the content was higher, but when expressed relative to the weight of dry substance, it was lower than in unchanged bone. The data for the copper and

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manganese content in tumor tissues were compared with their histological structure. The result showed that the level of trace elements could be correlated to some extent with the morphological structure of the specimen.

The character of distribution of copper and manganese and the ratio between their content were found to be very close in sarcomas of different genesis. The values for the content of copper and manganese in human bone tumors and the ratio between them can be used, in conjunction with statistical analysis, as an additional diagnostic test.