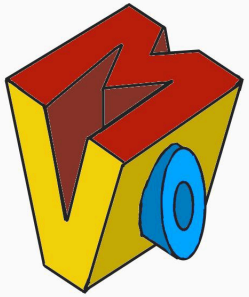
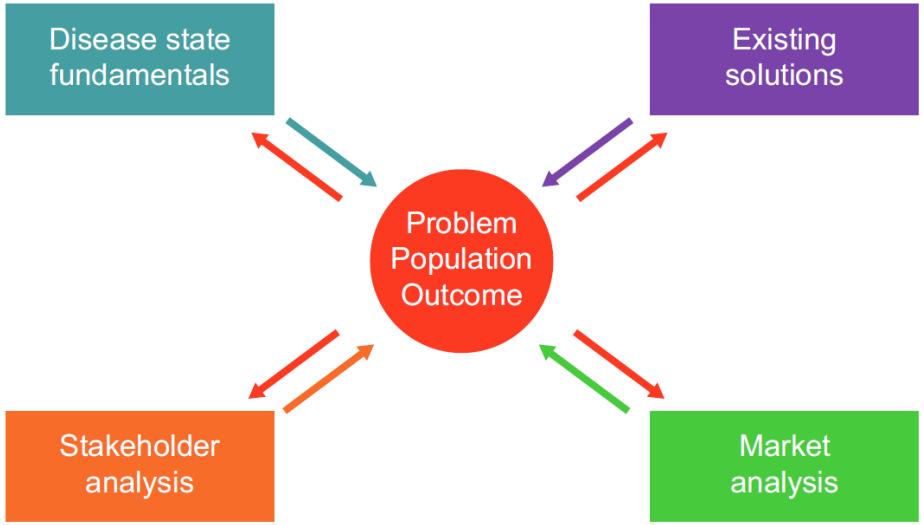


Agenda – Design Inputs

- Enumerated User Needs
- Design Requirements
  - Standards
- Assignment 2 Overview
- *Break*
- Group work time
  - User Needs OR Design Requirements
  - Open office hours & teamwork opportunities

Last LAST Time – Researching Needs

- Literature Review
- Database “dig”
  - FDA registered products
  - Patents



Biomedical Engineering

Use the tabs above to find more information on finding information in Biomedical Engineering.

- **Background Information:** Sources like encyclopedias, handbooks, databases to help find material properties and data, statistics, etc.
- **Books:** A quick guide to searching for books in the U-M Library.
- **Articles:** Links to scholarly databases to find article, conference proceedings, technical reports, etc.
- **Patents:** Links to patent databases.
- **Standards:** A quick guide to finding industrial standards.
- **Marketing Resources:** Links to the websites and databases on marketing research, reports, and statistics.
- **Regulatory Resources:** Links to the regulatory resources from government organizations.
- **Citation Management Software:** Links to software that enable you to capture information about research materials, create bibliographies, and add citations to your assignments.

Online Library Tools

- **Introduction to the Library for Graduate Students**

  This short video goes over the highlights for using the UM Library website to find books, articles and much more.
- **Interlibrary Loan**
  UM doesn't own the article or book you are looking for? With this free service, we can get almost anything for you!
- **Proxy Bookmarklet**
  When not on a campus computer or using an MWireless or MWireless-UMHS network connection, you can use our proxy server bookmarklet to check for a library subscription to specific content.
- **Library Access Browser Extension**

  Available for Chrome, Edge, Explorer, Firefox, Opera, and Safari on desktops and laptops, as well as through an iOS app, this extension automatically detects when you come across a resource, ebook, or article online that the library has a subscription for.

Need(s) Statement

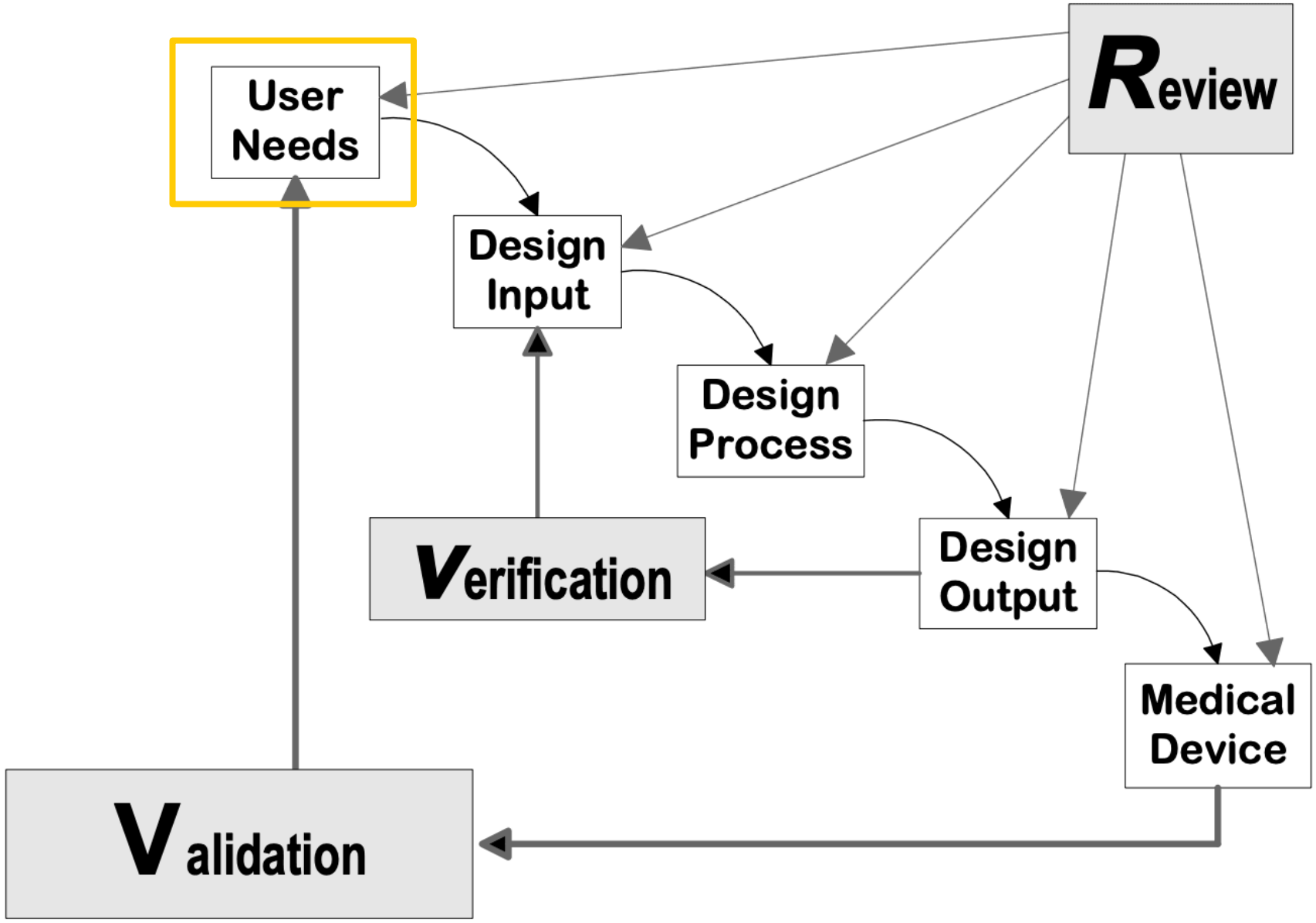
Overarching statement describing the problem, population and desired outcome

User Needs

List of statements that must be met in order to fully address the Needs Statement. (goals)

Design Requirements

Specific statements that describe what can be measured to ensure the needs/goals are met. (goalposts)



Need(s) Statement

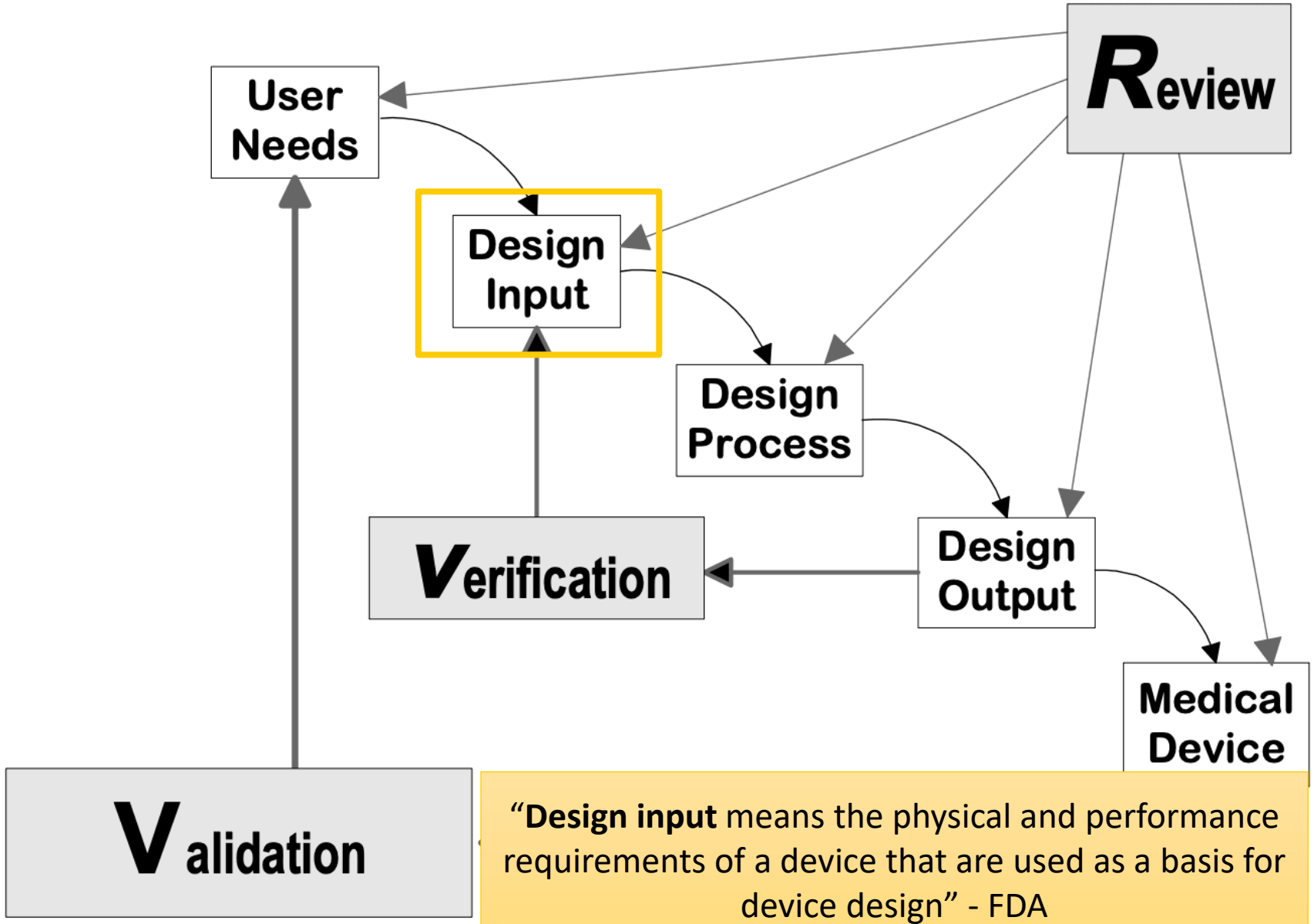
Overarching statement describing the problem, population and desired outcome

User Needs

List of statements that must be met in order to fully address the Needs Statement. (goals)

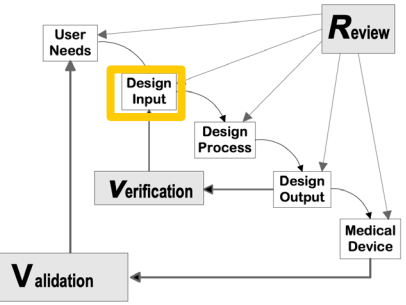
Design Requirements

Specific statements that describe what can be measured to ensure the needs/goals are met. (goalposts)



"**Design input** means the physical and performance requirements of a device that are used as a basis for device design" - FDA

Note on nomenclature!



Design Requirement and *Design* Specification (Reqs & Specs) is another way to describe **Design Inputs**

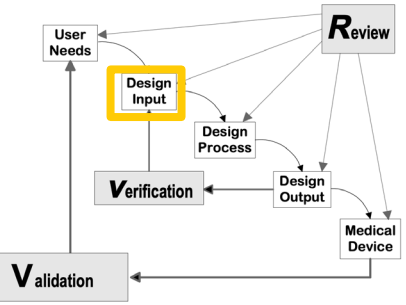
Detailed Design or *Design Details* is another way to describe **Design Outputs**

Design Inputs (Req & Spec as goalposts)	**Design Outputs** (final, measured feature)
Weight (< 15 lbs)	Calculated weight = 13.2 lbs
Temperature (0 F – 120 F)	Sensor chosen functional in -10F to 130F (safety factor -> +/- 10 degrees)
< 30% reduction in cell viability	Material chosen is effective in literature review

Specification: a detailed description of how something should be done, made, etc.
Cambridge Dictionary, Cambridge University Press & Assessment 2023, accessed 9/11/2023, https://dictionary.cambridge.org/us/dictionary/english/specification

(there are many many definitions of specification, and it has a very, pun intended, *specific* use case in industry. Here's a company that sells a spec management system that describes what a "spec" is pretty well: https://specright.com/what-is-a-specification)

For this class



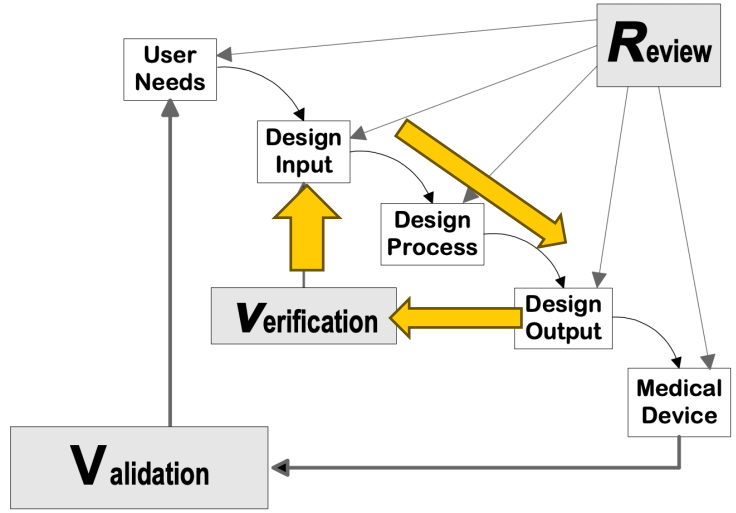
Design Requirement and *Target* Specification for **Design Inputs**.

Product Specification for the **Design Outputs**

Design Inputs			**Design Outputs** (final measured feature)
Design requirements	Target Specifications	Justifications	
Weight	< 15 lbs	[references for why 15lbs is considered portable]	Geometry & Material choice calculated to be: Weight = 13.2 lbs
Temperature (functioning)	32 F – 120 F	[references]	Sensors chosen that: Functional in -10F to 130F
Effects on cell viability	< 30% reduction	[ANSII 10993-5:??]	Material effective in literature review chosen

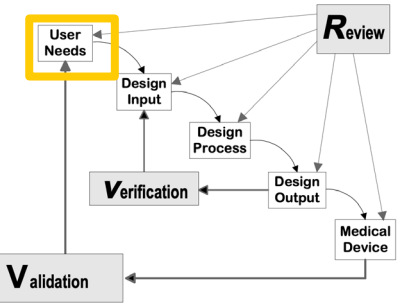
Industry professionals may exclusively refer to Design Outputs as "Specs"

How these fit together?



User Needs	Design Inputs	Design Outputs	Validation & Verification
"Must be portable"	Weight (< 15 lbs)	Geometry & Material choice calculated to be: Weight = 13.2 lbs	Weighs 13.9lbs PASS
"Must be portable"	Temperature (0 F – 120 F)	Materials rated for -10F to 130F (safety factor -> +/- 10 degrees)	Tested in 0-120F PASS
"Biocompatible"	< 30% reduction in cell viability	Material effective in literature review chosen	Cell viability reduced by 32% NOT PASS

How can we break down our Needs Statement into action items?



A good starting point is considering in the following categories:

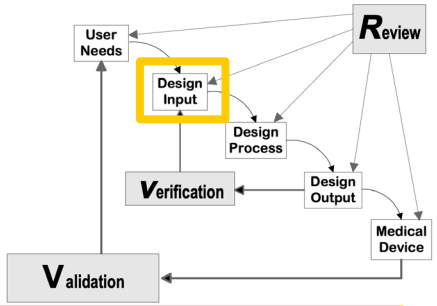
Efficacy **Safety** **Usability** **Durability** **Cost**

As you refine from Needs to Design Requirements, you'll ask questions like the following:

- What does this DR **mean**? (What is the outcome in which I'm interested?)
- How can it be **assessed** as passed or not?
- What **standards** or **norms** exist for this need?
- What **thresholds** are acceptable? (tolerances, +/1, range of values, etc)
- Is this need **absolutely necessary** or more **nice to have**?

VMO will provide you with enumerated User Needs
You'll be tasked with developing Design Requirements

User Needs can be split into *Categories*



Effectiveness / Function

- Does the device address the problem?
- What is considered a “success”?

Safety

- Are there any risks added due to this device?
- How can you prove the risks are minimized?

Usability/Feasibility

- Will stakeholders actually use it?
- Will stakeholder use it correctly?

Durability

- How long will the device last?
  - How can you test this?
- What does the device need to withstand?

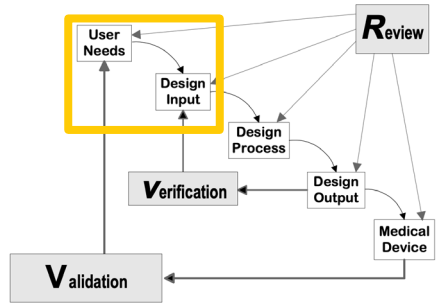
Cost

- Can your target population afford this?
  - What price range should you aim for?
  - What does that mean for design choices?

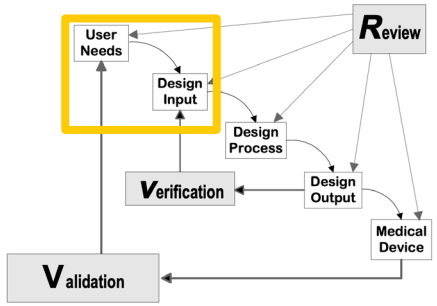
Biocompatibility

- ***Tricky! Beware!
- Device vs. Body
  - Device - breaks down or lose function
  - Body – inflammation in host

Translating User Needs into Specs



User/Stakeholder Need	**Design Requirement (& Target Spec)**
"Can't cut off circulation"	
"Must be portable"	
"Biocompatible"	
"Hold temperature for set time"	



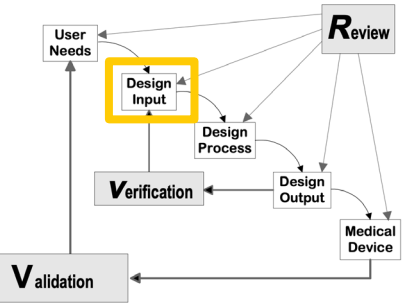
User Need	Design Requirement (Target Spec)
"Can't cut off circulation"	• Pressure (≤ 80 mmHg)
"Must be portable"	• Size (mm or in) • Weight (< 15 lbs) • Vibration (100-2000 Hz, 10m/s^2, 8hrs – IEC 60068-2-64) • Temperature (0 F – 120 F)

"Biocompatible"	• Using methods in ANSI/AAMI/ISO 10993-5
	  • < 30% reduction in cell viability
	  • Morphologic grade of ≤ 1
	  • (0 – 4 scale; 0 = no reactivity, 4 = severe)

"Hold temperature at set time"	• Minimum: +/- 3.0°F for 30 min • Target: +/- 3.0°F for 2 hr • Goal: +/- 3.0°F for 8 hr

Note: All target specs should be justified by references

What makes a good design requirement?



Does this cover every imaginable situation?

Comprehensive

Quantitative, including measurement tolerance

+/- how much?

Where did I get this range of acceptable values?

Justified, including citation checks

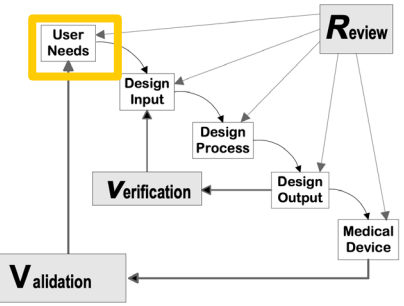
Solution-blind

Am I really just describing a solution? Or can this apply to anything?

Unambiguous, with an established test modality

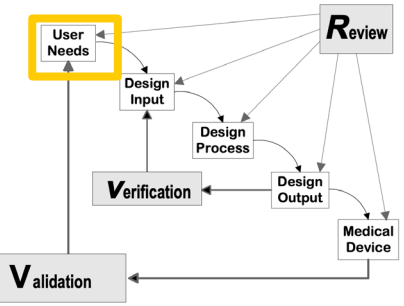
Do I know what success is? #goalposts

BME 450 example- OpSafe



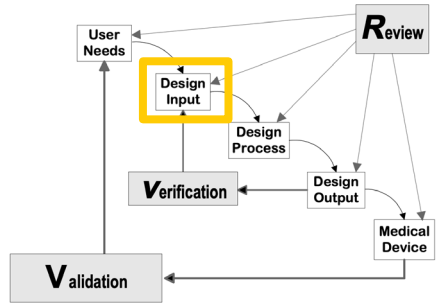
Needs statement. There is a need to prevent 0–2 year old patients from interfering with the surgical field for surgeries using spinal anesthesia in order to reduce safety concerns, limit surgeon distractions, and improve surgical efficiency and outcomes.

OpSafe's User Needs



User Need
1.1 Comfortable and safe for patients 0-2 years old
1.2 Compatible with emergency operating room procedures
2.1 Limits arm movement of infants 0-2 years old
2.2 Can be used with patients 0-2 years old
2.3 Does not interfere with current operating room procedures
3.1 Can be used with all types of surgical beds
3.2 Can be cleaned/disinfected easily in the operating room
3.3 Does not require extensive training

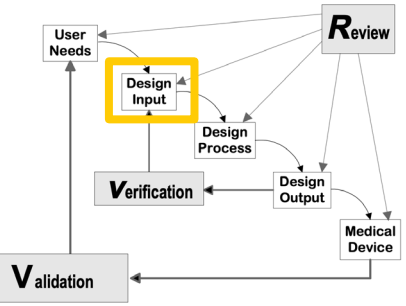
OpSafe's Design Requirements Table



User Need	Critical/ Non-Critical	Long/ Short Term	Design Requirement	Design Specification	Justification
1.1 Comfortable and safe for patients 0-2 years old	Critical	Long Term	Avoids laceration causing edges	Passes sharp edge test method according to **16 CFR 1500.49**	Passing the sharp edge test will ensure that our solution does not have laceration-causing edges that could harm the patient during the procedure. [16]
		Long Term	Meets Joint Commission Standards for Restraint/ Seclusion	Complies with Joint Commission Standards for Restraints and Seclusion **PC.03.05**	This standard requires the least restrictive form of restraint that still protects the physical safety of the patient. This ensures we balance limiting movement enough to optimize safety while not violating patient rights. [17,18,19]
			No scissor or pinch points exposed to the patient	No scissor or pinch points **< 20 cm** from solution perimeter	Surgical beds specification for pinch point locations describe a distance of 20 cm from perimeter of bed as safe locations for any pinch points. We are following this guidance to ensure the safety of our solution. [20]
1.2 Compatible with emergency operating room procedures	Critical	Long Term	Easily removable	Can be removed in **< 15 sec.**	Average response time in emergencies is about 60 seconds, so a safety factor of 4 was applied. Interviews with two doctors also identified this as the maximum allowable removable time emergency situation. [21,22]

User Need	Critical/ Non-Critical	Long/ Short Term	Design Requirement	Design Specification	Justification
2.1 Limits arm movement of infants 0-2 years old	Critical	Short Term	Resists force produced by the arms of infants 0-2 years old	Can withstand force up to **83.5 N**	The push strength force of 2–5 year old was found. The maximum of the first quarter of that range was assumed to be the maximum push/pull strength of a 2 year old. [23]
		Long Term	Blocks patient arms/hands from entering sterile area	**< 3 out of 50** infants can interfere with surgical drapes	The safety control testing for poison prevention packaging standard outlines the test method that can be used to verify children are unable to open packages. Following this testing criteria will determine if our device is able to sufficiently prevent infant interference with the sterile site. [24]
2.2 Can be used with patients 0-2 years old	Critical	Short Term	Fits the height of 0–2-year-old patients	Accommodates length range: **45–93 cm**	Our range spans from the 2nd percentile newborn height to the 95th percentile 2 year old height. [25]
			Fits the width of 0–2-year-old patients	Accommodates width range: **12.2–25.3 cm**	Mean newborn shoulder width is 12.2 cm. Assuming that the height-shoulder ratio is ~constant from 0-2 years old, we used the height values 45–93 cm to calculate the upper range limit for width. [25,26]

User Needs can be described as



Short Term

- Can be achieved in class
  - Verification/validation testing
    - Solidworks + COMSOL
    - Engineering analysis

For Assignment #2, Short-term Critical ONLY

Critical

- Must-haves to address Need
  - Function
  - Efficacy
  - Immediate safety

Long Term

- Can NOT be achieved in class
  - Requires physical prototype
  - Broaden market/population
  - Clinical studies
  - Marketability/Manufacturing

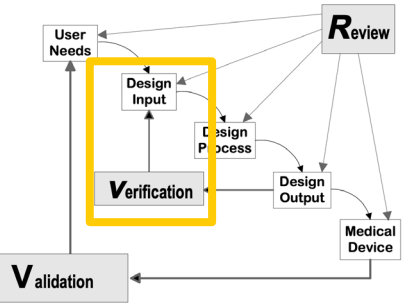
Some will be shifted to long-term after Assignment #2

Non-Critical

- Beyond the basic User Needs
  - Aesthetics, customization, *added* comfort
  - Easier to user

What is most critical? **Safety and Efficacy**

Looking ahead what does verification look like for each DR?



Mechanics: *How does the implant bear the physiological load?*

Governed by stress-strain-displacement relationships of linear elastic materials

$$\nabla \cdot \underset{\sim}{\sigma} + \vec{F} = 0 \qquad \underset{\sim}{\sigma} = \underset{\sim}{\sigma}_0 + E\underset{\sim}{\epsilon} \qquad \underset{\sim}{\epsilon} = \frac{1}{2}(\nabla\vec{u} + (\nabla\vec{u})^T)$$

Fluid Flow: *How does bypass graft affect local hemodynamics?*

Governed by Navier-Stokes equations:

$$\frac{\partial\vec{u}}{\partial t} + \vec{u}\cdot\nabla(\vec{u}) = -\frac{1}{\rho}\nabla p + \vec{F} + \frac{1}{\rho}\nabla^2\vec{u}$$

$$\nabla\cdot(\vec{u}) = 0$$

Drug Transport: *How is the drug delivered over time?*

Governed by transport (advection-diffusion) in porous media:

$$\frac{\partial \varepsilon C}{\partial t} + \vec{u}\cdot\nabla C - \nabla\cdot(\varepsilon D\nabla C) = R + S$$

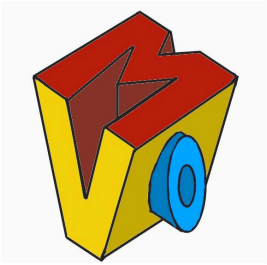
VMO provided User Needs

Hip

1) Functional
    a. Avoid additional, correctional surgeries due to Aseptic loosening
    b. Withstand walking forces of target population
    c. Withstand stationary forces of target population
    d. Match stiffness of surrounding tissue
2) Effective
    a. Therapeutic is present in effective concentrations
    b. Therapeutic is delivered long enough to prevent aseptic loosening
3) Safety
    a. Nonreactive with bodily fluids
    b. Does not cause an immune response
        i. Note: metal on metal implants are not allowed
    c. Therapeutic is present in safe concentrations

Bypass

1) Functional
    a. Avoid harvesting from a second surgical site
    b. Allows blood flow to resume in the area affected by stenosis
    c. Matches stiffness of surrounding tissues
    d. Does not burst or balloon when physiological pressures are applied
2) Effective
    a. Avoids restenosis for as long as or longer than current technology
    b. Therapeutic is present in effective concentrations
3) Safe
    a. Nonreactive with bodily fluids
    b. Does not cause an immune response
        i. Note: tissue engineered constructs are not allowed (management)
    c. Therapeutic is present in safe concentrations



Assignment #2: Design Inputs Draft

You will be receiving an "initial draft of the Design inputs Section.

Your job is to **fill in the missing details for the Specifications and Justifications,** as well as to **write out the full explanation** of the Design Requirements

Table 2.1.1. Critical short-term design requirements, inputs, and justifications.

Index	Need Category	Requirements	Target Specifications	Justifications
2.1.1a	Durability / Safety	In range of surrounding physiological stiffness	..	(Hint: Literature Review – arterial stiffness)
2.1.1b	Durability / Safety	In range of surrounding physiological tensile strength	..	(Hint: Literature Review – arterial tensile strength)
2.1.1c	Feasibility	Lumen does not buckle or collapse during use	..	(Hint: what geometries matter? What does collapse mean here?)
2.1.1d	Feasibility	Graft can be surgically applied to the target artery	External diameter: (this might be a range)	(Hint: which arteries are most often affected by PAD? Should the bypass be the same size or a different size?)
2.1.1e	Function	Graft is long enough to bypass the intended stenosis	Bypass length: (this might be a range) Insertion angle: (this might be a range)	(Hint: different severities of PAD have different lengths – which one are you focusing on? With the insertion angle, how long does the bypass need to be?)
2.1.1f	Effectiveness	Pressure drop across stenosis indicates successful intervention	..	(Hint: research/consider metric(s) useful to clinicians or researchers in assessing hemodynamics before and after intervention)
2.1.1g	Safety	Anti-restenosis agent is present in safe concentrations	Local concentration of the therapeutic in the blood/arterial tissue does not exceed identified toxic concentration at any time in ____ days.	(Hint: Lit Review with toxic thresholds; *in vitro* data may also be helpful here, as may more systemic parameters such as MTD. Also see note below on possibility for "further experimentation")
2.1.1h	Effectiveness	Anti-restenosis agent is present in effective concentrations	Local concentration of the therapeutic in the blood/arterial tissue remains above identified minimum concentration at all times in ____ days.	(Hint: investigate parameters such as EC50; note that for this section and the above, it is possible that values will be unavailable via literature review alone and will require further experimentation. If this is the case, document the search procedures and lack of acceptable results)
2.1.1i	Feasibility	Option that does not include autografts or other cell/tissue collections	Material used in device is a synthetic or natural biomaterial	Management will reject autogenous grafts due to risk, time, and practical constraints[1]. Management will also reject tissue engineered constructs due

Design Inputs (Assignment #2) notes

Index	Need Category	Requirement	Target Specification	Justifications
2.1.1a	Durability / Safety	Device should withstand extreme (maximal) loading	Maximum stress does not exceed [yield stress in MPA] of chosen material(s) when [Force in N] is applied to implant head at orientation of [X, Y, and Z directions in degrees]	(Hint: consider also adding a safety factor; for the purposes of this class, we find 1.2-1.3 to be sufficient for our constraints. Also, consider what the maximal loading would be for your target population)

We started this for you!

Please fill in the blanks, **move wordy description to the text of your report**, and then summarize this Target Spec as much as possible!

This does not need to be a complete sentence

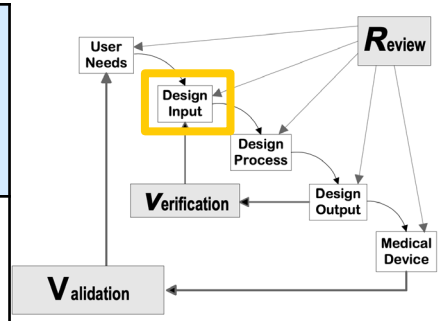
Design Inputs (Assignment #2) notes

Index	Need Category	Requirement	Target Specification	Justifications
2.1.1a	Durability / Safety	Device should withstand extreme (maximal) loading	Maximum stress does not exceed [yield stress in MPA] of chosen material(s) when [Force in N] is applied to implant head at orientation of [X, Y, and Z directions in degrees]	(Hint: consider also adding a safety factor; for the purposes of this class, we find 1.2-1.3 to be sufficient for our constraints. Also, consider what the maximal loading would be for your target population)

Additional hints are for either the spec OR the justification, put together for spacing purposes

Justifications in the TABLE should be SHORT and include references (ie. [3])
Write the full justification in the main text of the report.

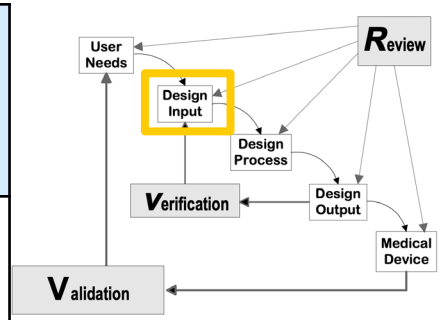
User Need	Critical /Non-Critical	Long/ Short Term	Requirement	Target Specification	Justification
1.1 Comfortable and safe for patients 0-2 years old	Critical	Short-Term	Avoids laceration causing edges	PTFE tape has **<0.5 inch cut** after full rotation with **6N** applied by device	Passes sharp edge method according to **16 CFR 1500.49**



Design Requirement 1.1.1 Avoids laceration-causing edges

Given the unpredictable nature of an infant's movements, any solution produced must account for the possibility of the patient hitting the solution and potentially harming themselves. To account for this, we developed the design requirement that our solution must avoid laceration-causing edges. This design requirement has been classified as both long term and critical, as the solution will not be used in a clinical setting if it has the potential to harm the infant, especially when existing solutions are less likely to do so. Our solution will meet this design requirement if it can pass the sharp edge test method detailed in 16 CFR 1500.49, a standard for "Technical requirements for determining a sharp metal or glass edge in toys and other articles intended for use by children under 8 years of age".[16] The sharp edge test entails the use of a cylindrical mandrel covered in polytetrafluoroethylene (PTFE), which will be in contact with an edge with a normal force of 6 N. If the edge cuts the tape by at least half an inch after one full revolution of the mandrel, the edge is considered sharp. Passing the sharp edge test will ensure that our solution does not have laceration-causing edges that could harm the patient during the procedure.

User Need	Critical /Non-Critical	Long/ Short Term	Requirement	Target Specification	Justification
1.1 Comfortable and safe for patients 0-2 years old	Critical	Short-Term	Avoids laceration causing edges	PTFE tape has **<0.5 inch cut** after full rotation with **6N** applied by device	Passes sharp edge method according to **16 CFR 1500.49**

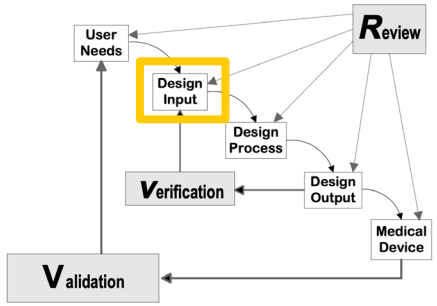


Design Requirement 1.1.1 Avoids laceration-causing edges

Given the **unpredictable nature of an infant's movements**, any solution produced must account for the possibility of the patient **hitting the solution and potentially harming themselves**. To account for this, we developed the design requirement that our solution **must avoid laceration-causing edges.** This design requirement has been classified as both long term and critical, as the solution will not be used in a clinical setting if it has the potential to harm the infant, especially when existing solutions are less likely to do so. Our solution will meet this design requirement if it can pass the sharp edge test method detailed in **16 CFR 1500.49, a standard for "Technical requirements for determining a sharp metal or glass edge in toys and other articles intended for use by children under 8 years of age**".[16] The sharp edge test entails the use of a cylindrical mandrel covered in polytetrafluoroethylene (PTFE), which will be in contact with an edge with a normal force of 6 N. If the edge cuts the tape by at least half an inch after one full revolution of the mandrel, the edge is considered sharp. Passing the sharp edge test will ensure that our solution does not have laceration-causing edges that could harm the patient during the procedure.

Biomedical Engineering Research Guide

Standards



Finding Standards

- AAMI - Association for the Advancement of Medical Instrumentation
  Database for AAMI standards. Click 'Institutional Access' located directly below the login box to access this database.

- ASTM Compass
  Access full text of ASTM (Standards from the American Society for Testing and Materials) standards

>>> Access also include ISO (International Organization of Standardization) and IEC (International Electrotechnical Commission) standards.

- FDA Recognized Consensus Standards
  FDA database of Recognized Consensus Standards "provides the most up-to-date list of voluntary consensus standards to which FDA will accept a Declaration of Conformity."

Looking for standards from a different Standards Granting Organization (ANSI, IEEE, etc.)? The Standards Research Guide has a comprehensive list of where to locate standards.

Can't find the standard you're looking for? Contact lkuck@umich.edu. They may be able to order it for you.

ASTM Compass

Standard | ASTM | Active | Updated: Jan 11, 2021 | English

F3446-20

Standard Test Method for Determination of Frictional Torque and Friction Factor for Hip Implants Using an Anatomical Motion Hip Simulator

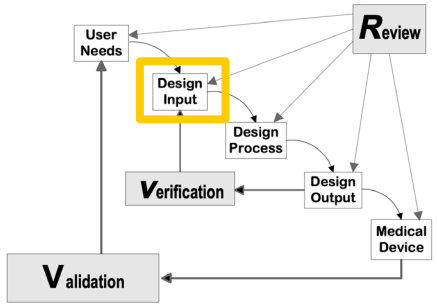
1.1 This test procedure provides a method of evaluating the frictional torque and friction factor of artificial hip joint bearings used in Total Hip Replacement systems. The method presented here was based on a published study, first as a conference paper in 2008 **(1)**2 and then as a peer-reviewed journal paper **(2)**. The method is compatible with and is capable of being carried out during actual wear testing of total hip replacement implants on wear simulators equipped with multiple degrees of freedom force and moment sensors.

1.2 Although the methodology described does not replicate all physiological loading conditions, it is a means of *in-vitro* comparison of the frictional torque and friction factor of artificial hip joint bearings used in Total Hip Replacement systems under the stated test conditions.

1.3 Units—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

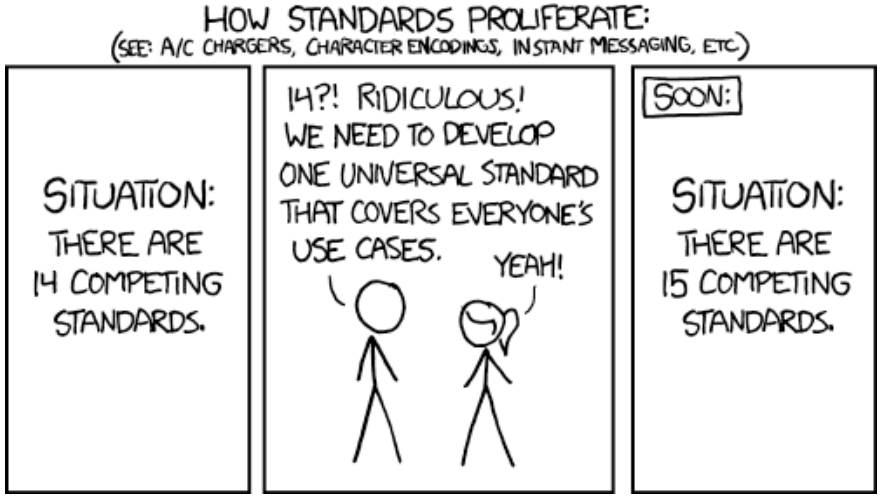


You may find test beds

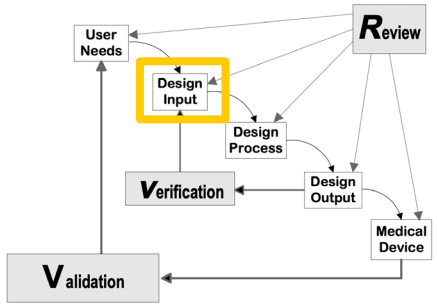
You may find typical results of said tests

You may find *other* standards that are better

You may find a **range** of acceptable “success” criteria for this test

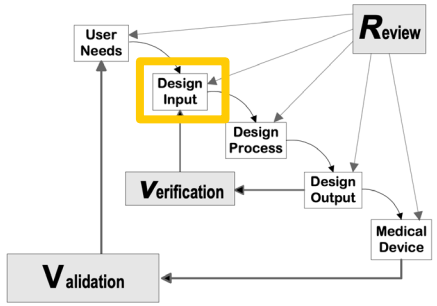


ISO 10993: Biological Evaluation of Medical Devices



- MANY subsections – You **must** specify
- Part 14: Identification and quantification of degradation products from ceramics
- Part 11: Tests for systemic toxicity
- Part 18: Chemical characterization of materials
- Part 7: Ethylene oxide sterilization residuals
- Part 10: Tests for irritation and sensitization
- Part 5: Tests for in vitro cytotoxicity
- And it goes on!

ISO 10993: Biological Evaluation of Medical Devices



GUIDANCE DOCUMENT

Use of International Standard ISO 10993-1, "Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process"

Guidance for Industry and Food and Drug Administration Staff

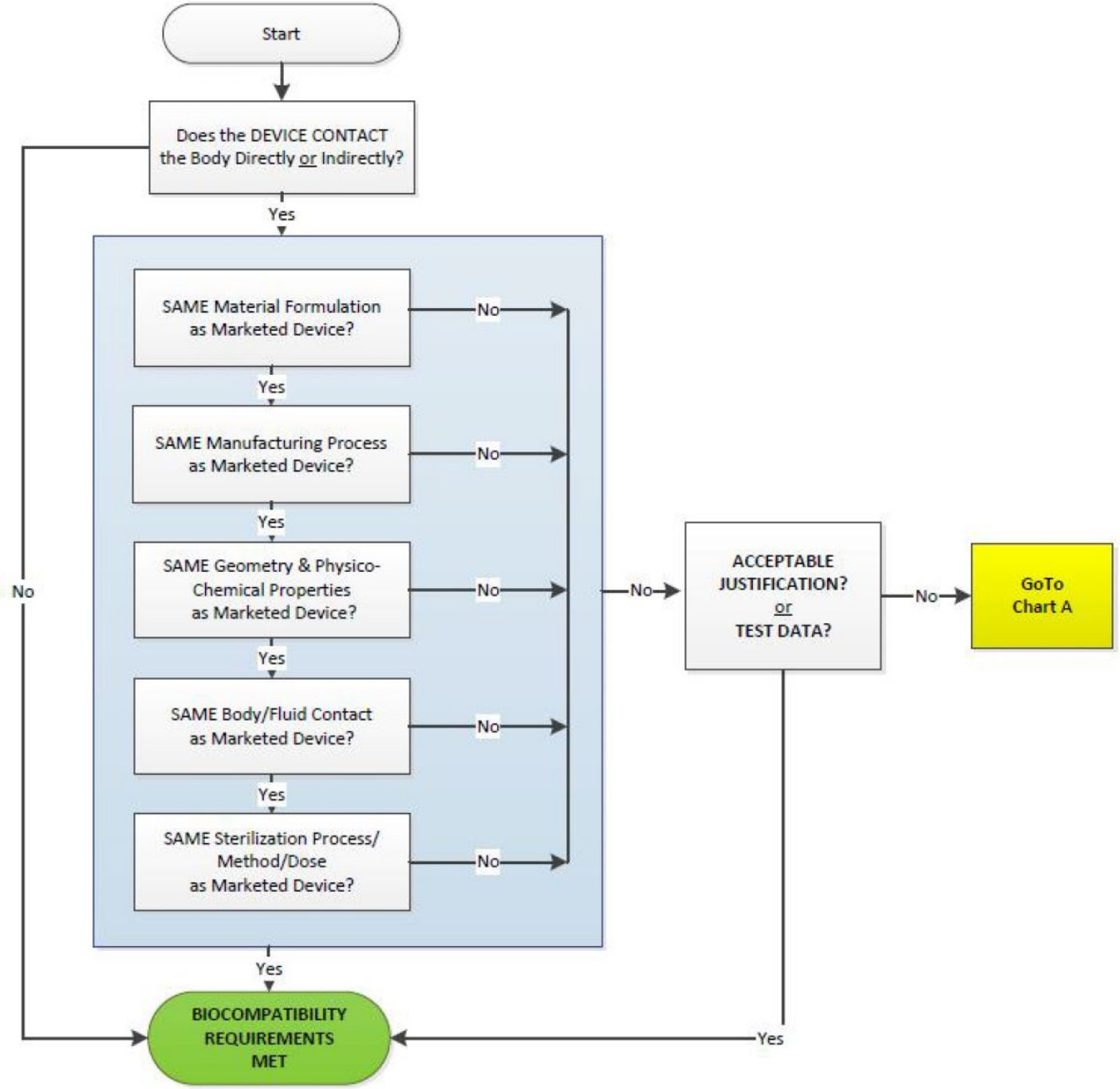
SEPTEMBER 2020

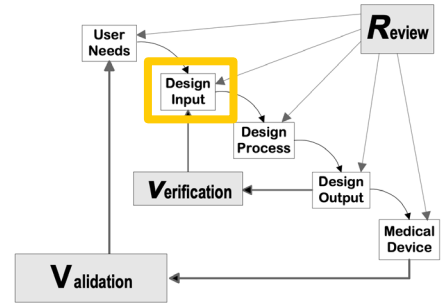
Download the Final Guidance Document

Final

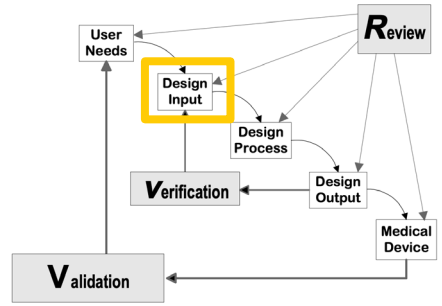
Attachment D: Biocompatibility Evaluation Flow Chart

The flow chart below is provided to illustrate how one might proceed with a biocompatibility evaluation





Remember the FDA?



Recognized Consensus Standards

FDA Home › Medical Devices › Databases

This database provides the most up-to-date list of voluntary consensus standards to which FDA will accept a Declaration of Conformity. After FDA has decided to recognize a standard, we will update our online database to reflect the decision even before formal recognition of the standard occurs by publication in the Federal Register. Publications in the Federal Register to the lists of recognized consensus standards can be accessed at https://www.fda.gov/medical-devices/standards-and-conformity-assessment-program/federal-register-documents.

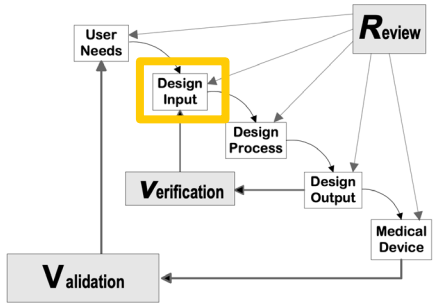
Learn More...

Search Database — Help

Standards Organization	All Standards Organizations		
Standard Designation Number *Note: numbers only, e.g., 14971, 60601-1*		Recognition Number	
Standards Title or Keywords *Note: do not include standard designation number*		Included in ASCA pilot?	☐
Specialty Task Group Area	All Categories		
Product Code		Regulation Number *(e.g., 888.1111)*	
Date of Entry	to	Sort	Date of Entry (9-0)

Clear Form — Search

Remember the FDA?



U.S. FOOD & DRUG ADMINISTRATION

March 2, 2020

Yunyi (Beijing) Medical Device Co., LTD
% Diana Hong
General Manager
Mid-Link Consulting Co. Ltd
P.O Box 120-119
Shanghai, 200120 Cn

Re: K192637
Trade/Device Name: High Strength Suture
Regulation Number: 21 CFR 878.5000
Regulation Name: Nonabsorbable Poly(Ethylene Terephthalate) Surgical Suture
Regulatory Class: Class II
Product Code: GAT
Dated: September 20, 2019
Received: September 24, 2019

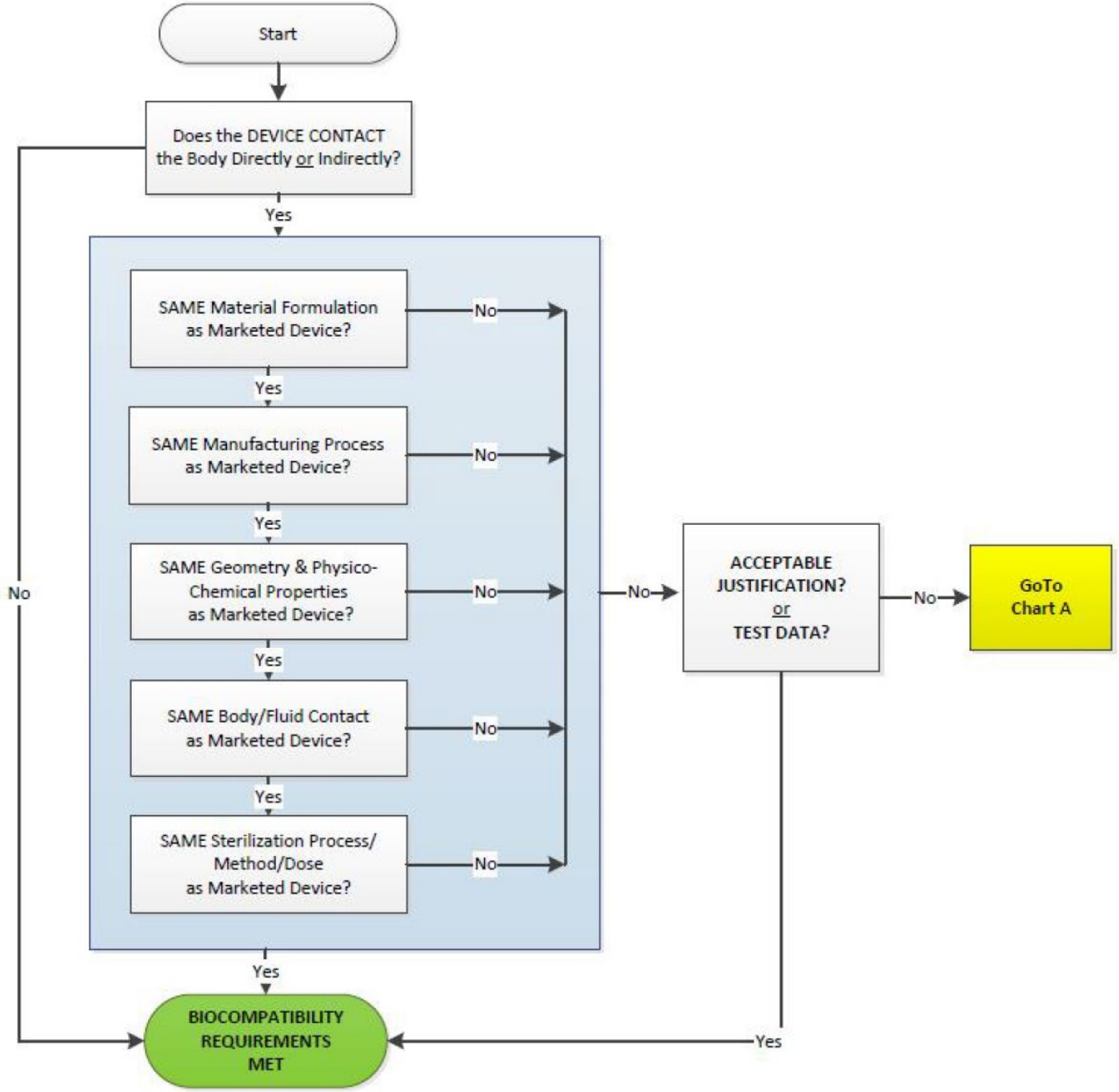
6. Non-Clinical Test Conclusion

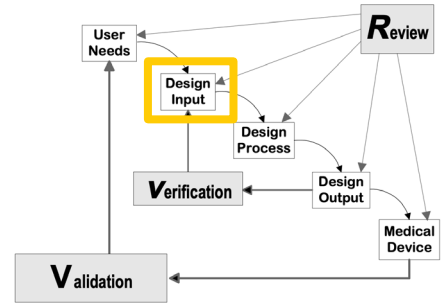
Non clinical tests were conducted to verify that the proposed device met all design specifications as was Substantially Equivalent (SE) to the predicate device. The test results demonstrated that the proposed device complies with the following standards:

- USP 41-NF 36:2018 Non-absorbable Surgical Suture
- USP 41-NF 36:2018 <881> Tensile Strength
- USP 41-NF 36:2018 <861> Sutures – Diameter
- ASTM F88/F88M-15 Standard test method for seal strength of flexible barrier materials
- ASTM F1929-15 Standard Test Method for Detecting Seal Leaks in Porous Medical Packaging by Dye Penetration
- ISO 10993-5:2009 Biological Evaluation Of Medical Devices - Part 5: Tests For In Vitro Cytotoxicity
- ISO 10993-10:2010 Biological Evaluation Of Medical Devices - Part 10: Tests For Irritation And Skin Sensitization
- ISO 10993-7:2008 Biological Evaluation Of Medical Devices - Part 7: Ethylene Oxide Sterilization Residuals
- ISO 10993-11:2017 Biological Evaluation Of Medical Devices - Part 11: Tests For Systemic Toxicity
- USP 41 NF 36 <151> Pyrogen Test (USP Rabbit Test)
- ISO 10993-3:2014 Biological Evaluation Of Medical Devices - Part 11: Tests For Systemic Toxicity
- ISO 10993-6:2016 Biological Evaluation Of Medical Devices -- Part 6: Tests For Local Effects After Implantation
- USP 41 NF 36 <85> Bacterial Endotoxins Test

Attachment D: Biocompatibility Evaluation Flow Chart

The flow chart below is provided to illustrate how one might proceed with a biocompatibility evaluation



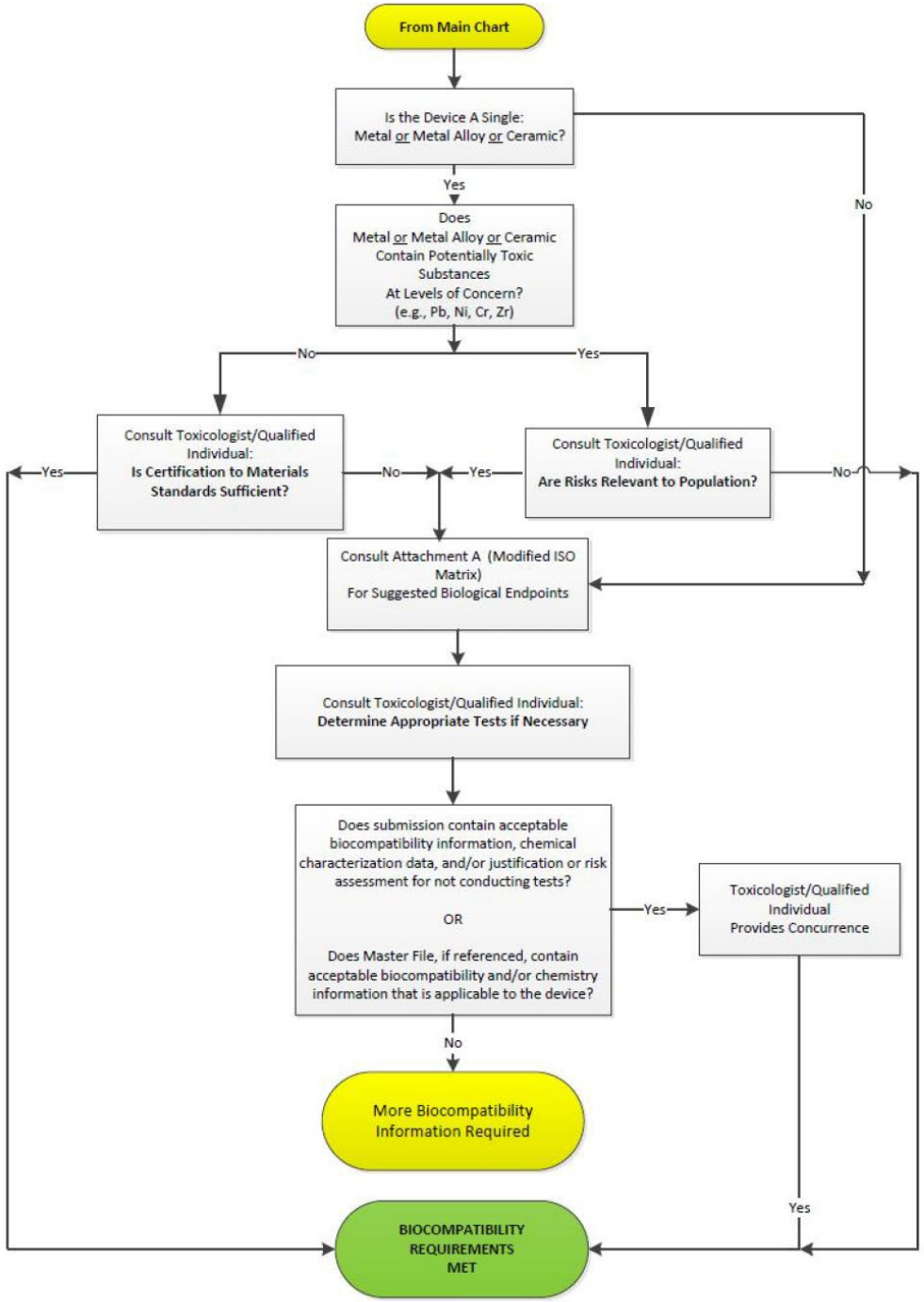


Assignment #2 Biocompatibility:

similar dimensions and geometries (no sharp edges)

Chart A

- Metal or Alloy or ceramic
- Potentially toxic?
  - Pb, Ni, Cr, Zr (Co?)
- Toxicologist / Qualified Individual evaluates
  - Equivalent to predicate device OR
  - Go back to 10993-1 for guidance on additional testing



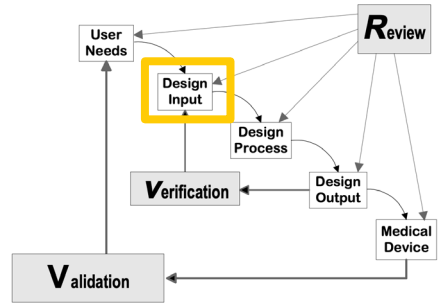
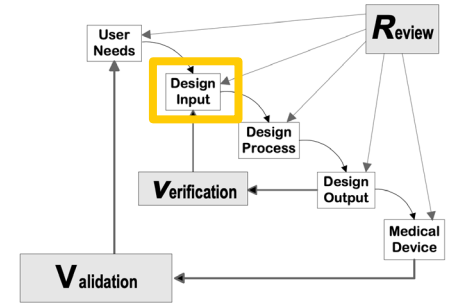


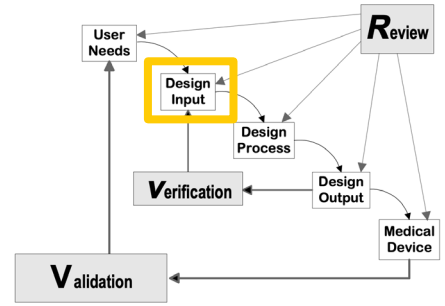
Table A.1: Biocompatibility Evaluation Endpoints



Medical device categorization by			Biological effect											
Nature of Body Contact		Contact Duration A – limited (≤24 h) B – prolonged (>24 h to 30 d) C – permanent (> 30 d)	Cytotoxicity	Sensitization	Irritation or Intracutaneous Reactivity	Acute Systemic Toxicity	Material-Mediated Pyrogenicity	Subacute/Subchronic Toxicity	Genotoxicity	Implantation	Hemocompatibility	Chronic Toxicity	Carcinogenicity	Reproductive/Developmental Toxicity#	Degradation@
Category	Contact														
Surface device	Intact skin	A	X	X	X										
		B	X	X	X										
		C	X	X	X										
	Mucosal membrane	A	X	X	X										
		B	X	X	X	O	O	O		O					
		C	X	X	X	O	O	X	X	O		O			
	Breached or compromised surface	A	X	X	X	O	O								
		B	X	X	X	O	O	O		O					
		C	X	X	X	O	O	X	X	O		O	O		
External communicating device	Blood path, indirect	A	X	X	X	X	O				X				
		B	X	X	X	X	O	O			X				
		C	X	X	O	X	O	X	X	O	X	O	O		

Medical device categorization by			Biological effect												
Nature of Body Contact		Contact Duration A – limited (≤24 h) B – prolonged (>24 h to 30 d) C – permanent (> 30 d)	Cytotoxicity	Sensitization	Irritation or Intracutaneous Reactivity	Acute Systemic Toxicity	Material-Mediated Pyrogenicity	Subacute/Subchronic Toxicity	Genotoxicity	Implantation	Hemocompatibility	Chronic Toxicity	Carcinogenicity	Reproductive/Developmental Toxicity#	Degradation@
Category	Contact														
	Tissue+/bone/ dentin	A	X	X	X	O	O								
		B	X	X	X	X	O	X	X	X					
		C	X	X	X	X	O	X	X	X		O	O		
	Circulating blood	A	X	X	X	X	O		O^		X				
		B	X	X	X	X	O	X	X	X	X				
		C	X	X	X	X	O	X	X	X	X	O	O		
Implant device	Tissue+/bone	A	X	X	X	O	O								
		B	X	X	X	X	O	X	X	X					
		C	X	X	X	X	O	X	X	X		O	O		
	Blood	A	X	X	X	X	O		O	X	X				
		B	X	X	X	X	O	X	X	X	X				
		C	X	X	X	X	O	X	X	X	X	O	O		

X = ISO 10993-1:2009 recommended endpoints for consideration*
O = Additional FDA recommended endpoints for consideration*
Note * All X's and O's should be addressed in the biological safety evaluation, either through the use of existing data, additional endpoint-specific testing, or a rationale for why the endpoint does not require additional assessment.
Note + Tissue includes tissue fluids and subcutaneous spaces
Note ^ For all devices used in extracorporeal circuits
Note # Reproductive and developmental toxicity should be addressed for novel materials, materials with a known reproductive or developmental toxicity, devices with relevant target populations (e.g., pregnant women), and/or devices where there is the probability for local presence of device materials in the reproductive organs.
Note @ Degradation information should be provided for any devices, device components, or materials remaining in contact with tissue that are intended to degrade.



Design requirements related to device dimensions and biocompatibility

- Consider
  - What existing devices have been documented to pass
  - How you may follow or deviate from their geometries and materials
- If you deviate (later in semester)
  - List standards that will need to be emulated or performed
  - **Shift biocompatibility DRS to long-term critical due to testing needed**

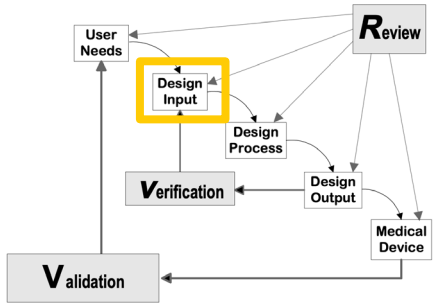
Up Next

- Enumerated User Needs
- Design Requirements
  - Yet ANOTHER database? – Standards
- Assignment 2 overview
- *Break*
- Group work time
  - Design Requirements

Take a 5-minute Break!

Versailles, France – August 2025

Next time: Brainstorming, Concept Evaluation + work time



- First hour = lecture
- Second hour = group work time
  - Focus: Design Requirements
    - Does brainstorming help you make decisions for your Inputs? It might!

For the remaining time in class….

- Group work time!
- Ask us questions!
- Treat this as open office hours