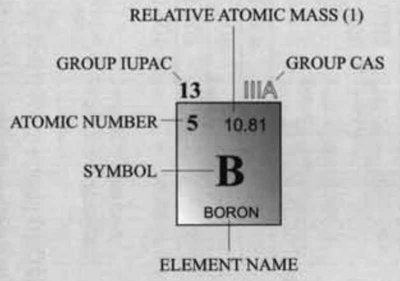
PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/



- ☐ Metal
- ▨ Semimetal
- ☐ Nonmetal
- ■ Alkali metal
- ▨ Alkaline earth metal
- ▨ Transition metals
  - ☐ Lanthanide
  - ▨ Actinide
- ☐ Chalcogens element
- ☐ Halogens element
- ■ Noble gas

STANDARD STATE (100 °C; 101 kPa)

Ne - gas
Fe - solid
Ga - liquid
Tc - synthetic

PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 **H** HYDROGEN																	2 4.0026 **He** HELIUM
2	3 6.941 **Li** LITHIUM	4 9.0122 **Be** BERYLLIUM											5 10.811 **B** BORON	6 12.011 **C** CARBON	7 14.007 **N** NITROGEN	8 15.999 **O** OXYGEN	9 18.998 **F** FLUORINE	10 20.180 **Ne** NEON
3	11 22.990 **Na** SODIUM	12 24.305 **Mg** MAGNESIUM											13 26.982 **Al** ALUMINIUM	14 28.086 **Si** SILICON	15 30.974 **P** PHOSPHORUS	16 32.065 **S** SULPHUR	17 35.453 **Cl** CHLORINE	18 39.948 **Ar** ARGON
4	19 39.098 **K** POTASSIUM	20 40.078 **Ca** CALCIUM	21 44.956 **Sc** SCANDIUM	22 47.867 **Ti** TITANIUM	23 50.942 **V** VANADIUM	24 51.996 **Cr** CHROMIUM	25 54.938 **Mn** MANGANESE	26 55.845 **Fe** IRON	27 58.933 **Co** COBALT	28 58.693 **Ni** NICKEL	29 63.546 **Cu** COPPER	30 65.39 **Zn** ZINC	31 69.723 **Ga** GALLIUM	32 72.64 **Ge** GERMANIUM	33 74.922 **As** ARSENIC	34 78.96 **Se** SELENIUM	35 79.904 **Br** BROMINE	36 83.80 **Kr** KRYPTON
5	37 85.468 **Rb** RUBIDIUM	38 87.62 **Sr** STRONTIUM	39 88.906 **Y** YTTRIUM	40 91.224 **Zr** ZIRCONIUM	41 92.906 **Nb** NIOBIUM	42 95.94 **Mo** MOLYBDENUM	43 (98) **Tc** TECHNETIUM	44 101.07 **Ru** RUTHENIUM	45 102.91 **Rh** RHODIUM	46 106.42 **Pd** PALLADIUM	47 107.87 **Ag** SILVER	48 112.41 **Cd** CADMIUM	49 114.82 **In** INDIUM	50 118.71 **Sn** TIN	51 121.76 **Sb** ANTIMONY	52 127.60 **Te** TELLURIUM	53 126.90 **I** IODINE	54 131.29 **Xe** XENON
6	55 132.91 **Cs** CAESIUM	56 137.33 **Ba** BARIUM	57-71 La-Lu **Lanthanide**	72 178.49 **Hf** HAFNIUM	73 180.95 **Ta** TANTALUM	74 183.84 **W** TUNGSTEN	75 186.21 **Re** RHENIUM	76 190.23 **Os** OSMIUM	77 192.22 **Ir** IRIDIUM	78 195.08 **Pt** PLATINUM	79 196.97 **Au** GOLD	80 200.59 **Hg** MERCURY	81 204.38 **Tl** THALLIUM	82 207.2 **Pb** LEAD	83 208.98 **Bi** BISMUTH	84 (209) **Po** POLONIUM	85 (210) **At** ASTATINE	86 (222) **Rn** RADON
7	87 (223) **Fr** FRANCIUM	88 (226) **Ra** RADIUM	89-103 Ac-Lr **Actinide**	104 (261) **Rf** RUTHERFORDIUM	105 (262) **Db** DUBNIUM	106 (266) **Sg** SEABORGIUM	107 (264) **Bh** BOHRIUM	108 (277) **Hs** HASSIUM	109 (268) **Mt** MEITNERIUM	110 (281) **Uun** UNUNNILIUM	111 **Uuu** UNUNUNIUM	112 (285) **Uub** UNUNBIUM		114 (289) **Uuq** UNUNQUADIUM				

LANTHANIDE

57 138.91 **La** LANTHANUM	58 140.12 **Ce** CERIUM	59 140.91 **Pr** PRASEODYMIUM	60 144.24 **Nd** NEODYMIUM	61 (145) **Pm** PROMETHIUM	62 150.36 **Sm** SAMARIUM	63 151.96 **Eu** EUROPIUM	64 157.25 **Gd** GADOLINIUM	65 158.93 **Tb** TERBIUM	66 162.50 **Dy** DYSPROSIUM	67 164.93 **Ho** HOLMIUM	68 167.26 **Er** ERBIUM	69 168.93 **Tm** THULIUM	70 173.04 **Yb** YTTERBIUM	71 174.97 **Lu** LUTETIUM

ACTINIDE

89 (227) **Ac** ACTINIUM	90 232.04 **Th** THORIUM	91 231.04 **Pa** PROTACTINIUM	92 238.03 **U** URANIUM	93 (237) **Np** NEPTUNIUM	94 (244) **Pu** PLUTONIUM	95 (243) **Am** AMERICIUM	96 (247) **Cm** CURIUM	97 (247) **Bk** BERKELIUM	98 (251) **Cf** CALIFORNIUM	99 (252) **Es** EINSTEINIUM	100 (257) **Fm** FERMIUM	101 (258) **Md** MENDELEVIUM	102 (259) **No** NOBELIUM	103 (262) **Lr** LAWRENCIUM

(1) Pure Appl. Chem., **73**, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Editor: Aditya Vardhan (adivar@nettlinx.com)

HEAVY METALS:
METALLURGY PRIMER

Teri Junge, CST/CFA

AS ROBOTICS BECOME INCREASINGLY PREVALENT IN SURGERY, THE SURGICAL TECHNOLOGIST WILL COME IN CONTACT WITH MORE AND VARIED TYPES OF SURFACES. MANY OF THE PROPERTIES OF THE METALS THAT ARE COMMONLY USED IN THE OPERATING ROOM AND THE RELATED TERMINOLOGY ARE OFTEN LITTLE UNDERSTOOD BY THE SURGICAL TECHNOLOGIST. THIS ARTICLE PROVIDES BASIC COMPOSITION AND PERFORMANCE INFORMATION ABOUT SOME OF THE MORE COMMONLY USED TYPES OF FERROUS METALS AND THEIR ALLOYS, AS WELL AS A GLOSSARY CONTAINING RELATED TERMS AND THEIR DEFINITIONS.

Properties of metals

Metallic elements are located on the left side of the periodic table (Table 1) and are separated from the nonmetals by a diagonal line of elements that exhibit both metallic and nonmetallic qualities. The elements creating the separation are boron (B, 5), silicon (Si, 14), germanium (Ge, 32), arsenic (As, 33), antimony (Sb, 51), tellurium (Te, 52), polonium (Po, 84), and astatine (At, 85).

Although there is great variation from one metal to the next, most metals are strong and resistant to various stresses. Metals are rated according to their ductility, elasticity, fatigue resistance, hardness, inertness, malleability, tensile strength, and resistance to abrasion and corrosion.

Very few metals, such as gold (Au, 79) and platinum (Pt, 78), are found in their pure state; the rest must be refined prior to use.

Most metals are cationic, meaning that they are positively charged, and are capable of donating electrons. Most nonmetallic elements are anionic, meaning that they are negatively charged, and are capable of accepting electrons. The exchange of positive and negative electrons sets up the potential for chemical reactions to occur that are capable of changing the properties of the element.

Corrosion

Corrosion is a complex chemical or electrochemical reaction that occurs when a metal is exposed to another element capable of causing oxidation. Corrosion of medical devices occurs from exposure to dissimilar metals (electrolytic reaction), the atmosphere, body fluids, irrigation fluid, and the presence of foreign bodies. Fretting corrosion occurs when abrasive wear is accompanied by corrosion. Formation of rust on iron is probably the best-known example of corrosion. Three methods are used to prevent corrosion of metallic devices.

1. An alloy is used that is resistant to corrosion.
2. A coating, such as nitric acid, is used to form a protective oxide on the surface.
3. An impermeable coating is applied to prevent oxidation.

Electrolytic reaction

An electrolytic reaction, sometimes referred to as the battery effect, is an unfavorable electrochemical reaction resulting in corrosion of a metal or tissue destruction within the body. An electrolytic reaction can occur with implantation of a single metal simply from exposure to saline solution or oxygen. However, an electrolytic reaction most often occurs due to implantation of two or more different kinds of metal. Biocompatible metals must be used to prevent electrolytic reactions in the surgical patient. For example, stainless steel alloys can be combined with themselves and with each other. The same is true for titanium- and cobalt-based alloys; however, they cannot be combined with stainless steel alloys.[9] *Note: When implanting metallic devices, related instrumentation and suture material must be of the same type of metal to prevent an electrolytic reaction.*

Stainless steel

Carbon steel is made from refined iron (Fe, 26) ore and varying amounts (up to 0.8 %) of carbon (C, 6) and approximately 0.5 % manganese (Mn, 25). Carbon steel is highly susceptible to corrosion. Stainless steel, which is resistant to corrosion, is manufactured by adding a minimum of 10.5 % chromium (Cr, 24) to carbon steel. Elements, such as nickel (Ni, 28), may also be added to improve corrosion resistance. Other elements may be added to increase tensile strength. Stainless steel is recyclable.

Stainless steel was invented by Harry Brearley, an English metallurgist, in 1913. Brearley was experimenting with an alloy that he thought would be more resistant to erosion, when, by chance, he discovered its anticorrosive properties. The alloy revolutionized the cutlery industry and was quickly adopted by emerging aircraft manufacturers.[4]

Stainless steel has many applications related to the medical field. Not only is stainless steel resistant to corrosion, but it also has several other qualities that make its use desirable. Medical equipment, such as patient beds, OR tables, stretchers, and cabinets have long been manufactured from stainless steel because of its hygienic, easy-to-clean qualities and aesthetic appearance. The fact that stainless steel does not shed particles or absorb liquids makes it ideal for use in the preparation of pharmaceuticals.

Surgical instruments made from stainless steel are light weight and several finishes (ebonized, mirror, or satin) are available. Its strength and resistance to fatigue make it an ideal candidate for medical implants, such as artificial joints and internal fracture stabilization devices.[4] Stainless steel is considered the most inert of all currently available suture materials.[1]

Chromium

Chromium (Cr, 24) was discovered by Louis Nicolas Vauquelin, a French chemist, in 1797. Chromium is used primarily as an alloy, replacing iron or aluminum in some metals, providing strength, hardness, and corrosion resistance. Chromium gets its name from the Greek "chroma" meaning color, because various chromium compounds feature unique colors.[3]

Cobalt

Cobalt (Co, 27) was discovered by George Brandt, a Swedish chemist, in 1735. Cobalt is found in the earth's crustal rocks and is primarily used for making alloys such as cobalt chromium and vitallium. Cobalt-60 is a radioactive isotope of cobalt that is a principle source of gamma radiation used for industrial sterilization. Cobalt-60 is also used in nuclear medicine to help diagnose and treat malignancies.[3]

Mercury

Mercury (Hg, 80) has been known to man since ancient times and is named after the Roman god Mercury. Its symbol on the periodic chart is derived from the Latin word hydrargyrum, which means liquid silver. Mercury is the only metal commonly found in the liquid state at atmospheric temperatures. In the past, mercury has been used in thermometers, sphygmomanometers, and dental fillings. Because mercury is a poison that can be absorbed through

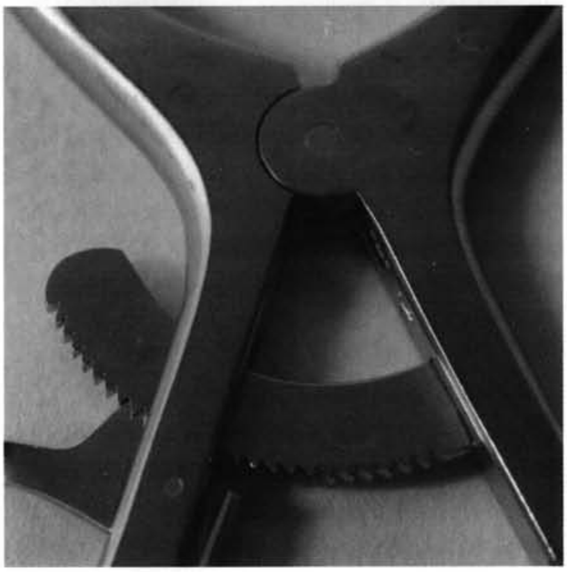
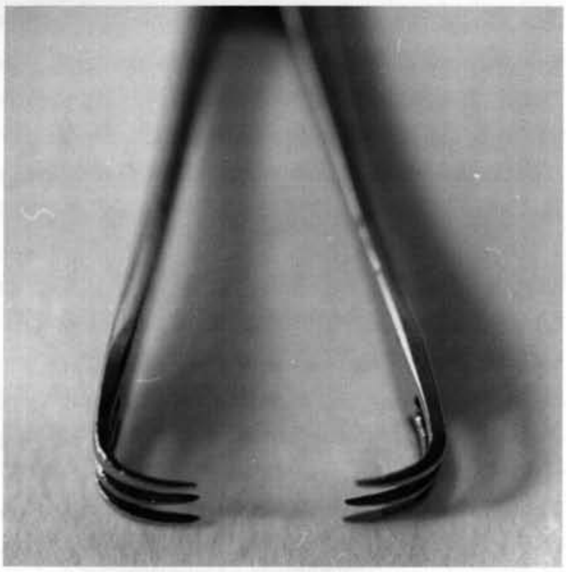
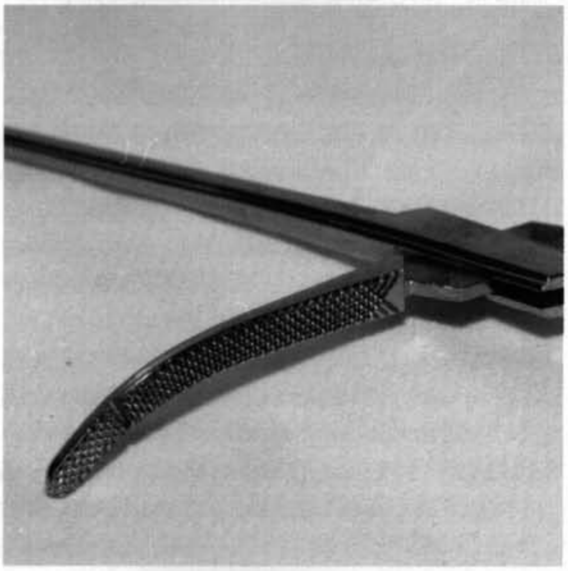


PHOTO Denis Frolov





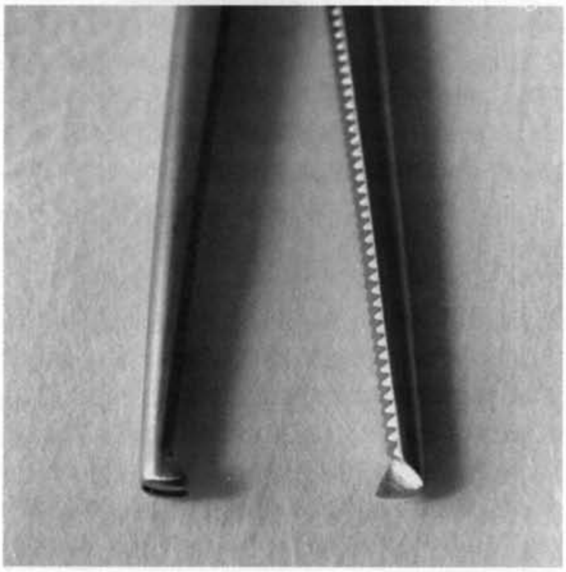


PHOTO Denis Frolov

the respiratory and gastrointestinal tracts and through intact skin, its medical use has diminished in recent times. Mercury is still widely used in industrial settings, and pollution of lakes and rivers from industrial waste remains a problem.[8]

Titanium

Titanium (Ti, 22) was discovered by William Gregor, a British clergyman, in 1791. It was originally found in the mineral menachanite and was named menachite. In 1910, the element was rediscovered in the mineral rutile by German chemist Martin Heinrich Klaproth. Because of its strength, Klaproth named the element titanium in reference to the Titans in Greek mythology.[8]

Vitallium

Vitallium was first patented by in Germany by Reiner W Erdle, a dental technician, and his brother-in-law Charles H Prange, an engineer and businessman, in 1933. Vitallium is an alloy consisting of cobalt, chromium, tungsten, and small amounts of carbon, manganese, and nickel. The alloy was first used in the manufacture of dental appliances. When vitallium was found resistant to the hostile saline environment within the human body, it was considered for orthopedic use. In 1936, following experiments on dogs, WG Stuck, an orthopedic surgeon in San Antonio, Texas, implanted the first vitallium alloy to stabilize a fracture, without evidence of corrosion or tissue reaction. A subtle change in the formula for vitallium was made in 1936 to increase its strength and ductility without disturbing its other properties. Vitallium continues to be used as dental and orthopedic implant material.[7]

Conclusion

An understanding of metals and their properties applies to many aspects of the OR, including asepsis, instrumentation, sterilization, and implanted materials. As more technology is introduced into this setting, this knowledge will become even more valuable to the surgical technologist.

Related Terminology

Abrasion—to roughen or remove by friction; erosion.

Alloy—a substance composed of two or more metals; or a substance composed of a nonmetal and a metal such as carbon.

Amalgam—an alloy that contains mercury.

Axial tension—stress or force applied to the long axis of an object.

Cast—to form an object by pouring into a mold.

Compression—stress or force applied in an attempt to press together or condense an object.

Corrosion—disintegration of the texture or substance of an item by a destructive agent.

Ductility—a metal's ability to be stretched into wire.

Elastic limit—maximum strain that can be applied to an object that will allow it to resume its original shape.

Elastic strain—stretch applied to an object that produces a linear slope (bend), but allows the object to return to its original length (shape) when removed.

Electrolytic reaction—an unfavorable electrochemical reaction (resulting in decomposition) that occurs due to implantation of two or more different kinds of metals.

Ferrous—containing iron.

Force—energy or power exerted on an object to either initiate or arrest movement. The metric measure of force is the newton. One newton equals 0.225 pound of force.

Forge—to shape a metal by heating it and then beating or hammering it into shape

Fretting corrosion—corrosion accompanied by abrasion.

Inert—displays no chemical activity.

Load—weight applied or stress imposed.

Load test—performed to determine an object's ability to withstand or absorb the weight or stress applied.

Malleable—pliable; capable of bending.

Metal fatigue—fracture or breakdown of a metal caused by repeated application of a load.

Strain—application of a force or load that is capable of producing a change (deformity) in the linear dimension of an object.

Stress—intensity of a load that produces an intense force within an object.

Tensile strength—the breaking point of an object due to an applied force.

Tension—stress or force applied in an attempt to pull an object apart.

Wrought—to form an object by hammering or forcing into shape.

Yield strength—limit of an object's elastic region.

Yield point—stress beyond the elastic limit (also referred to as the fatigue or endurance limit) of an object to produce a permanent deformity. Metals are ranked according to their yield strength and are in order from highest to lowest: cast cobalt chrome, titanium, wrought cobalt chrome, stainless steel.

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Periodic table of elements used courtesy of Eni Generalic, Faculty of Chemical Technology, Split, Croatia, © 2002. For additional information on mercury pollution, please read "The Point at Issue," published in The Surgical Technologist, *July 1999.*