UNIT 2: Research- Types and measures

- Definition, scope and role of biostatistics, biomedical and social research in the life sciences, Need for research and challenges in life science research
- Data: Types of data and its presentation, Level of measurements
- Types of research and techniques
- Statistical measures: Measures of central tendencies. Measures of dispersion, different types of distributions (Standard, Binomial, Poisson) and basics of probability theory.

Definition

Research is a systematic and rigorous investigation aimed at acquiring new knowledge, ubjnderstanding, or solving problems through the collection, analysis, and interpretation of data and evidence.

Research is a systematic and organized process of inquiry and investigation conducted to gain knowledge, explore phenomena, or answer specific questions. It involves the collection, analysis, and interpretation of data to produce new insights, test hypotheses, or contribute to existing knowledge in a particular field of study.

Research aims to expand understanding, solve problems, or explore new areas of interest, and it is a fundamental activity in various disciplines, including science, social sciences, humanities, technology, and more.

scope and role of biostatistics

Scope of Biostatistics: The scope of biostatistics is vast and encompasses various aspects of biological, medical, and health-related research. It involves the application of statistical methods and techniques to analyze and interpret data from biological and health studies. Some key areas within the scope of biostatistics include:

1. **Study Design:** Biostatisticians are involved in the planning and design of research studies. They help researchers select appropriate study designs, sampling methods, and sample sizes to ensure the study's objectives are met and results are reliable.
2. **Data Collection:** Biostatistics involves developing data collection protocols and instruments, such as surveys, questionnaires, and clinical trial protocols. Biostatisticians ensure that data collection procedures are standardized, unbiased, and yield high-quality data.
3. **Data Analysis:** One of the central aspects of biostatistics is the analysis of data. Biostatisticians use various statistical methods, such as regression analysis, survival analysis, and hypothesis testing, to analyze data and draw meaningful conclusions.
4. **Clinical Trials:** Biostatistics plays a pivotal role in clinical trials, which are essential for evaluating the safety and efficacy of new drugs, treatments, and medical interventions. Biostatisticians design clinical trial protocols, analyze trial data, and interpret results to determine treatment effects.
5. **Epidemiology:** Biostatistics is closely linked to epidemiology, the study of disease patterns and factors influencing health outcomes in populations. Biostatisticians help analyze epidemiological data to identify risk factors, trends, and patterns of disease occurrence.
6. **Public Health Research:** Biostatistics is indispensable in public health research, where it aids in understanding disease prevalence, identifying health disparities, and evaluating the impact of public health interventions.

7. **Genomics and Genetics:** In genomics and genetics research, biostatisticians analyze large-scale genetic data to study genetic variations, heritability of diseases, and gene-environment interactions.
8. **Bioinformatics:** Biostatistics is closely related to bioinformatics, which involves analyzing and interpreting biological data using computational techniques. Biostatisticians contribute to the analysis of genomic and proteomic data.
9. **Health Policy and Decision Making:** Biostatistical analysis provides evidence for health policy formulation and decision-making. It helps policymakers understand health trends, assess healthcare outcomes, and allocate resources effectively.
10. **Environmental Health:** Biostatistics is applied in environmental health studies to analyze data related to exposure to pollutants, toxic substances, and their impact on human health.
11. **Biomedical Research and Clinical Studies:** Biostatisticians collaborate with biomedical researchers and clinicians to analyze data from medical studies, ensuring that results are valid and applicable.

Role of Biostatistics: The role of biostatistics is multi-faceted and crucial in advancing scientific knowledge, public health, and medical practice. Some key roles of biostatistics include:

1. **Study Design:** Biostatisticians contribute to the planning and design of research studies, ensuring that appropriate statistical methods are used to address research questions effectively. They help determine the sample size, randomization, and control measures to maximize the study's validity and reliability.
2. **Data Collection and Management:** Biostatisticians develop protocols and tools for data collection, ensuring that data are gathered in a standardized and unbiased manner. They also ensure the integrity and quality of data by implementing data management procedures.
3. **Data Analysis:** Biostatistics is at the core of data analysis in the life sciences. Biostatisticians apply various statistical techniques to analyze data, identify trends, draw meaningful inferences, and determine the significance of research findings.
4. **Interpretation of Results:** Biostatisticians play a critical role in interpreting research results. They help researchers and stakeholders understand the implications and limitations of study outcomes, guiding them in making informed decisions.
5. **Clinical Trials:** In medical research, biostatistics is essential for the design and analysis of clinical trials. Biostatisticians ensure that clinical trial results are valid, reliable, and compliant with regulatory standards.
6. **Epidemiological Studies:** Biostatistics is integral to epidemiological studies that investigate disease patterns, risk factors, and public health interventions. Biostatisticians analyze epidemiological data to identify trends, assess disease burden, and develop preventive strategies.
7. **Public Health Policy:** Biostatistics provides evidence for public health policymaking and decision-making. It helps policymakers understand the impact of health interventions, assess healthcare disparities, and allocate resources effectively.
8. **Genomic and Genetic Studies:** Biostatisticians analyze large-scale genomic and genetic data to identify genetic factors associated with diseases, assess heritability, and identify potential therapeutic targets.
9. **Quality Improvement in Healthcare:** Biostatistical methods are used to evaluate healthcare processes and outcomes, leading to continuous quality improvement in patient care.
10. **Risk Assessment:** Biostatistics aids in risk assessment for exposure to environmental hazards, occupational health risks, and infectious diseases.

11. **Health Informatics and Big Data:** Biostatisticians contribute to the analysis of health-related big data, such as electronic health records, wearable devices, and health surveys, to derive meaningful insights and patterns.

biomedical and social research in the life sciences

It encompasses the study of the human body at the molecular, cellular, organ, and systemic levels. Biomedical science plays a crucial role in advancing medical knowledge, improving patient care, and developing new treatments and therapies.

Biomedical and social research are two distinct but interconnected approaches in the life sciences that contribute to our understanding of human health, well-being, and the factors that influence them. Both types of research play critical roles in advancing medical knowledge, public health, and healthcare practices. Below, we explore the key characteristics and contributions of biomedical and social research in the life sciences:

Biomedical Research:

1. **Focus:** Biomedical research primarily investigates biological processes, mechanisms of diseases, genetics, and the development of medical interventions and treatments. It focuses on understanding the fundamental aspects of human biology and the underlying causes of diseases.
2. **Laboratory-based Studies:** Biomedical research often involves laboratory-based experiments, cell studies, and animal models to study biological processes and test the efficacy and safety of new medical treatments.
3. **Clinical Trials:** A significant part of biomedical research involves conducting clinical trials to evaluate the safety and effectiveness of drugs, medical devices, and therapies in human subjects.
4. **Contributions:** Biomedical research has led to groundbreaking discoveries such as the development of vaccines, antibiotics, gene therapies, and targeted cancer treatments, significantly improving human health and extending life expectancy.
5. **Examples:** Research on the genetic basis of rare diseases, drug development for neurological disorders, investigations into the mechanisms of cancer development, and studies on infectious diseases are all examples of biomedical research.

1. specialisms involving life sciences
2. specialisms involving physiological science
3. specialisms involving medical physics or bioengineering

life sciences specialties you mentioned:

1. **Molecular Toxicology:** The study of the effects of toxic substances at the molecular and cellular levels, focusing on how chemicals interact with biological systems and the mechanisms of toxicity.
2. **Cervical Cytology:** The examination of cervical cells under a microscope to detect abnormal changes, often performed as part of cervical cancer screening (Pap smear).
3. **Molecular Pathology:** The application of molecular techniques to diagnose diseases by studying changes at the molecular level, such as genetic mutations or alterations in gene expression.
4. **Clinical Biochemistry:** The analysis of bodily fluids to measure biochemical markers and assess the function of organs and metabolic processes for diagnosing and monitoring diseases.
5. **Blood Transfusion Science:** The study of blood groups, blood compatibility, and safe blood transfusion practices to ensure the proper matching and safe transfusion of blood products.
6. **Clinical Embryology:** The study of human embryonic development and assisted reproductive technologies used in infertility treatments and prenatal diagnosis.

7. **Electron Microscopy:** A powerful imaging technique that uses electron beams to visualize structures at the cellular and subcellular levels with high resolution.
8. **External Quality Assurance:** Quality assessment programs used to evaluate the accuracy and reliability of laboratory test results across different laboratories.
9. **Clinical Immunology:** The study of the immune system and its role in health and disease, including autoimmune disorders and immune responses to infections.
10. **Haematology:** The study of blood and blood-forming tissues, including the diagnosis and management of blood disorders.
11. **Haemostasis and Thrombosis:** The study of blood clotting mechanisms and disorders related to blood clotting and bleeding.
12. **Histocompatibility and Immunogenetics:** The study of tissue compatibility, organ transplantation, and the genetics of immune responses.
13. **Histopathology and Cytopathology:** The examination of tissue and cellular samples to diagnose diseases, especially cancer.
14. **Molecular Biology and Cell Biology:** The study of cellular processes, gene expression, and molecular mechanisms in living organisms.
15. **Molecular Genetics and Cytogenetics:** The study of genetic material, including chromosomes and genetic mutations, with applications in understanding genetic disorders.
16. **Bacteriology:** The study of bacteria, including their identification, classification, and role in infections and diseases.
17. **Microbiology (Tropical Diseases):** The study of microorganisms, including bacteria, viruses, and parasites, particularly those causing tropical diseases.
18. **Tissue Banking/Transplant:** The collection, storage, and distribution of human tissues for transplantation and medical research.
19. **Phlebotomy:** The process of collecting blood samples from patients for diagnostic testing and research purposes.
20. **Virology:** The study of viruses, including their structure, replication, and role in causing diseases.

Physiological science encompasses a wide range of specializations that focus on understanding the functions and mechanisms of the human body and how they relate to health and disease. Each specialization delves into specific aspects of physiology, exploring unique topics and research areas. Here are some physiological science specializations:

1. **Therapy:** This specialization focuses on therapeutic interventions and treatments for various physiological conditions and disorders.
2. **Autonomic Neurovascular Function:** The study of the autonomic nervous system and its control over blood vessels and other physiological functions.
3. **Clinical Perfusion:** The study of the circulation and oxygenation of blood during surgical procedures, particularly in cardiopulmonary bypass.
4. **Gastrointestinal Physiology:** The study of the functions and processes involved in the digestion and absorption of nutrients in the gastrointestinal tract.
5. **Audiology and Hearing:** This specialization deals with the study of hearing, auditory systems, and the diagnosis and management of hearing disorders.
6. **Cardiac Physiology:** The study of the heart's functions, including cardiac muscle contraction, electrical activity, and cardiovascular regulation.
7. **Critical Care Science:** This specialization focuses on the physiological monitoring and management of critically ill patients.

8. **Neurophysiology:** The study of the nervous system's functions and activities, including electrical signaling and neural pathways.
9. **Ophthalmic and Vision Science:** This specialization deals with the physiology of the eyes and visual processing.
10. **Respiratory and Sleep Physiology:** The study of the respiratory system's functions, gas exchange, and the physiology of sleep.
11. **Urology:** This specialization focuses on the physiology of the urinary system and related disorders.
12. **Vascular Science:** The study of the vascular system, including blood vessels and their functions.

Physics and bioengineering offer a diverse range of specializations that combine principles of physics with engineering to address challenges in medicine and healthcare. These specializations involve the application of physics concepts, technology, and engineering techniques to develop innovative solutions for medical diagnostics, treatments, and patient care. Here are some physics and bioengineering specializations:

1. **Biomechanical Engineering:** The application of mechanical engineering principles to study the mechanics of biological systems and design biomedical devices and implants.
2. **Biomedical Engineering:** This field involves the application of engineering principles to design and develop medical devices, equipment, and systems for various medical applications.
3. **Clinical Engineering - Equipment Management:** The management and maintenance of medical equipment used in healthcare settings, ensuring their safe and efficient operation.
4. **Clinical Measurement:** The development and application of measurement techniques to assess physiological parameters in clinical settings.
5. **Diagnostic Radiology:** The use of medical imaging techniques, such as X-rays, CT scans, and MRI, to diagnose and visualize internal structures.
6. **Maxillofacial Prosthetics:** The design and fabrication of prosthetic devices to restore the function and appearance of the head and neck region, particularly the face and jaws.
7. **Medical Electronics:** The development and integration of electronic components and systems used in medical devices and equipment.
8. **Medical Engineering Design:** The process of designing medical devices and technologies, ensuring they meet specific medical needs and safety standards.
9. **Medical Illustration and Clinical Photography:** The creation of visual representations and images to aid in medical education, research, and documentation.
10. **Non-Ionizing Radiation:** The study and safe use of non-ionizing radiation, such as ultrasound and laser, in medical diagnostics and treatments.
11. **Nuclear Medicine Monitoring:** The use of radioactive substances and imaging techniques for diagnosing and monitoring diseases.
12. **Radiopharmacy:** The preparation and use of radiopharmaceuticals for diagnostic and therapeutic purposes.
13. **Radiation Protection:** The development and implementation of safety measures to protect healthcare professionals and patients from ionizing radiation exposure.
14. **Renal Technology and Science:** The study and development of medical devices and technologies related to kidney function and renal therapies.
15. **Radiotherapy Physics:** The application of physics principles in radiation therapy to treat cancer and other medical conditions.
16. **Rehabilitation Engineering:** The design and development of assistive devices and technologies to aid individuals with disabilities or impairments.

17. **Ultrasound:** The use of high-frequency sound waves for medical imaging and diagnostic purposes.

Social Research in Life Sciences:

1. **Focus:** Social research in the life sciences explores the social, behavioral, and cultural factors that influence health, disease prevention, and healthcare utilization. It considers the impact of socio-economic factors, lifestyle choices, and healthcare policies on population health.
2. **Epidemiological Studies:** Social research employs epidemiological methods to study disease patterns, risk factors, and health disparities in various populations.
3. **Health Behavior Studies:** Social research investigates health behaviors, such as smoking habits, physical activity levels, dietary choices, and adherence to medical treatments, to understand their impact on health outcomes.
4. **Public Health Interventions:** Social research informs the design and evaluation of public health interventions aimed at promoting healthy behaviors, preventing diseases, and improving population health.
5. **Examples:** Research on the effectiveness of public health campaigns to reduce smoking rates, studies on health disparities in vulnerable populations, investigations into the social determinants of health, and surveys on healthcare access and utilization are all examples of social research in the life sciences.

Interdisciplinary Collaboration: Biomedical and social research often overlap and complement each other, leading to interdisciplinary collaboration in the life sciences. Researchers from both fields collaborate to better understand the complex interactions between biological, genetic, and social factors that influence health and disease outcomes. This interdisciplinary approach is vital for developing holistic and e ffective strategies to improve public health, provide patient-centered care, and address health disparities.

Objectives of Social Research

1. Academic Objectives

- To find new propositions
- To discover new facts
- To propose and intimate knowledge for academicians

2. Utilitarian Objectives

- To find the various causes for problem
- To provide principles of problem solution
- To give remedies for a social problem

Need for Research in Life Science:

Research in life science is crucial for advancing our understanding of living organisms, their interactions, and the underlying mechanisms that govern life processes. Here are some key reasons why research in life science is essential:

1. **Medical Advancements:** Research in life science contributes to the development of new medical treatments, drugs, and therapies. It helps us better understand diseases, find ways to prevent them, and improve patient care.

2. **Biodiversity Conservation:** Life science research helps us study and conserve the incredible variety of life on Earth, from endangered species to ecosystems. This is vital for maintaining a balanced and healthy environment.

3. **Agricultural Innovation:** Research in genetics, biotechnology, and plant sciences leads to the development of improved crops, better farming practices, and sustainable food production.

4. **Public Health:** Life science research is critical for addressing public health challenges, including infectious diseases, epidemics, and health disparities.

5. **Environmental Sustainability:** Understanding how living organisms interact with their environment informs strategies for protecting natural resources, managing pollution, and mitigating climate change.

6. **Human Evolution and Anthropology:** Research in life science helps us explore our origins, the evolution of our species, and the history of human societies.

7. **Bioinformatics and Biotechnology:** Advances in computational biology, bioinformatics, and biotechnology have transformative impacts on fields like drug discovery, personalized medicine, and synthetic biology.

Challenges in Life Science Research:

While life science research offers numerous benefits, it also comes with its share of challenges:

1. **Complexity of Life:** Living organisms are incredibly complex, and understanding their intricate systems requires sophisticated research methods and interdisciplinary collaboration.
2. **Ethical Considerations:** Research involving animals, human subjects, and genetic modification raises ethical questions that need careful consideration.
3. **Data Management and Analysis:** The vast amount of data generated in life science research demands efficient methods for data storage, analysis, and interpretation.
4. **Funding and Resources:** Life science research requires significant funding for equipment, technologies, and personnel. Competition for grants can be intense.
5. **Interdisciplinary Collaboration:** Addressing complex questions often requires collaboration across different scientific disciplines, which can be challenging due to differences in language, methods, and priorities.
6. **Rapid Technological Advancements:** While technological innovations drive progress, they also require researchers to continually update their skills and adapt to new tools.
7. **Reproducibility and Transparency:** Ensuring that research findings are reproducible and transparent is vital for building a robust scientific foundation.

8. **Global Health Disparities:** Research should address global health challenges and disparities, which may require considering diverse cultural, economic, and social factors.
9. **Environmental and Ecological Issues:** Studying and mitigating the impacts of human activity on ecosystems requires careful observation, data analysis, and policy recommendations.
10. **Regulatory and Legal Frameworks:** Researchers need to navigate complex regulatory frameworks, especially in fields like genetic research and biotechnology.

Data:

Data is a set of values recorded one or more observational unit

Data are facts and statistics, expressed either in qualitative or quantitative from and used for refernce and analysis. It is collective information on specific subject.

Data refers to a collection of facts, figures, statistics, or information that has been gathered, observed, measured, or recorded. It can exist in various forms, such as numbers, text, images, or symbols, and it serves as the foundation for analysis, decision-making, and understanding in various fields including science, business, research, and technology. Data plays a crucial role in generating insights, identifying patterns, and drawing conclusions, enabling informed actions and discoveries.

Types of data

Data classification depending upon variables

1. **Qualitative Data**
2. **Quantitative Data**

1. **Qualitative Data**: It arises when observation falls into separate distinct categories.

Qualitative data consists of non-numerical information that describes qualities, characteristics, attributes, or properties. It is often collected through observations, interviews, open-ended surveys, and textual sources. Qualitative data provides insights into the subjective aspects of a phenomenon and helps to understand underlying meanings, emotions, and contexts.

Example ; colour of eyes: blue, green, brown etc

Exam result: pass or fail

Socio-economic status: low middle or high

- This type of data are discrete in which there are finite numbers of possible categories into which each observation may fall.
- It has no magnitude and cannot be measured
- There are classified by counting the individuals having the same characteristics or attributes and not by measurements

There are two types of qualitative data

a. Nominal data : represent most basic form of data this form category data into certain groups and gives them a name example in a study grouping the sample of subject maybe done as male and female

b. Ordinal data: it gives more information then nominal data in an ordinally example in study group male and female subjects can also discriminate as oldest older mild ageed younger or engaged

a. Nominal Data: Nominal data is the simplest form of qualitative data. It involves categorizing items into distinct groups or classes without any specific order or ranking. Each category is given a name or label, which represents its identity but does not imply any inherent value or order. Nominal data can only be used for classification purposes.

Example: In a research study, grouping subjects into categories like "male" and "female" is an example of nominal data. These categories are names given to different groups, but they don't indicate any specific ranking or order.

b. Ordinal Data: Ordinal data goes beyond nominal data by introducing the concept of order or ranking among categories. It represents qualitative data in a way that reflects their relative positions or preferences. While the intervals between categories might not be uniform, ordinal data indicates that one category is higher or lower than another.

Example: Continuing with the research study example, if you group male and female subjects based on age ranges like "oldest," "older," "middle-aged," "younger," and "youngest," this represents ordinal data. The categories have an order that suggests different levels of age, even though the exact intervals between them might not be equal.

Both nominal and ordinal data are essential in qualitative research as they help researchers classify, compare, and analyze qualitative information in meaningful ways. Understanding the distinctions between these two types of data enables researchers to choose appropriate analysis methods and draw accurate conclusions from their research findings.

2. **Quantitative Data:**

   Quantitative data it arrives when the observation are counts or measurements

   Quantitative data is numerical information that can be measured and counted. It involves quantities and can be analyzed using mathematical and statistical methods. This type of data is collected through measurements, surveys with closed-ended questions, experiments, and objective observations. Quantitative data provides objective and measurable information about the quantities or amounts of variables.

- Here a characteristic doesn't vary but only frequency vary.
- Example number of births number of deaths etc
- The characteristics are measured either on an interval or on A ratio scale
- The data is said to be discrete if the measurement are integer and continuous if the measurement can take on any value usually within a some range
- 30 data are characterized by variability and continuity
    a. **Variability** it is a difference that can be measured in for the same feature in different subjects

example in a group of 10 subjects weight may be 45 48 52 46 and so on weight is a single character or feature that differ in a 10 different subjects

b. **Continuity** it is the difference seen in the same subject of a features over a period of a time

example a person may be measured for weight at 5 different occasions with he shows the following value 54.8 55.1 55.3 55.5 55.7……..

Source/ collection of data

1. Internal data
2. External data

1. **Internal data** it is the information generated or collected from within the organisation business etc
2. **External data** the information collected from outside and intuition or organisation

these are two characters of external data

i primary data

ii secondary data

A. **Primary data** data that is a collected by a researcher from first hand source primary data can be collected by following methods

a. personal interview

- These are of two type direct and indirect methods

i. Direct personal interview

- Researchers collect data personally from person who are the subjects to enquiry
- Researchers should be skilled and pleased
- Ex if a teacher want to know the personality of a students in a class she may interview her students personally one by one

ii. Indirect personal interview

- If the person refuse to provide information to investigator then this method can be used here information can be collected from the person who are nearest to him
- Ex information about alcoholic drinker may not provide accurate answer so we may ask their family members

b. information from correspondents

- Here a local agents are correspondence are appointed in different part of a investigation area example newspaper or radio departments
- The obtain a news or articles or programs etc by this method
- It is a used when information is to be obtained from wild area and where high degree of accuracy is not required

c. Questionaries

1. It is a set of printed questions usually with a choice of answers in this questions sheet itself space is provided for a giving answers two types of a questionnaire
    i. **Mailed questionnaires**: these to be filled by investigator: Mailed questionnaires certain questions are sent to informants or respondence by post or a male and answer will be kept confidential . it is most popular method used
    ii. **Questions to be filled by investigator**: here a questions are to be filled by investigator itself and answer will be kept confidential.

Basic principle of drafting questions are

1. **Clarity and Simplicity:** Use clear and straightforward language. Avoid jargon or complex terminology that could confuse respondents.
2. **Single Idea:** Each question should focus on a single idea or concept. Avoid asking multiple questions within one.
3. **Avoid Leading Questions:** Avoid phrasing questions in a way that suggests a desired response or bias. Questions should be neutral and objective.
4. **Avoid Ambiguity:** Ensure that questions have only one interpretation. Ambiguous questions can lead to varied or inaccurate responses.
5. **Use Specific Language:** Be specific in your wording. Vague terms like "often" or "sometimes" can be interpreted differently by different respondents.
6. **Avoid Double Negatives:** Questions with double negatives (e.g., "Do you not like this product?") can confuse respondents. Use positive language whenever possible.
7. **Use Balanced Options:** If you provide answer options, make sure they cover a range of possibilities and are balanced in tone.
8. **Consider Response Scale:** If using a Likert scale or other response format, ensure it matches the nature of the question and provides meaningful distinctions between options.
9. **Prevent Social Desirability Bias:** Avoid questions that may lead respondents to provide socially desirable answers. This can be achieved by using anonymous surveys or framing questions carefully.
10. **Avoid Biased Language:** Ensure that the language used in questions is neutral and unbiased, without favoring any particular response.
11. **Logical Flow:** Organize questions in a logical sequence that flows naturally and maintains respondent engagement.
12. **Pilot Testing:** Before finalizing the survey, conduct a pilot test with a small group to identify any issues or confusion in the questions.
13. **Open-Ended Questions:** Include open-ended questions to allow respondents to provide detailed responses and insights.
14. **Relevance:** Ensure that each question is relevant to the survey's overall goals and objectives.
15. **Length:** Keep the survey a reasonable length. Long surveys can lead to respondent fatigue and reduced quality of responses.
16. **Demographic Questions:** Include demographic questions (age, gender, education, etc.) if relevant to your research, but place them at the end of the survey to avoid biasing earlier responses.

B. Secondary data

Data that is already published or Unpublished which is used for investigation purpose

a) Published data

i. **Government publication:** mini government departments such as a health and family welfare department or a central state governments regularly published current information with statistics
example health statistics agriculture statistics of India Indian trade journal etc

ii. **International organisation** : many international organisations like WHO UN UNICEF etc published valueable data annually regarding peoples health and other related area which provide valuable statistical information about each country and it place in the world

iii. **Semi official publication:** local bodies such as municipal corporation gram Panchayat etc publisher reports periodically which provides information about people's health birth and the death race sanitation literacy etc

iv. **Reports of committees or commissions:** There are committees and commissions of enquiry appointed by central and state governments for some special purpose and study. There reports have very high values

v. **Private publications:** these include journals articles and newspapers research institute like ICMR NIN etc private companies like Honda Tata Birla company etc articles and reports published by local workers

b) Unpublished data

its many departments like atomic research departments information and technology departments medical research institutions etc never published their data without government permission or their head of the department or chief
Unpublished data also personal diaries notes etc

Classification of statistical data

1. Geographical classification
2. chronological classification
3. qualitative classification
4. quantitative classification

1. Geographical classification collection of data according to area origin of Assam part of country it is further classified into

i. **Alphabetical order**: names of the local districts village state or countries given alphabetically or as per their name example country America Burma China France etc literacy rate 95% 65% 60% 80% respectively

ii. **Descending order:** names of the country don't appear in alphabetical order but percentage of a distribution is according to descending order example country America France Burma China literacy rate 95% 80% 65% 60% respectively

2. Chronological classification: classification of data according to time its difference . Time maybe in the form of ear month week etc it may be classified either in ascending or descending order as per requirement
Ascending type
Descending type

3. Qualitative classification

i. **Simple classification:** classification done with respect to one quality or attribute of a group into two classes example if a group of a student in a class is to be classified in respect of gender we can classify them into two groups male and female this type is also called as "dichotomous classification "

ii. **Compound classification**: classification done with respect to two attribute qualities and where several classes are formed

4. **Quantitative classification:** collected data is group with reference to characteristics which can be measured and numerically distributed such as a weight age income expenditure etc

   types of qualitative classification

   i. **Continuous data** these are possible value between any other two possible values

      Example if we measure height of an individual for two different occasion then height may be 70cm and 71 CM there is a every possibility that the height of any student may be in the range 70- 71 centimetre is that 70.3 CM 70.7 CM etc.... Thus here we get a continuous variable

   ii. **Discrete data** it is a one which is limited to certain numerical values of variable Ex if we found the number of leaves on a tree the quality maybe 40, 41, 42 etc but the numerical can never be 41.5 42.8 etc

   iii. Class interval : If number of observation having wild range definite c haracteristics are expressed in numerical value then they are classified into a numbers of groups at certain interval.

Presentation of data

The way or method of presenting collected information for statistical analysis is called presentation of data

Methods of presentation

1. tabulation or tabular presentation
2. diagrammatic presentation
3. graphical presentation

1. Tabular presentation the classified data are putting the table having a rows and columns.

The process by which the classified data are present dead in an orderly manner in rows and columns of a table with their characteristics are known as a tabulation

Ideal table

- The following are the essential features of a table
- A table should be simple easy to understand
- Should not be overloaded with the details of each point
- Should be attribute (i.e proportion of columns rows and size should be maintained)
- Unit of measurements must be mentioned
- Should have tittle table no. And if required a footnote and source should be mentioned
- Columns and draw should be number for the convenience of feature reference

Part of ideal table

- Table number
- title or headnote
- heading of column rows
- body of table
- footnote
- source

Types of tabulation

i. Simple tabulation : only one set of data gives information we find only two columns only one characters of the data is studied if he is also called as "one way table"

ii. Complex tabulation: more than one set groups are presented in a table the two groups must be related to each other types of complex tabulations are also followed

   a) Two way table data are present at into two characters in a table
   b) 3 way table collected data are classified and presented into three characters

c) Compound table data are classified according to more than three characters and table

2. **Diagrammatic representation** in occasion tabular presentation of statistical data become difficult to understand in that case diagrammatic representation is appearing to ice and create a lasting impression in mind it reveals hidden fact of data usually picture presentation of data makes a clear impression that an other diagrams

An ideal diagram

- Should be observed by naked eye
- should be orderly divided considering it accuracy
- should have heading
- scale should be mentioned and selected according to size of paper and graph
- geometric instruments must be used
- if necessary footnote and source should be mentioned
- shades and colours make a diagram more attractive
- should be easy to comprehensive.

Types of diagram

1. One dimensional diagram

Bar diagram is called one dimensional diagram because height of the bar is of real significance and not width of the bar

A bar diagram consist of parallel bars each of which has same width

All the bars are drawn on a column based line and distance between two constitute bar is always same

The height of each bar represents the value of each item of the bar data

Following guard different types of bar diagrams

a) Simple bar diagram it is a used to represent only one characters one bar represents only one variable
b) Sab divided bar diagram or compound bar chart: these bar is subdivided into certain part where the total height is proportional to difference sub division representing the component parts
c) Multipur bar diagram or compound column chart: these charts depends more than one type of data at a time this type of bars are used when we have to make a comparative study of different characters
d) Percentage bar diagram: in compound bar chart when subdivision are more than two then the subdivisions are converted into percentage of whole and the height of each bar is considered as a 100 unit

2. Two dimensional diagram

Here area instead of lengths are proportional to given figure

a) Rectangle: length represents one quality, 2nd quality is represents by breadth and area of rectangle represents 3rd quality provide these qualities are proportionate to each other
b) Square: it is a used when the ratio between quality is very high
c) Pie diagram: it is used where the qualities are proportionate to the area of circle or square of radius it is a more attractive than square
d) Pie chart it is a circle of situated radius subdivided into sectors by radius in such a way that the areas of the sector 8 are proportional to the value of the component item under investigation it is a very useful in drawing composition among various compounds are between a part and the whole

3. three dimensional diagrams

a) Cube when the ratio of two qualities is very high (example 125 :1) they are represented by cubes their side are proportional to cube roots of given qualities

b) Rectangular solids: used when three qualities are joinly proportional to a fourth qualities
c) Pictogram: When the presentation is in the form of picture it is known as pictogram. It is also known as Vienna method or ISO type method. Here a symbol represents value
d) Cartogram or map a geographical representation of data or information it is mainly used for compression of two different area under same characters

3.Graphical representation

They are made to represent the data of frequency distribution over a period of time

1. **Graphs of frequency distribution**: class interval mid value and measurements on x-axis and frequency on y axis are taken
    i. **Lines frequency graph:** two variable are used one ON x-axis and other on y-axis independent variable should be taken on x-axis and dependents variable on y axis points are plotted and joined by a line.
    For comparative study two or more graphs are drawn on same graph paper considering the same scale
    ii. **Histogram** it is a pictorial form of frequency diagram distribution which consist of series of blocks drawn adjacently on the same horizontal baseline
    iii. **Frequency polygon:** various value are plotted on x-axis and corresponding frequency on y axis then point plotted on the graph paper are jointed successfully by straight line and polygon is completed by joining 2 extremities of rectiline
    iv. **Frequency curve** it points plotted for a frequency polygons are joined by a free hand then we get a curve called frequency curve
    v. **Cumulated frequency curve or ogive**: it is the total number of individual in each particular range from the lowest value of the characteristics upon and include any higher group value
        - Ogive is a graph of the cumulative relative frequency distribution
        - If we want to draw ogive we should convert ordinal frequency distribution into relative cumulative frequency
    vi. **Lorenz curve:** it is useful in the study of degree of inequality in the distributionar figure.
2. **Graph in time series historigram**
    It shows change in a value of a variable over a passage of time

LEVELS OF MEASUREMENT

- Measurement is often viewed as being the basis of all scientific inquiry, and measurement techniques and strategies are therefore an essential component of research methodology.
- Measurement can be defined as a process through which researchers describe, explain. and predict the phenomena and constructs of our daily existence (Kaplan, 1964, Pedhazur & Schmelkin, 1991), For example, we measure how long we have lived in years, our financial success in dollars, and the distance between two points in miles.

There are two basic categories of data: non-metric and metric.

- **Non-metric data** (also referred to as qualitative data) are typically attributes. characteristics, or categories that describe an individual and cannot be quantified.

- **Metric data** (also referred to as quantitative data) exist in differing amounts or degrees, and they reflect relative quantity or distance.

Metric data allow researchers to examine amounts and magnitudes, while non-metric data are used predominantly as a method of describing and categorizing (Hair, Anderson, Tatham, & Black, 1995).

Scales of Measurement

There are four main scales of measurement under the broader categories of non-metric and metric measurement: nominal scales, ordinal scales, interval scales, and ratio scales. Nominal and ordinal scales are non-metric measurement scales

Nominal scales

- Nominal scales are the least sophisticated type of measurement and are used only to
- qualitatively classify or categorize They have no absolute zero point and cannot be ordered in a quantitative sequence, and
- there is no equal unit of measurement between categories. This makes it impossible to conduct standard mathematical operations such as addition. subtraction, division, and multiplication
- Common examples of nominal scale data include gender, religious and political affiliation, place of birth, city of residence, ethnicity, marital status, eye and hair color. and employment status. Notice that each of these variables is purely descriptive and cannot be manipulated mathematically.

Ordinal Scales

- Unlike the nominal scale, ordinal scale measurement is characterized by the ability to measure a variable in terms of both identity and magnitude
- This makes it a higher level of measurement than the nominal scale because the ordinal scale allows for the categorization of a variable and its relative magnitude in relation to other variables. Variables can be ranked in relation to the amount of the attribute possessed.
- Like nominal data, ordinal data are qualitative in nature and do not possess the mathematical properties necessary for soph sticated statistical analyses,
- A common example of an ordinal scale is the finishing positions of runners in a race. We know that the first runner to cross the line did better than the fourth, but we do not know how much better. We would know how much better only if we knew the time it took each, runner to complete the race.

Interval and ratio scales are the two types of metric measurement scales, and are quantitative in nature Collectively, they represent the most sophisticated level of measurement and lend themselves well to sophisticated and powerful statistical techniques.

Interval Scales

- The interval scale of measurement builds on, ordinal measurement by providing
- information about both order and distance between values of variables.
- The numbers on an interval scale are scaled at equal distances, but there is no absolute zero point. Instead, the zero point is arbitrary. Because of this, addition and subtraction are possible with this level of measurement, but the lack of an absolute zero point makes division and multiplication impossible.
- Example: On either the Fahrenheit or Celsius scale, zero does not represent a complete absence of temperature, yet the quantitative or measurement difference between 10 and 20 degrees is the same as the difference between 40 and 50 degrees. There might be a qualitative difference

between the two temperature ranges, but the quantitative difference is identical-10 units or degrees.

Ratio Scales

- The properties of the ratio scale are identical to those of the interval scale, except that the ratio scale has an absolute zero point, which means that all mathematical operations are possible.
- Money is a pertinent example. It is possible to have no (or zero) money--a zero balance
- in a checking account, for example. This is an example of an absolute zero point
- Unlike with interval scale data, multiplication and division are now possible.
- Ten dollars is 10 times more than I dollar, and 20 dollars is twice as much as 10 dollars.
- If we have 100 dollars and give away half, we are left with 50 dollars, which is 50 times more than I dollar. Other examples include height weight, and time
- Ratio data is the highest level of measurement and allows for the use of sophisticated statistical techniques.

Types of research and techniques

Definitions of Research:

The following are the important definitions of research: "Research is an endeavor / attempt to discover, develop and verify knowledge. It is an intellectual process that has developed over hundreds of years ever changing in purpose and form and always researching to truth."

J. Francis Rummel

"Research is an honest, exhaustive, intelligent searching for facts and their meanings or implications with reference to a given problem. The product or findings of a given piece of research should be an authentic, verifiable contribution to knowledge in the field studied."

P.M. Cook

"Research may be defined as a method of studying problems whose solutions are to be derived partly or wholly from facts."

W.S. Monroes.

"Research is considered to be the more formal, systematic intensive process of carrying on the scientific method of analysis. It involves a more systematic structure of investigation, usually resulting in some sort of formal record of procedures and a report of results or conclusion."

John W. Best

"Research comprises defining and redefining problems formulating hypothesis or suggested solutions, collecting,organizing and evaluating data, making deductions and reaching conclusions and at last careful testing the conclusions to determine whether they fit the formulated hypothesis."

Clifford Woody

"Research is a systematic effort to gain new knowledge."

Redman & Mori

"Social research may be defined as a scientific undertaking which by means of logical and systematized techniques aims to discover new facts or verify and test old facts, analyse their sequences, inter-relationships and casual explanation which were derived within an appropriate theoretical frame of reference, develop new scientific tools, concepts and theories which would facilitate reliable and valid study of human behavior."

P.V. Younge

Purpose of Research: objective of research

The purpose of research is to systematically investigate and explore a specific topic, issue, question, or problem with the aim of generating new knowledge, insights, and understanding. Research serves various important objectives, including:

1. Discovery of Knowledge: Research helps uncover new information, facts, theories, or patterns that contribute to expanding human understanding of the world.
2. **Problem Solving:** Research seeks solutions to existing problems or challenges by analyzing data and generating evidence-based recommendations.
3. **Advancement of Science and Technology:** Research drives progress in various fields by pushing the boundaries of knowledge and creating innovations.
4. **Validation and Verification:** Research validates or verifies existing theories, models, or claims through empirical evidence and rigorous analysis.
5. **Exploration of Possibilities:** It explores different possibilities, scenarios, and alternatives to make informed decisions or predictions.
6. **Development of Theories:** Research contributes to the development, refinement, or modification of theories that explain various phenomena.
7. **Improvement of Practices:** It informs and improves practices, policies, and strategies in areas such as healthcare, education, business, and public policy.
8. **Creation of New Perspectives:** Research can challenge established beliefs and bring new perspectives to light, leading to paradigm shifts.
9. **Understanding Complex Phenomena:** It helps unravel the complexity of intricate phenomena by dissecting and analyzing various components.
10. **Contribution to Literature:** Research adds to the body of knowledge and academic literature by publishing findings in journals, reports, and articles.

11. **Support for Decision-Making:** Research provides factual information that supports informed decision-making in various sectors.
12. **Identification of Trends:** Research identifies trends, patterns, and emerging issues that can guide future actions.
13. **Evaluation and Assessment:** Research assesses the effectiveness, impact, or outcomes of interventions, policies, or programs.
14. **Generation of Hypotheses:** Research generates hypotheses that can be tested through experimentation or further investigation.
15. **Documentation of History:** Research documents historical events, cultural practices, and societal changes for future generations.
16. **Contributions to Academia:** Research contributes to the academic community by fostering critical thinking, peer review, and scholarly discourse.

Characteristics of Research:
Following are the characteristics of research;

(1) Research is directed toward the solution of a problem.
(2) Research requires expertise.
(3) Research emphasizes the development of generalizations principles, or theories that will be helpful in predicting future Occurrences.
(4) Research is based upon observable experience or Empirical evidence.
(5) Research demands accurate observation and description.
(6) Research involves gathering new data from primary or first-hand sources or using existing data for a new purpose.
(7) Research is characterized by carefully designed procedures that apply rigorous analysis.
(8) Research involves the quest for answers to un-solved problems.
(9) Research strives to be objective and logical, applying every possible test to validate the procedures employed the data collected and the conclusions reached.
(10) Research is characterized by patient and unhurried activity. (xi) Research is carefully recorded and collected.
(11) Research sometimes requires courage.

Types of research based on different classification criteria:

These different types of research classifications help researchers choose the most appropriate approach for their specific research goals, questions, and contexts.

(A) On the Basis of Nature of Information:

1. **Qualitative Research:**
    - **Explanation:** Qualitative research involves gathering non-numerical data such as opinions, perceptions, experiences, and narratives. It seeks to understand underlying meanings and contexts.
    - **Example:** Conducting in-depth interviews to explore participants' attitudes towards a particular social issue.
2. **Quantitative Research:**

- **Explanation:** Quantitative research deals with numerical data and employs statistical methods for analysis. It focuses on measuring variables and establishing patterns or relationships.
- **Example:** Using surveys to collect data on the percentage of people who prefer different brands of a product.

(B) On the Basis of Utility of Content or Nature of Subject Matter of Research:

3. **Basic/Fundamental/Pure or Theoretical Research:**
    - **Explanation:** This type of research is driven by curiosity and aims to expand general knowledge without immediate practical application. It explores theories and principles.
    - **Example:** Investigating the fundamental properties of a certain particle in physics.
4. **Experimental or Applied Research:**
    - **Explanation:** Applied research focuses on solving specific real-world problems. It involves using knowledge gained from basic research to address practical issues.
    - **Example:** Developing a new drug based on insights from fundamental research on a specific biological process.

(C) On the Basis of Approach of Research:

5. **Longitudinal Research:**
    - **Explanation:** Longitudinal research involves studying a subject or phenomenon over an extended period to observe changes or developments over time.
    - **Example:** Tracking the educational and career paths of a group of students over several years.
6. **Cross-Sectional Research:**
    - **Explanation:** Cross-sectional research involves studying a sample of a population at a single point in time to gather data about a specific issue.
    - **Example:** Conducting a survey to understand people's preferences for different types of entertainment.

(D) On the Basis of Method of Research:

7. **Philosophical Research:**
    - **Explanation:** Philosophical research explores existing philosophical theories, concepts, and perspectives on a particular topic. It focuses on understanding different philosophical viewpoints.
    - **Example:** Analyzing various philosophical arguments on the nature of reality.
8. **Historical Research:**

- **Explanation:** Historical research examines past events and phenomena to understand their context, causes, and effects. It can involve both qualitative and quantitative analysis.
- **Example:** Studying primary sources to understand the social and cultural factors that led to a historical event.

9. **Survey Research:**
    - **Explanation:** Survey research collects data from a sample of respondents through structured questionnaires. It aims to gather information about current attitudes, behaviors, or opinions.
    - **Example:** Conducting a national survey to determine public opinion on a particular political issue.
10. **Experimental Research:**
    - **Explanation:** Experimental research involves manipulating variables in a controlled environment to establish cause-and-effect relationships. It's focused on testing hypotheses.
    - **Example:** Investigating the effect of a new teaching method on student performance by comparing it with a traditional method.
11. **Case-Study Research:**
    - **Explanation:** Case-study research examines a specific instance, phenomenon, or individual in depth. It can be qualitative or quantitative, depending on the research goals.
    - **Example:** Analyzing a particular company's strategies and practices to understand its success in a competitive market.

These different types of research classifications help researchers choose the most appropriate approach for their specific research goals, questions, and contexts.

These categories help researchers choose the most appropriate approach based on their research goals, data type, and the nature of the subject they are studying.

Research techniques

Research techniques are specific methods or procedures used to gather, analyze, and interpret data in order to answer research questions or test hypotheses. Here are some commonly used research techniques:

1. **Surveys:** Collect structured data from a sample through questionnaires or interviews. Surveys help gather information about opinions, behaviors, preferences, and demographics.
2. **Observational Research:** Observe and record behaviors, events, or phenomena in their natural setting. This technique is useful for studying real-life situations and behaviors.
3. **Experiments:** Manipulate variables under controlled conditions to establish cause-and-effect relationships. Experiments allow researchers to study the impact of independent variables on dependent variables.
4. **Case Studies:** In-depth analysis of a single case, individual, or group to gain insights into specific phenomena. Case studies provide rich contextual information.

5. **Content Analysis:** Analyze and code textual, visual, or audio content to identify patterns, themes, and meanings. This technique is often used for qualitative data.
6. **Interviews:** Conduct structured or unstructured interviews with participants to gather detailed information and insights. Interviews provide rich qualitative data.
7. **Focus Groups:** Facilitate group discussions with a small number of participants to explore opinions, attitudes, and perceptions on a specific topic.
8. **Ethnography:** Immerse researchers in a specific social or cultural group to understand their behaviors, beliefs, and practices in their natural context.
9. **Archival Research:** Analyze existing records, documents, or historical data to study past events, trends, or behaviors.
10. **Experimental Design:** Plan and design controlled experiments, including selecting participants, manipulating variables, and collecting data.
11. **Case-Control Studies:** Compare individuals with a particular condition (cases) to individuals without the condition (controls) to identify potential associations.
12. **Longitudinal Studies:** Collect data from the same individuals or groups over an extended period to study changes over time.
13. **Cross-Sectional Studies:** Collect data from individuals at a single point in time to analyze relationships or trends among variables.
14. **Meta-Analysis:** Combine data from multiple studies to provide a comprehensive overview and draw more robust conclusions.
15. **Sampling Techniques:** Select a subset of a larger population for study. Common sampling methods include random sampling, stratified sampling, and convenience sampling.
16. **Quantitative Data Analysis:** Use statistical methods to analyze numerical data, including descriptive statistics, inferential statistics, and regression analysis.
17. **Qualitative Data Analysis:** Analyze non-numerical data, such as text, images, or videos, using techniques like thematic analysis, content analysis, and grounded theory.