

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

I – Semester

Course Title: **Human Biology-I**

(Course Code: 4310301)

Diploma programme in which this course is offered	Semester in which offered
Biomedical Engineering	First

1. RATIONALE

Human biology provides knowledge and underlying structural and functional concepts of the different organs and systems of the human body, from the smallest part to the whole body. Student need to become familiar with anatomical and physiological terms and their meaning, understand general anatomy and physiology of major systems and their importance in the design and use of biomedical devices. The course also provides increased awareness of personal health.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competencies through various teaching-learning experiences:

- **Analyse anatomical structure and physiology of the major human body systems for their relevance in biomedical devices.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the following Course Outcomes (COs) achievement:

- Use relevant anatomical terminology to identify planes, key body structures, body regions, and directions in the body.
- Distinguish between various types of cells and tissues present in each of the body systems along with their functions.
- Explain the structure and functions of cardiovascular system.
- Explain the structure and functions of the given organ of respiration system.
- Describe the functions of the given sensory organ.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be

taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* -Practical; *C* – Credit, *CA* - Continuous Assessment; *ESE* -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the Co. *Some of the PrOs marked “*” are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify the various anatomical planes from Human Skeleton model.	I	02*
2	Categorize various blood groups.	I	02
3	Measure blood pressure using a sphygmomanometer and stethoscope.	I	02*
4	Identify various parts of the human heart along with working of systematic and pulmonary circulation.	I	02
5	Recognize the internal structure of the human heart using the heart model.	I	02
6	Explain the blood flow through the heart using the heart-lung model.	I	02
7	Interpret electrical activity of the heart by observing ECG.	I	02
8	Calculate heart rate using an electrocardiogram.	II	02
9	Interpret various heart sounds with the use of a stethoscope.	II	02
10	Measure oxygen saturation using a pulse oximeter.	II	02*
11	Distinguish between various parts of the respiratory tract using a respiratory model system.	II	02
12	Measure lung volumes and capacities using a spirometer (spirogram).	III	02
13	Locate the various organs of the respiratory tract using the respiratory tract model.	III	02*
14	Discriminate between various layers of the skin using a skin model.	III	02
15	Identify various structures of special senses using charts/ models.	III	02
16	Locate the parts of eyes and ears using eye and ear model.	III	02
17	Identify the various types of connective tissues using a chart.	III	02
18	Identify the various types of epithelial tissues using a chart.	IV	02
19	Identify bones of the skeleton using the human skeleton model.	IV	02
20	Draw the biological cells by observing under a microscope.	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
21	Identify different joints of the skeleton using the human skeleton model.	IV	02
22	Identify different muscles using the chart/model.	IV	02
Minimum 14 Practical Exercises			28 Hrs.

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup.	20
2	Operate the equipment setup or circuit/working model.	20
3	Follow safe practices.	10
4	Record observations/reading correctly.	20
5	Interpret the result and conclude.	30
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Model of Human skeleton It should have following features: life-size, plastic model, removable arms and legs, skull with movable jaw, removable head cover, bone sutures and three removable lower teeth. Display nerve branches, vertebral artery, and lumbar inter vertebral disc. It should be placed on a solid metal rack. Made with PVC, washable, unbreakable, Approx. size: 180 cm.	1,19,21
2	Microscope Observation Head: Binocular head inclined at 45-deg., rotated through 360-deg with adjustable inter-pupillary distance. Focusing: By Rack and Pinion mechanism with adjustable tension collar. Magnification: Standard magnification 20X & 40X with flat field. Illumination: With an integral illuminator, 2 lamps fitted to provide both transmitted and incident illumination. Objectives: 2 sets of objectives 2X and 4X, selected by rotating nose piece through 90-degrees. Eyepieces: Standard extra wide field eyepieces WF-10X	2,20

S. No.	Equipment Name with Broad Specifications	PrO. No.
3	Pumping Heart Model For displaying how the heart and lungs work together for oxygen exchange with a simple hand pump to demonstrate basic heart and pulmonary blood flow, should display clearly labelled heart chambers, main artery, veins and lungs	4,5,6
4	Sphygmomanometer and stethoscope For non invasive measurement of blood pressure. Stethoscope to listen to the sounds made by the heart, lungs or intestines, as well as blood flow in arteries and veins.	3,7,8,9
5	Heart Model It should have following features: It should show the external features and internal structures of the heart, and its relation with the large blood vessels. It should be dissectible into 3 parts. Size: 4 times enlarged of life size.	4,5,6
6	Model of Respiration system It should have the following features: Human Respiratory System with Magnified Alveolus including oral and nasal cavity shown with internal details like oronasal cavity, larynx and trachea, primary bronchi and bronchial tree. Size: 150 times of life-size	11,13
7	Model of Circulatory system It should have following specifications: A section feature of enlarged heart and blood circulation diagram, wall of heart made of flexible material which can demonstrates the heart beating by the mechanical power, valves should show the opening and closing, Blood circulation should be shown by light flash, which in red represent arteries, in blue represent vein, should work on power supply, Size: 40x15x15 cm (Approx.), Instructional manual with description of the Blood circulation/pumping heart.	4,6
9	Model of Human heart with lungs It should have following features: Life-size anatomical models of Larynx, Heart and Lungs, should be separated in 7 parts and have two removable lobes that shows the internal structures, the heart bisects showing atria, ventricles and valves, the larynx bisects and the diaphragm; mounted on a base and available in the size of 36x23x12 cm (Approx.)	11,13
10	Model of Skin system It should have following features: About 100 times enlarged cross sectional view of the human skin showing three layers and a close-up view of a hair follicle, sweat gland, fatty tissue. Front, side and back view. Mounted on a plastic base, should show the structures of the human scalp and the skin - epidermis, dermis, hypodermis as well as appendages of the skin - the sweat glands, the sebaceous glands, the hairs, Blood vessels and nerves of the skin.	15

S. No.	Equipment Name with Broad Specifications	PrO. No.
11	<p>Model of Muscle system</p> <p>It should have following features: It should be full size of human body showing muscles and organs (85 cm); should consist of various parts such as muscles of chest wall and abdomen, muscles of upper and lower limbs, skull, brain and viscous. It should show the structure of head, neck, torso, upper and lower limbs, muscles, muscular tendon, ligaments, viscous, blood vessels, brain, etc.</p>	22
12	<p>Model of Eye ball dissected</p> <p>It should have following features :</p> <p>Tunica external: It should show cornea and sclera with attachments of ocular muscles and optic nerve.</p> <p>Tunica media: It should show the iris, the culinary body and the choroid</p> <p>Tunica internal is retina.</p> <p>Refraction media: It should show the lens and the vitreous body.</p> <p>Premium graded of PVC and mounted on a plastic stand.</p> <p>It should be available in the size of 15 cm.(Approx.)</p>	16
13	<p>Model of Ear dissected</p> <p>It should consists of parts of the ear: inner ear, auditory ossicles, external ear, Size: Four times life size</p>	16
14	<p>Pulse Oximeter</p> <p>It should have following features: Integrated with SPO probe and processing display module, accurately measure and display SPO and PR, PR waveform and bar graph display, four directions and six modes, Low power consumption, shut off automatically when no signal, 1.0' double Color OLED display, resolution 128 x 64, SPO 35 ~ 99 % 2, Pulse Ratio : 30 ~ 250 BPM</p>	10
15	<p>ECG machine</p> <p>It should have following features :Light in weight, compact in size Soft, silicone-gel keyboard, Detection and alarm for lead-off and low battery, Automatic adjustment of baseline for optimal printing, Built-in ECG simulator for DEMO purpose, Pre 10 second printing to print out any abnormal ECG waveform, Auto-save function, printed ECG files should be saved automatically, 12-lead simultaneous acquisition, 3 Kinds of Operation Mode-AUTO, MAN and ANA, 3 Kinds of Filters-HUM, EMG and ADS, 3 Kinds of Power Supply- AC, DC, Battery, 2 Types of Lead Mode- Standard and Cabrera, 1000 ECG files should be saved to the ECG, 2000 files to SD card, should be able to communicate with PC</p>	7
16	<p>Cell Model</p> <p>Should display undifferentiated cell of the animal organism at 40,000 times magnification, providing an insight into the electron-microscopic structure of the smallest microorganisms capable of independent life.</p>	20

S. No.	Equipment Name with Broad Specifications	PrO. No.
17	Tissue Charts: Laminated with 27-micron thick polyester film rendering the chart; tear, water & dust resistant. Size : 55 x 90 cm explaining various concepts related to biology through illustrations	17,18

7. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs More could be added to fulfil the development of this course competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices.
- c) Practice environmentally friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I Human Biology and Skeleto-Muscular Systems	1a. Differentiate human anatomy and physiology. 1b. Briefly explain anatomical planes and their directional terms. 1c. Identify individual bones of the skeleton along with their location. 1d. Explain the function of the given type of bone. 1e. Classify the main types of joints on the basis of their structure as well as their role in skeletal movement. 1f. Classify muscles based on the given criteria.	1.1 Human Biology, anatomy and physiology 1.2. Anatomy: Anatomical planes such as median, parasagittal, coronal, axial planes and anatomical directional terms like anterior, posterior, superior, inferior, proximal, distal, medial, lateral. 1.3. Overview of the human skeleton 1.4 Skeletal System: Types of bones such as long, short, irregular, flat, sesamoid bone with their location, functions of bones, classification of joints 1.5. Muscles- Classification of muscles on the basis of

		striations, voluntary control, and function
Unit – II Cell, Tissue and Blood	<p>2a. Explain the structure and function of the cell membrane and nucleus with the help of sketch.</p> <p>2b. Explain the structure and function of organelles of cytoplasm-endoplasmic reticulum, lysosomes, Golgi apparatus, mitochondria, ribosomes.</p> <p>2c. Define action potential, depolarization, repolarization, and resting membrane potential.</p> <p>2d. Describe functions of the given type of tissue.</p> <p>2e. Describe the composition and properties of blood.</p> <p>2f. Explain the structure and functions of erythrocytes, leukocytes, and platelets with the help of sketch.</p> <p>2g. Describe blood grouping system.</p>	<p>2.1. Cellular system: Structure and function of the cell including different organelles like cell membrane, nucleus, organelles of cytoplasm-endoplasmic reticulum, lysosomes, Golgi apparatus, mitochondria, ribosomes, Cell electrophysiology</p> <p>2.2. Tissues: Types of tissues, structure, and function of epithelial and connective tissues</p> <p>2.3. Blood: Composition and Properties of blood, Structure and functions erythrocytes, leukocytes, and platelets, Blood groups - ABO grouping system and RH grouping system.</p>
Unit– III Cardiovascular System	<p>3a. Sketch anatomical structure of heart–identifying layers, chambers, different valves, and blood vessels associated with heart.</p> <p>3b. Explain blood flow through heart.</p> <p>3c. Explain conducting system of heart.</p> <p>3d. Define various terms related to heart.</p> <p>3e. Sketch an ECG waveform.</p>	<p>3.1 Anatomy of the heart</p> <p>3.2 Blood flow through the heart</p> <p>3.3 Conducting System of Heart</p> <p>3.4 Heart-related terms: Cardiac cycle, Heart Sounds, Heart rate, Pulse, stroke volume, Cardiac output, Blood pressure - systolic, diastolic, pulse, and mean arterial pressure</p> <p>3.5 Electrocardiogram(ECG)</p>
Unit– IV Respiratory System	<p>4a. Identify different organs of a respiratory tract with a sketch.</p> <p>4b. Explain the mechanism of respiration.</p> <p>4c. Describe internal and external respiration.</p> <p>4d. Describe effect of air</p>	<p>4.1 Respiratory system: organs of the respiratory tract</p> <p>4.2 Mechanism of respiration</p> <p>4.3 Principle of gas exchange: Internal respiration, External respiration</p> <p>4.4 Air pollution's effects on the human respiratory system</p>

	pollution's on human respiratory system.	
Unit- V Special senses	5a. Explain the structure of the eye with the help of sketch. 5b. Explain the physiology of sight. 5c. Explain the structure of the ear with the help of sketch. 5d. Explain the physiology of hearing. 5e. Draw structure of the skin along with the functions. 5f. Describe the impact on human body of global warming and climate change.	5.1 Senses-hearing, sight, smell and taste 5.2 Anatomy of eye -including structure of sclera, cornea, choroid, ciliary body, iris, lens , retina, optic nerve 5.3 Physiology of sight -using pathway of optic nerve through brain 5.4 Anatomy of ear-structure of external, internal and middle ear 5.5 Physiology of hearing 5.6 Integumentary system- structure and functions of the skin 5.7 Impact on human body of global warming and climate change

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Human Biology and Skeleto-Muscular Systems	08	6	8	0	14
II	Cell, Tissue and Blood	10	8	8	0	16
III	Cardiovascular System	10	6	8	2	16
IV	Respiratory System	06	4	6	2	12
V	Special Senses	08	4	4	4	12
Total		42	28	34	8	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare charts of different organs of the body.
- Undertake micro-projects in teams for making working models of different organs.
- Seminar/Presentation on any relevant topic.
- Categorized various diseases and disorders commonly found in various organs.
- Identify various instruments used for measurement signals associated with different organs.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide students for using instructional manuals.
- Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- Cell/Tissue**: Build a 3D Model. (make it from waste material).
- Heart** : Build a circuit/working model showing the circulation of blood.
- Lung** : Build a circuit working model show the gas exchange.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Ross and Wilson Anatomy and Physiology in Health and Illness	Waugh, Anne; Grant, Allison	Churchil Livingstone Elsevier, U.K, 2014, ISBN:978-0702032288
2	Essentials of Medical Physiology	Sembulingam, K.; Sembulingam, Prema	Jaypee Brothers Medical Publishers, 2019 ISBN: 978-9352706921
3	Textbook of Anatomy	Singh, Vishram	Elsevier,2020 ASIN : B08LNNK6KH
4	Human Anatomy and Physiology made Easy	Sanghani, Padma	Akshat,2010
5	Essentials of Human Anatomy and Physiology	Marieb, Elaine N.	Pearson International New Delhi, 2014, ISBN:0321919009
6	BD Chaurasia's Human Anatomy Vol 1,2	Chaurasia, B.D.	CBS Publishers, 2019 ASIN : B07TH9BRZQ

14. SOFTWARE/LEARNING WEBSITES

- www.visiblebody.com
- <https://anatomy3datlas.com>
- <https://human.biodigital.com>
- <https://www.cdc.gov/climateandhealth/effects/default.htm>

15. PO-COMPETENCY-CO MAPPING

Semester I	Human Biology (Course Code: 4310301)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Analyse anatomical structure and physiology of the major human body systems to appreciate their importance in the design of biomedical devices.						
CO a) Use relevant anatomical terminology to identify planes, key body structures, body regions, and directions in the body.	3	1	1	-	-	-	2
CO b) Distinguish between various types of cells and tissue found in each body system along with its functions.	3	1	1	1	-	-	2
CO c) Explain the structure and functions of cardiovascular system.	3	1	1	2	1	-	2
CO d) Explain the structure and functions of the given organ of respiration system.	3	1	1	2	1	-	2
CO e) Describe the functions of the given sensory organ.	3	1	1	2	1	-	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

S. No	Name and Designation	Institute	Contact No.	Email
1.	Ms. Poonam G. Lakhani, Lecturer	GP Gandhinagar	9898645087	poonamlakhani17@gmail.com
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NITTTR Resource Persons

S. No	Name and Designation	Department	Contact No.	Email
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