


The vital — and deadly — substances that  
determine your health and how to monitor them



# Trace Elements, Hair Analysis and Nutrition

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**Richard A. Passwater, Ph.D.  
and Elmer M. Cranton, M.D.**

Introduction by Jeffrey Bland, Ph.D.

# TRACE ELEMENTS, HAIR ANALYSIS AND NUTRITION

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*Richard A. Passwater, Ph.D.  
and Elmer M. Cranton, M.D.*

*Foreword by Jeffrey Bland, Ph.D.*

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R.A.P. AND E.M.C.

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# FOREWORD

The field of trace element nutrition and its relationship to human health and disease is one of the most rapidly advancing fields within the health sciences area. There has been a considerable need over the past two or three years for a comprehensive book which would address the major implications of trace element nutrition in such a way that it would encompass: how to recognize trace element insufficiencies, what the health implications are of these insufficiencies and what the treatment for these problems is.

Such is the value of this excellent book by Dr. Richard Passwater and Dr. Elmer Cranton entitled *Trace Elements, Hair Analysis and Nutrition*. The authors have accomplished the herculean task of consolidating a vast body of clinical and research data into a concise summary which allows the nonspecialist to appreciate not only the large questions concerning mineral nutrition and health, but some of the more subtle and important relationships. The section of the use and misuse of hair mineral analysis in assessment is well written and is the first definitive survey of clinical implications of hair mineral analysis in the literature.

Although the field of mineral metabolism and assessment is still rapidly changing, this volume provides up-to-date and concise information which should be the measuring stick in the field for the next period of time.

This book represents a major contribution to the field and will considerably improve the understanding and knowledge about the important role that trace elements play in human health. I recommend this book as part of the library of all nutritionists who are concerned about the important role that trace elements play in human health and disease.

JEFFREY BLAND, PH.D.

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University of Puget Sound  
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September, 1982

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# INTRODUCTION

The majority of diseases begin when biochemical imbalances occur at the cellular level. "Deficiencies or excesses of metal ions cause most adverse biological effects," comments D. R. Williams.<sup>1</sup> Occasionally these imbalances actually cause illness; more often they simply hinder the body's efficiency, thereby weakening any number of chemically based immunity processes.

Imbalance of those elements essential to health or interference due to heavy metal accumulation will leave the door open to potential disease; yet more and more, research points out that modern health care has the potential to correct these imbalances before disease reaches the stage of physical symptoms.

This book discusses how nutrient minerals and toxic elemental pollutants affect your health and how a simple hair analysis for trace metals (those elements present in minute quantities) can uncover many mineral deficiencies and toxic accumulations. We want to make you aware that your health depends on what you eat, but just as important, your health depends on what is missing from or contaminating the food you select and how much of that nourishment is digested and assimilated by your body. It is not just a matter of what you put in your mouth, but what reaches every cell in your body.

We feel that this book will help many people overcome health problems that range from "not feeling well" or unexplained tiredness to forestalling the



major killer diseases such as cancer and heart disease. We present documented evidence showing how proper mineral balance can achieve this.

This book is jointly written by a biochemist with more than twenty years in trace element research and a physician who has been a leader in incorporating nutrition into a holistic clinical practice and who is also the Chairman of the Hair Analysis Standardization Board, a committee of experts who have no commercial laboratory ties. This book is for you if you have a disease or health problem that has not responded to treatment. It is directed toward everyone; appendices are included in certain discussions to accommodate additional technical details.

This book is for you if you are concerned about the effects of air, water and food pollution on *you*.

Joggers, how much lead are you breathing from car exhausts? Seafood lovers, how much mercury have you accumulated? Ladies, are you developing frail and brittle bones as you pass menopause? Gentlemen, are you developing prostate trouble? Will you be able to respond well to surgery? Do you have increased risk of cancer or heart disease? Are *your* foods supplying the proper balance of minerals?

There is no need to worry about these things needlessly if *you* are not in danger. But how do you know? This book will answer that question by alerting you to the dangers, showing you *how* to protect yourself and how to determine your nutrient mineral levels and toxic element levels.

On the other hand, if you do have a mineral deficiency or toxic accumulation, this book may save your life!

Let's look at a few common examples. A housewife in her early forties had been troubled with that dragging, tired feeling. After running all the standard tests, her doctor said she was in "fine shape." But she was still tired. Finally, her doctor did an analysis for trace minerals in her hair. The hair analysis showed her body had high amounts of toxic lead that caused her tired feeling. Most of the lead came from auto exhaust (this will be explained in Chapter 26).

Once her problem was understood, the cure came easily. She was feeling better in two weeks and the tired feeling vanished within a month.

Undiagnosed lead poisoning had institutionalized a printer as a manic depressive before he discovered his real problem. Simple treatment "cured" him and he has had no symptoms for eight years.

We have seen many hyperactive children and children suffering personality changes that have been solely due to "mild" lead poisoning. One woman went to twenty-two doctors without proper diagnosis until she diagnosed herself as having lead poisoning. She was correct, but it proved to be too late to save her life.

Another example is an executive who suffered from "unexplained" headaches, backaches, weakness and tremors. Most doctors he consulted advised

him it was "nerves" due to stress. One psychotherapist gave him antidepressant drugs and shock treatment; they did not work. Later he was found to have mercury poisoning, an increasingly common finding explained in Chapter 28.

That is the toxic pollutant side of the story, which is relatively easy to detect and correct. The nutritional deficiency side escapes detection more frequently, is more difficult to diagnose, and it is not always a simple matter to correct. Without proper guidance, improper attempts to correct a mineral deficiency by taking massive amounts of that one mineral may create deficiencies in other minerals, due to imbalance. This book will show you how to uncover mineral deficiencies, confirm that they do exist and restore mineral balance.

Mineral imbalance increases vulnerability to disease, aggravates existing diseases and shortens the lifespan. When mineral balance is restored, you'll begin to feel better and look better within weeks. Proper mineral balance can restore vigor, put luster back in your hair, a healthy glow in your skin, sparkle in your eye, and a spring to your step. We have records of improved sex life, prostates returning to normal health, and menopausal symptoms disappearing when mineral balance is restored.

Dieters who had been physical wrecks for months after taking diuretics while they dieted, athletes who had suddenly become weak, and heart patients on medication who had become tired and impotent have improved immediately when proper mineral balance was restored. This book contains many such case histories.

Our experience suggests that most people have mineral imbalances. We agree with Dr. Donald Oberleas, Chairman of the Department of Nutrition and Food Sciences at the University of Kentucky, who estimates that as many as 80 percent of Americans are deficient in mineral intake.<sup>2</sup> Dr. William Strain, Director of the Trace Elements Laboratory at Case Western Reserve University, has done trace mineral analysis on more than 16,000 people and has found virtually all of them to have mineral deficiencies.<sup>3</sup>

It is clear that Americans are becoming essential element-starved and toxic element-polluted due to improper diet, depleted and contaminated soils, food processing and environmental pollution. What can you do about it? Protect yourself by reading on!

## REFERENCES

- 1 Williams, D. R., ed. 1976. *An Introduction to Bio-Inorganic Chemistry*. Springfield, Illinois: Charles C. Thomas, p. 315.
- 2 Vaisrub, S. May 31, 1976. *J. Amer. Med. Assoc.* 235(22): 2422.
- 3 Gibson, R. Nov. 29, 1977. *Nat. Eng.* 37.

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This review covers the following elements:

**CALCIUM**

**PHOSPHORUS**

**MAGNESIUM**

**POTASSIUM**

**SODIUM and CHLORIDE**

**IRON**

**ZINC**

**COPPER**

**MANGANESE**

**IODINE**

**CHROMIUM**

**SELENIUM**

**MOLYBDENUM**

**SILICON**

**VANADIUM**

**NICKEL**

**TIN**

**LITHIUM**

**RUBIDIUM**

**STRONTIUM**

**SULFUR**

**COBALT**

**LEAD**

**CADMIUM**

**MERCURY**

**ALUMINUM**

**ARSENIC**

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# 1

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## MINERALS AND TRACE ELEMENTS

In recent years there has been much concern about vitamin deficiencies in the American diet. Government surveys show that only 28 percent of American diets have vitamin A intakes providing 100 percent of the Recommended Dietary Allowance (RDA) and only 60 percent of the American diets have vitamin C intakes providing 100 percent of the RDA.<sup>1</sup>

However, the greatest deficiencies are the deficiencies of various elements in our diets commonly called minerals. There has not been much concern expressed over mineral deficiencies until now because only recently have the essential roles of many of these minerals been understood. The fact that these vital minerals are disappearing from modern diets has not been appreciated because few surveys ever include minerals and "trace elements." The Hanes survey (the U.S. Department of Health and the Health and Nutrition Examination Survey) includes only two minerals, calcium and iron. It found only 39 percent of Americans to be receiving 100 percent of the RDA for calcium and 64 percent receiving the RDA for iron (95 percent of females aged eighteen to forty-four had iron intakes below the RDA).<sup>1</sup>

The distinction between minerals and trace elements will be made shortly, but common usage groups them together as minerals.

Few physicians speak of trace elements because most physicians have not been exposed to studies showing the role of minerals and trace elements in

protecting us against heart disease, cancer, arthritis and other ailments. Others believe that since the required quantities are so small they cannot be very important

Most physicians who do learn of the roles of minerals and trace elements also learn of the complicated interrelationships between the various elements and decide to await further clarification. We hope this book will offer clarification of the existing knowledge of this new science.

The quantities of minerals and trace elements in our diets and in our bodies are often in the "milligram" or "microgram" range, and are sometimes referred to as a "part per million" or "part per billion." These units are not in common usage and may not be familiar to everyone. We'll try to give you a feeling for these small quantities now and later show how such small quantities exert such large influence on health.

Most people can visualize either an ounce or gram of something. A gram is the metric unit of weight which is one-twenty eighth of an ounce. A milligram is a thousandth of a gram and a microgram is a millionth of a gram (or a thousandth of a milligram). A milligram of most substances is just a speck or two, while a microgram is difficult to see with the naked eye.

If a gram of material contains a microgram of another substance, then the material is said to contain one-part-per-million of the other substance. If only a nanogram (a billionth of a gram or a thousandth of a microgram) of another substance is present in each gram of a material, then the substance is said to contain one part-per-billion of that material.

These are very small quantities indeed. A favorite device of scientists describing these quantities is to imagine that it was necessary to put one drop of an additive into 14,000 gallons of jet fuel. The drop represents one-part-per-billion concentration. Yet that drop makes the difference in whether a jet plane gets to its destination or not when flying from New York to Greece.

Our bodies consist of molecules made up of atoms of the basic elements. The vast majority of atoms in our bodies are of the elements hydrogen, carbon, nitrogen, oxygen and sulfur. These atoms are combined into molecules of protein, carbohydrates, fats, vitamins and water. Our bodies do not need elemental hydrogen, nitrogen or sulfur as such, but we do need to ingest certain essential groupings of these elements. The groupings, called molecules, are obtained from food, and we each have specific requirements for certain amino acids (portions of proteins), fatty acids (portions of fats) and vitamins. (Carbohydrates are not considered essential dietary components, but we all experience better health when adequate amounts are in the diet.)

An exception is oxygen, which we need as the pure element, as the diatomic molecule,  $O_2$ , and also as a component of proteins, carbohydrates, fats, vitamins and water.

Other elements in the body play major roles, even though their concentrations are low. Some of these elements are present in appreciable quantities,

while others are present only in hard-to-measure "traces." Those elements of the former type—such as calcium, which typically totals 1200 grams in the adult—have structural functions as well as enzymatic functions. In common usage these elements have been called "minerals." The elements of the latter type—such as selenium, which typically totals less than a milligram in an adult—do not usually contribute to the structure of the body, but only to enzymatic reactions. These elements are called "trace elements." How so few atoms of specific elements can be so important has to do with their role in enzymes and this will be explained later.

The body processes minerals as elements: therefore, the term "mineral" (an inorganic compound—a mixture of elements) is inappropriate. We can digest and absorb some of the elements in some minerals, but most of our "mineral" intake is a part of organic living tissue (plant or animal) and not inorganic. Some of the "mineral" is still in the elemental form, but much is incorporated into tissue or enzymes, just as it will eventually become in our bodies.

However, we are stuck with the common usage term for the most part. Today general usage in nutrition confines the term "mineral" to those elements that are largely incorporated into bone tissue, which contains compounds identical to true inorganic minerals found in the ground.

The Food and Nutrition Board of the National Academy of Sciences makes the following classifications:

**MACRO-MINERALS** calcium, phosphorus, magnesium, sodium, potassium and chlorine (The latter three are sub-classified as electrolytes)

**TRACE ELEMENTS** iron, zinc, copper, manganese, iodine, chromium, selenium, molybdenum

The Food and Nutrition Board also includes fluorine. Generally, fluorine is listed as a trace element. We do not consider the existing evidence sufficient to establish fluorine or fluoride as an essential element. We are aware of the many studies claiming improved resistance to tooth decay for fluoride, but these studies are not conclusive. We are also aware of studies showing that excesses are toxic.

Since fluoride deficiencies do not exist (by definition) and hair analysis for fluorine as a toxicant does not exist (due to instrumental limitation), we offer no further discussion of this element.

We also acknowledge the research indicating silicon, vanadium, nickel, tin, strontium, and arsenic as very likely to be essential, with lithium and rubidium as being probably essential.

When we discuss hair analysis, we refer to elements contained in the hair, not to "mineral" compounds. The elements incorporated into hair are usually attached to proteins, and are never present as inorganic minerals.

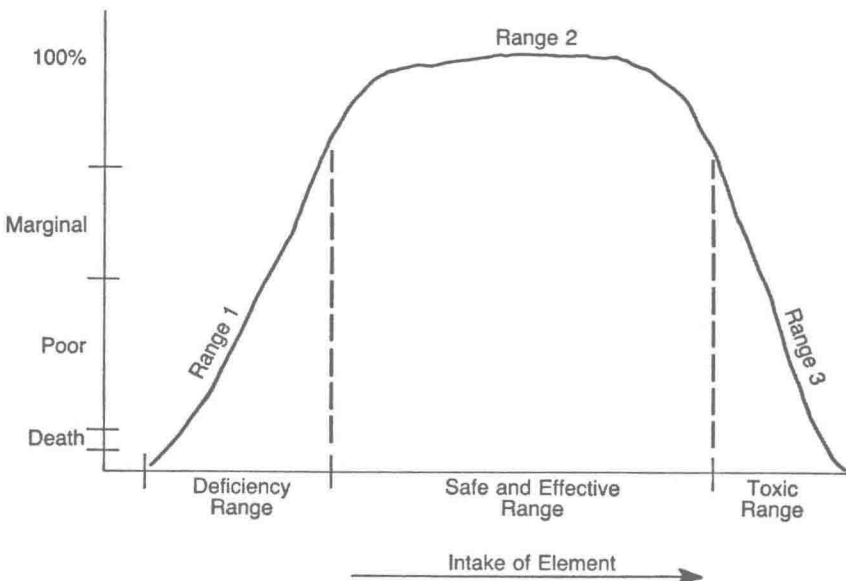
Our knowledge of trace elements is expanding, and at the present time, it is



felt that we probably have not identified all of the elements that are necessary for life. Some elements have been proven essential, others have shown evidence of being essential but need more research, and still others may have escaped our suspicion of being essential but may eventually enter that category.

Dr. Walter Mertz of the U.S. Department of Agriculture explains: "By the simplest definition, an essential element is one required for maintenance of life; its absence results in death of the organism. Severe deficiencies of an element that results in death are difficult to produce, particularly if the element is required in very low concentrations. A broader definition of essential elements has therefore been proposed and is widely accepted: an element is essential when a deficient intake consistently results in an impairment of a function from optimal to suboptimal and when supplementation with physiological levels of this element, but not of others, prevents or cures this impairment."<sup>2</sup>

FIGURE 1.1



The "Supernutrition Curve" showing the three ranges of intake versus health benefits described in the text. Source: Based on Passwater, R. 1975. *Supernutrition*. New York: Dial Press.