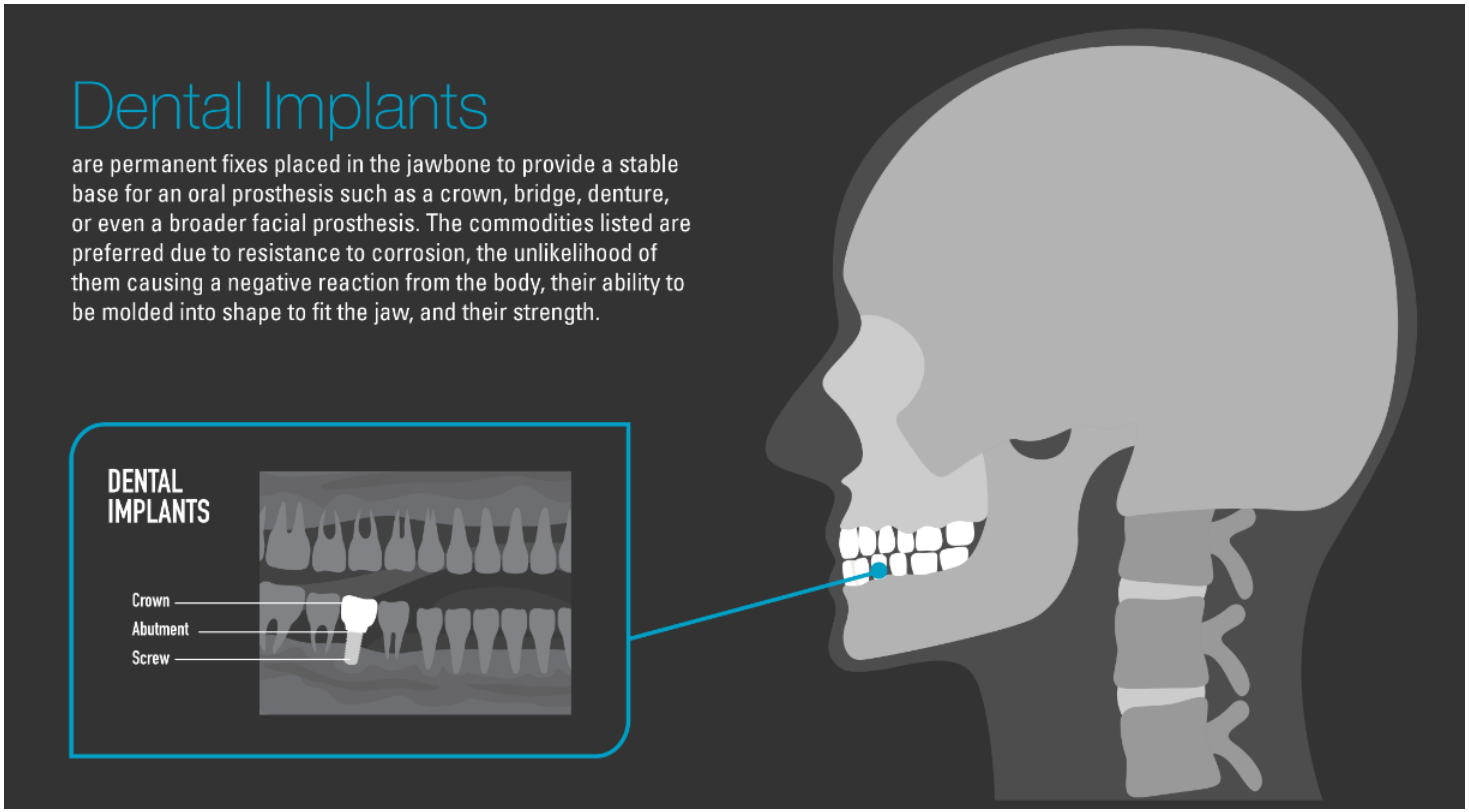
Metals in medical implants

HOME READING ASSIGNMENT

Metals in Medical Implants: dental



Co (alloys w Cr, Mo): denture frameworks

Au (alloys w Cu, Pt, Zn, Ag): dental prostheses, crowns, bridges

Fe (stainless steel): dental crowns, surgical tools

Ni (alloys w Ti): dental braces, drills

Ta: coat of carbon foam scaffold in biocompatible bone implants

Ag (alloys w Cu, Sn, Zn): dental fillings

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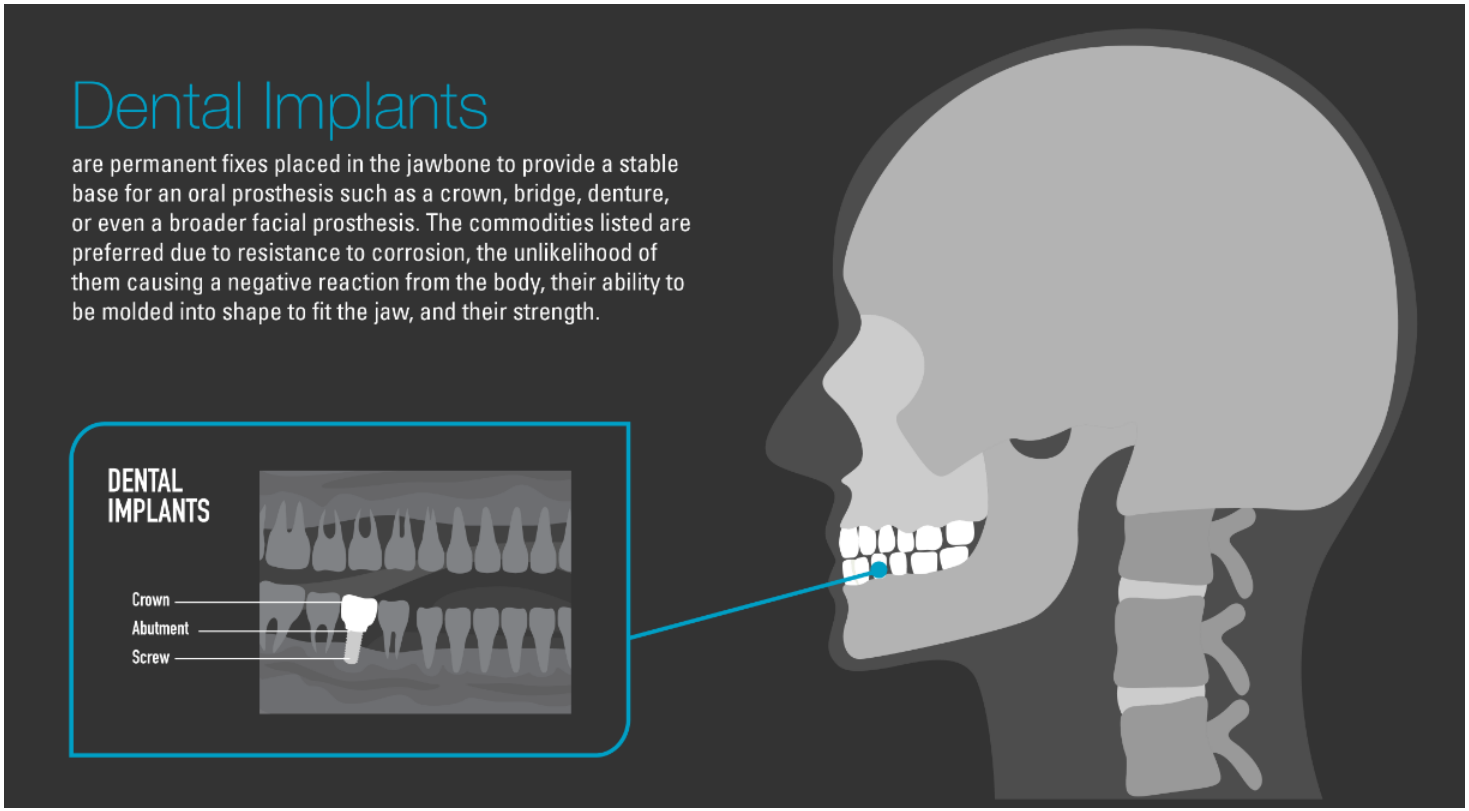
Metals in Medical Implants: dental



Ti:
mech properties similar to bone, promotes osseointegration

Zr:
major constituent in ceramics for dental applications, wear resistant, inert, mech prop suited for dental crowns

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METALS IN MEDICAL IMPLANTS: SENSORY & NEURO

Sensory and Neurological Implants

are implantable devices that communicate with the nervous system to either record electrical nerve activity or to electrically stimulate nerve cells that would improve senses that are not functioning properly. Examples include:

Cochlear Implants

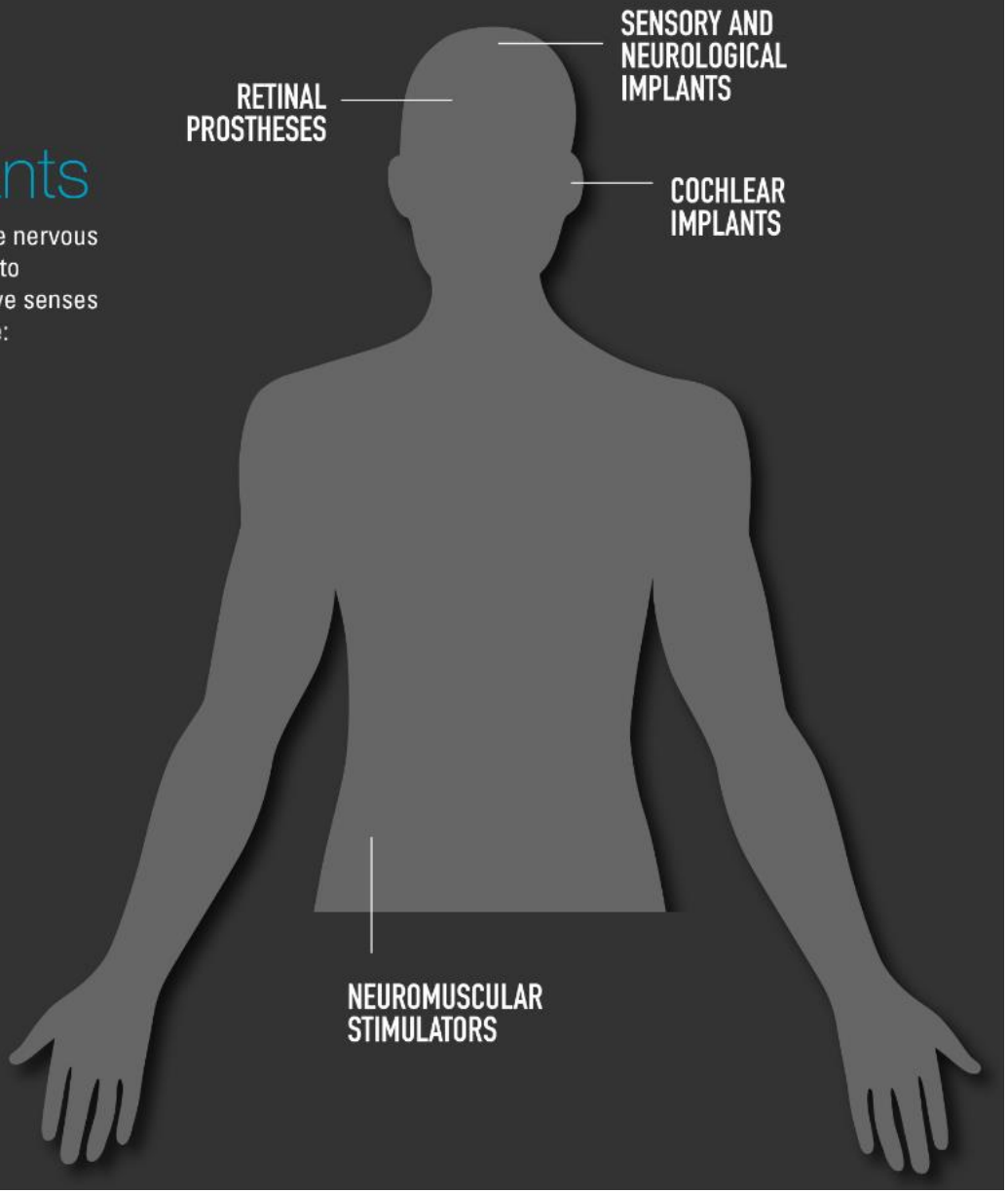
are designed to transmit sounds of speech into the brain, allowing the person to hear.

Retinal Prostheses

are fitted with sensors that trigger an electronic pulse. This pulse then stimulates nerves in the retina, which pass signals down the optic nerve to the brain to create an image.

Electrical Stimulators or Functional Neuromuscular Stimulation

are devices that deliver electrical impulses to nerves in the brain, treating disorders as deafness, incontinence, chronic pain, depression, and Parkinson's disease, among others.



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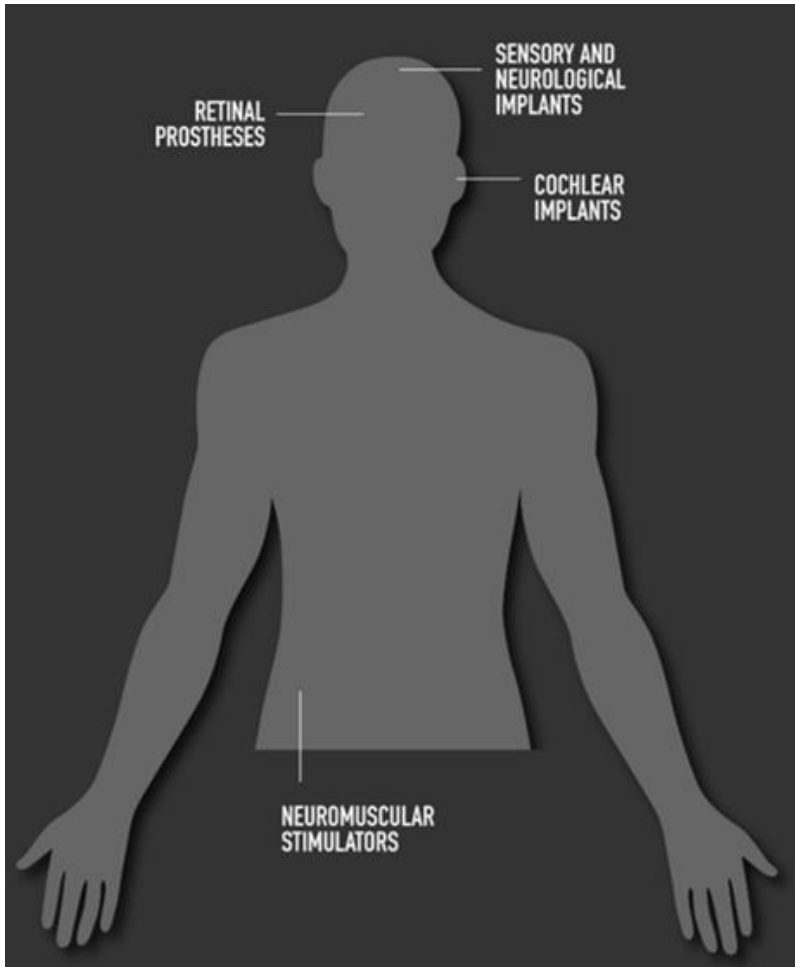
METALS IN MEDICAL IMPLANTS: SENSORY & NEURO

Au electrodes: **bioelectronics**, brain-machine interfaces, cochlear implants, glucose biosensors

Ir (oxide): coating for Au, Cu, Ti wires for functional stimulation electrodes

Pt:
one of best electrode materials, neuromodulation devices, guidewires, stents, coils, catheters



Ti: electrodes, non-toxic exterior of medical implants

Ag:
coating agent, anti-inflammatory, infection suppressant properties

Li (Li-I):
lithium iodide batteries suitable for implantable devices (long lifespan, stable voltage, reliable performance), also small and lightweight batteries

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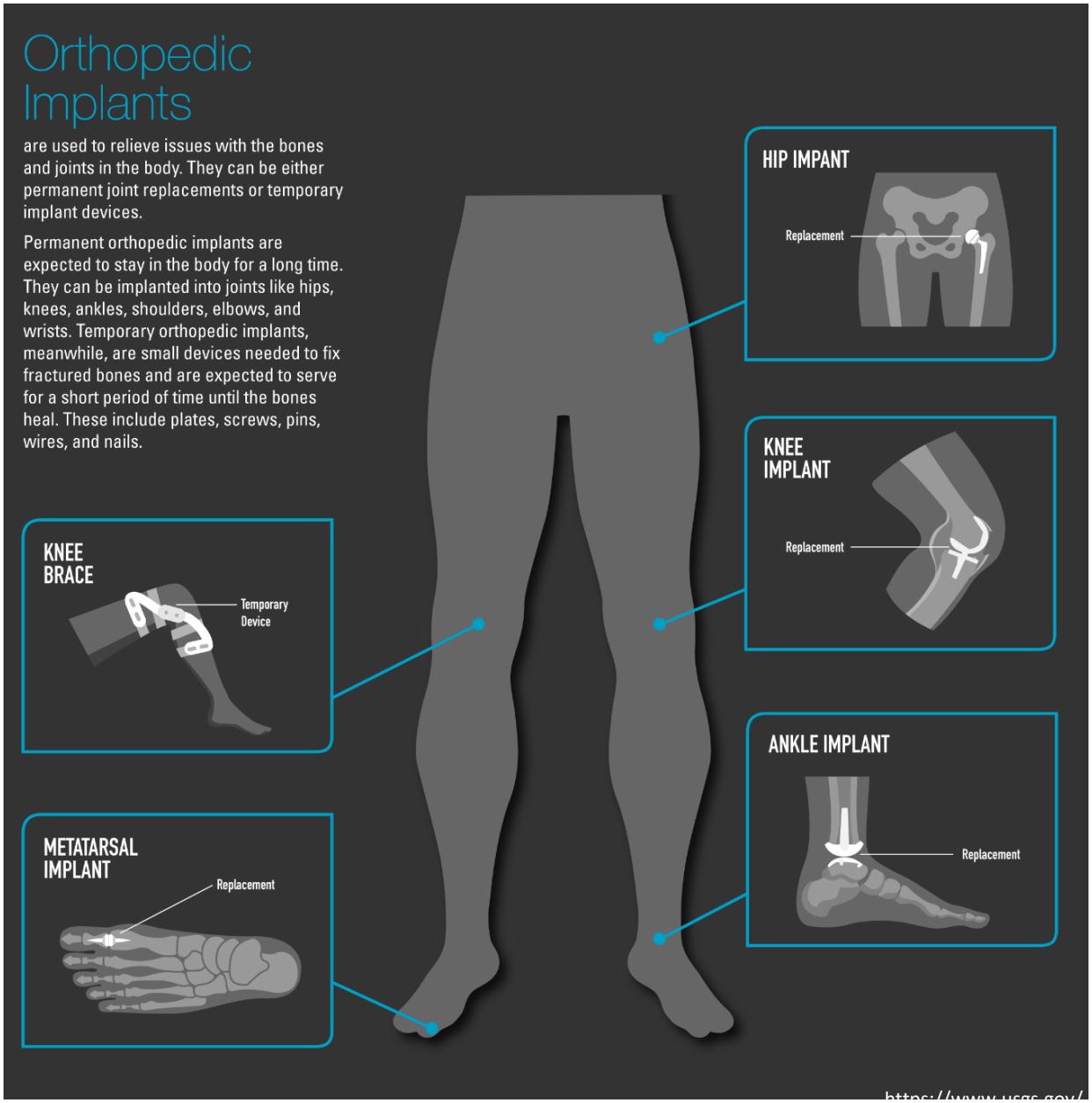
Metals in Medical Implants: Orthopedic



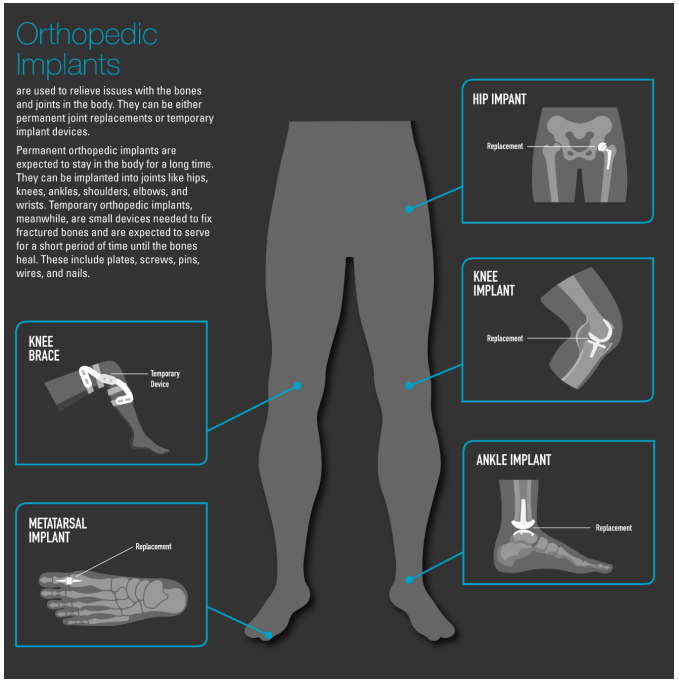
Metals in Medical Implants: Orthopedic

Al (alloys): major element for alloying w Ti for ortopedic appl; ceramics (Al oxides)

Fe (stainless steel): major component stainless steel, fracture fixing plates, bone screws

Cr (Co-Cr-**Mo** alloys): corrosion resistant alloys; Mo impart hardness

Co: orthopedic prostheses for knee, shoulder, hip, fracture-fixing devices



Mg (and alloys): degradable metal implants: bone screws, plates; alloyed w Zn, Al to control degradation rate

Zr (and oxides): hard, resistant to wear, biocompatible; ceramics in joint replacement

Ni (in Ni-Ti alloys): spinal fixation, compression screws, plates, limb-lengthening devices

Ni (in stainless steels): improve pitting corrosion resistance in orthopedic implants

Ti (alloys): improve mech prop, e.g. w Al, V; ability to physically bond w bone

Metals in Medical Implants: Cardiovascular

Cardiovascular Implants

are used in cases where the heart, its valves, and the rest of the circulatory systems are in disorder. These include artificial hearts, artificial heart valves, cardiac pacemakers, implantable cardioverter-defibrillators, and coronary stents.

Cr (and alloys): used in heart valves [29]

Co (and alloys): defibrillators; Co-Cr stainless steels used in catheters and stents [30,31]

Ni (Ni-Ti alloys): cardiac implantable devices [36,37,38]

Ti (and alloys): pacemaker encapsulation [45,46]

Au: good electrical cond, used on electronic circuits, interfaces, implantable pacemakers, defibrillators [32]

Fe (steels): guidewires, catheters, endovascular grafts [33]

Ta: radio-opacity, used as radiomarker on stents and endovascular grafts [42, 43, 44]

Mg: degradable metallic stents, alloyed with Al etc to control rate of degradation [35]

Pt: corrosion resistance, used as lead tips for pacemakers. radiomarkers on stents, catheters, guidewires: improve visibility during cardiovascular procedures (balloon angioplasty or stenting).[39,40,41]

Li (Li-I): lithium-iodide batteries suitable for implantable peacemakers [34]

Table 1.1 Biomedical metals and alloys and their primary use in the medical field.[4]

Type	Primary use	FDA Class
Routinely applied materials		
Stainless steels	Temporary fracture plates, screws, hip nails, *etc.*	II
	Total hip replacements	II
Co-based alloys	Total joint replacement	II
	Dentistry castings	II
Ti-based alloys	Stem and cup of total hip replacements with CoCrMo or ceramic femoral heads	II
	Other permanent devices (nails, pacemakers)	III
Emerging FDA approved materials		
NiTi	Orthodontic dental archwires	I
	Vascular stents	III
	Vena cava filter	II
	Intracranial aneurysm clips	II
	Catheter guide wires	II
	Orthopaedic staples	I
Ta	Wire sutures for plastic surgery and neurosurgery	III
	Radiographic markers for diagnostic applications	II
Materials in clinical trials and research		
NiTi	Contractile artificial muscles for an artificial heart	III
Mg	Biodegradable orthopaedic implants	III

O. Bazaka, K. Bazaka, P. Kingshott, R. J. Crawford and E. P. Ivanova, Chapter 1:Metallic Implants for Biomedical Applications , in *The Chemistry of Inorganic Biomaterials*, 2021, pp. 1-98 DOI: 10.1039/9781788019828-00001