

Block

1

HISTORY AND DEVELOPMENT OF PHYSICAL ANTHROPOLOGY

UNIT 1

Definition and Scope	5
-----------------------------	----------

UNIT 2

Relationship with Other Disciplines	17
--	-----------

UNIT 3

Applied Dimensions-I	25
-----------------------------	-----------

UNIT 4

Applied Dimensions-II	33
------------------------------	-----------

Expert Committee

Professor I. J. S. Bansal
Retired, Department of Human Biology
Punjabi University
Patiala

Professor K. K. Misra
Director
Indira Gandhi Rashtriya Manav
Sangrahalaya, Bhopal

Professor Ranjana Ray
Retired, Department of Anthropology,
Calcutta University
Kolkata

Professor P. Chengal Reddy
Retired, Department of Anthropology
S V University, Tirupati

Professor R. K. Pathak
Department of Anthropology
Panjab University
Chandigarh

Professor A. K. Kapoor
Department of Anthropology
University of Delhi, Delhi

Professor V.K.Srivastava
Principal, Hindu College
University of Delhi, Delhi

Professor Sudhakar Rao
Department of Anthropology
University of Hyderabad, Hyderabad

Professor S.Channa
Department of Anthropology
University of Delhi, Delhi

Professor P. Vijay Prakash
Department of Anthropology
Andhra University
Visakhapatnam

Dr. Nita Mathur
Associate Professor
Faculty of Sociology
School of Social Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi

Dr. S. M. Patnaik
Associate Professor
Department of Anthropology
University of Delhi, Delhi

Dr. Manoj Kumar Singh
Assistant Professor
Department of Anthropology
University of Delhi, Delhi

Faculty of Anthropology SOSS, IGNOU

Dr. Rashmi Sinha, Reader
Dr. Mitoo Das, Assistant Professor
Dr. Rukshana Zaman, Assistant Professor
Dr. P Venkatramana, Assistant Professor
Dr. K. Anil Kumar, Assistant Professor

Programme Coordinator: Dr. Rashmi Sinha, SOSS, IGNOU, New Delhi

Course Coordinator: Dr. Rashmi Sinha, SOSS, IGNOU, New Delhi

Content Editor

Professor P. K. Seth
Retired, Department of Anthropology
University of Delhi, Delhi

Language Editor

Mrs. Narinder Jit Kaur
Retired, Associate Professor in English
Government Mohindra College, Patiala

Blocks Preparation Team

Unit Writers

Dr Rashmi Sinha (Units 1,2 & 3)
Reader, Faculty of Anthropology
SOSS, IGNOU, New Delhi

Dr. P. Venkatramana (Unit 4)
Assistant Professor, Faculty of Anthropology
SOSS, IGNOU, New Delhi

Authors are responsible for the academic content of this course as far as the copy right issues are concerned.

Print Production

Mr. Manjit Singh
Section Officer (Pub.), SOSS, IGNOU, New Delhi

Cover Design

Dr. Mitoo Das
Asstt. Professor, Anthropology, SOSS, IGNOU

August, 2011

© Indira Gandhi National Open University, 2011

ISBN-978-81-266-5545-8

All rights reserved. No part of this work may be reproduced in any form, by mimeograph or any other means, without permission in writing from the Indira Gandhi National Open University.

Further information on Indira Gandhi National Open University courses may be obtained from the University's office at Maidan Garhi. New Delhi-110 068.

Printed and published on behalf of the Indira Gandhi National Open University, New Delhi by the Director, School of Social Sciences.

Laser Typeset by : Tessa Media & Computers, C-206, A.F.E.-II, Okhla, New Delhi

Printed at :

BLOCK 1 HISTORY AND DEVELOPMENT OF PHYSICAL ANTHROPOLOGY

Introduction

We are so inquisitive to know about ourselves right from what we were earlier to why we are like today. The scientific family and individual have been enamored by the subject for many years. All the answers lead us to the in-depth knowledge in the discipline of Anthropology. Anthropology is holistic in approach as it deals with human beings all around the world and throughout time by examining the historical and present geographical distribution and considering all aspects of human, both biological as well as social. The strength of physical anthropology lies in its wide horizon to understand man as a physical being in his prehistoric setting and cultural context ruled by a multifaceted system of customs, attitudes and behaviour. Amongst the branches in Anthropology, Physical Anthropology holds a very coveted position.

Physical anthropology is about humans' place in nature. It is a very sought-after arena of anthropology. The mechanisms of biological evolution [i.e., how man evolved to present form], genetic inheritance (refers to passing of traits from one generation to the next), human adaptability and variation, primatology, and the fossil record of human evolution set up Physical Anthropology.

What is Physical anthropology, its definition at various times past and present is dealt in **Unit 1**. Its historical journey to the days when physical anthropology meant human variation and measurement, to the current status when our knowledge has advanced through technical progression, the aim and scope of this subject and an overview of the several sub disciplines of physical anthropology exploring human yet maintaining its own identity will all be dealt in this introductory unit.

Anthropology is not an isolated but is a broad field of study. It involves all branches of learning that concerns human and hence is involved with several other disciplines. **Unit 2** concerns with the interdisciplinary and transdisciplinary approaches in relation to physical anthropology. There are some strong connections between physical anthropology and other disciplines like forensic science, life sciences, medical sciences, earth sciences, human biology, environmental sciences, social sciences, human engineering and technology, and physical sciences.

Anthropology has spread its tentacles to more than just being an academic discipline. The recent years reflect an ever increasing recognition; what anthropology has discovered and can discover about human is invaluable. Applied and academic anthropology are not mutually restricted approaches, infact, applied anthropology banks on research and theory of academic anthropology and simultaneously has much to contribute to theory and technique. But then the applied aspect of physical anthropology is far from the knowledge bank of the subject. Applied anthropology is dedicated in making theoretical anthropological knowledge useful. The applied aspect in physical anthropology is not a recent discipline which needs an introduction. The knowledge gained by physical anthropology has been used for getting practical benefits in various fields will

be dealt in unit 3 and 4. The application of physical anthropology in field of designing, forensic anthropology, diseases, aging, sports, public health and nutritional anthropology would be covered in **Unit 3** and **Unit 4** deals with paternity diagnosis, genetic counseling, eugenics and DNA technology and its use in disease and medicine.



UNIT 1 DEFINITION AND SCOPE

Contents

- 1.1 Introduction
- 1.2 Definition
- 1.3 Aim
- 1.4 Scope
- 1.5 History
- 1.6 Branches and its Development
- 1.7 Summary

Suggested Reading

Sample Questions

Learning Objectives



After reading this unit, you would know the:

- definition of physical anthropology and its historical background;
- scope of physical anthropology; and
- different branches of physical anthropology.

1.1 INTRODUCTION

Physical anthropology is an important field of anthropology. Aren't we inquisitive to know about ourselves? How we were in the past to why we are like today? In this course on Physical Anthropology, let us first define what physical anthropology is and what does one achieve knowing this discipline. The historical background will take you back to the days when physical anthropology meant human variation and measurement to the current status, when we have advanced our knowledge through technical progression. The progress in this discipline has paved the way for several branches in physical anthropology.

1.2 DEFINITION

It very much interests us to know more about our past, present and future. What were the stages that took us to our present day form? All the answers lead us to the in-depth knowledge of Anthropology. The word Anthropology consists of Greek word "Anthropos" which means man and "logos" stands for study. It is a very vast subject comprising man as a physical being, man in his prehistoric setting and man in his cultural context who is ruled by a multifaceted system of customs, attitudes and behaviour. Anthropology is holistic in approach as it is concerned with all human beings, at all times, around the world through the examination of historical and present geographical distribution of human both biological as well as social. In a broader perspective, it is comparative science of man, his variation and their causes.

Amongst the various branches in Anthropology, Physical Anthropology holds a very coveted position. What is Physical Anthropology? It is not a simple task to provide a specific definition of physical anthropology for the simple reason that it involves interdisciplinary approach. Paul Broca, father of Physical Anthropology defines it as natural history of the genus Homo and more concretely as the science whose objective is to study humanity as a whole and in relationship to rest of the nature. Herskovits identifies that physical anthropologists study such matters as the nature of racial differences; the inheritance of bodily traits; the growth, development and decay of human organism; the influence of natural environment on man. According to Juan Comas, it is defined as science which studies variation, comparative study of the human body and its inseparable functions, exposition of the causes and courses of human evolution, transmission and classification, effects and tendencies in the functional and organic differences, etc.

Broadly speaking, Physical Anthropology comprises of biological evolution, genetic inheritance, human adaptability and variation, primatology, and the fossil record of human evolution. Physical Anthropology thus reflects an important scenario in today's increasingly specialised world of science.

The discipline thereby facilitates us in investigating the sources of variation which are the result of genetic differences and environmental modifications and directions of change which originated in the past. These differences perhaps arose over long spans of time through evolution both among individuals and groups. This very understanding of human organism is the strength of physical anthropology and in today's increasingly specialised world of science, it constitutes an important perspective. The domain of physical anthropology is widespread leading into physicians' seminars, schoolroom classes or even in casual conversation, endorsing its broad spectrum.

The branch of anthropology that concerns the human and nonhuman primate evolution, the biological basis of human behaviour, and human biological variability and its significance (giving it a proximity to biological science) is referred to as biological anthropology while physical anthropology is largely an American and British concept. In most European and many other countries, physical anthropologists are the only ones who are considered as anthropologists, while others are referred to as archaeologists, ethnologists, linguists, or prehistorians depending upon their field of specialisation.

1.3 AIM

The broad based understanding of human organism is the strength of physical anthropology. Not only this, physical anthropology integrates bio-cultural studies of human diversity, the ancestors of human species, comparative anatomy, ecology, behaviour and history of primates. Physical anthropologists are interested in studying human genetics, growth and development and evolutionary history. They attempt to accurately describe human physical structure both past and present and also investigate how function and behaviour are integrated into the environment in which human beings live.

Human biology has many times been erroneously used as a synonym for physical anthropology although, there is clear cut area for both the fields. Human biology comprises structure and function of contemporary man, whereas physical

anthropology refers to all that is chronological, racial, social and even pathological groupings of human. They are very close knit, yet they maintain individual identity in working methods, techniques and objectives.

1.4 SCOPE

With so much information getting unveiled, do you think physical anthropology is merely an academic subject? On the contrary, the recent years reflect an ever increasing recognition of what anthropology has discovered and can discover about humans.

The essence of physical anthropology right from its inception remains focused on man's physical characters, their origin, how they evolved and their development to present state that is, whatever we are today is the result of past and present conditions. Physical anthropology is widely accepted as the comparative science of man as a physical organism in context to his total surrounding be it social or cultural or physical; because development of his physical and cultural factors is reliant on the environment prevailing at that time.

What makes physical anthropology so indispensable? The answer lies in the very fact that the understanding and assessment of the degree of human variability along with the accounting of factors responsible for our current distribution have been of vital concern. Major answer lies in the fields of genetics and anthropometry which has been used in approximating the causes of diversification and human variation. Human variation is a specialised branch of physical anthropology.

The stages of evolution particularly the 'prehuman' history of man to his present form is the basis of Primatology. It also includes the study of human biology including anatomy, physiology and ethology. Undeniable is the contribution of Primate Palaeontology on extinct primates. This entire phenomenon tracing the origin of man and his evolution comes under Palaeoanthropology. Appropriate evaluation of the remains of fossil men in evolutionary outlook requires the contribution of comparative anatomy as well as embryology or developmental anatomy and physiology of growth.

Human diversity, another important component of physical anthropology takes into account human taxonomy, which in anthropological perspective refers to study of races. It was decided to replace the term 'race' with 'ethnic group' due to the misuse of the term, but then again the term is being revived.

The inclusion of human genetics as an essential component of physical anthropology has witnessed tremendous growth even occupying place in health magazine about a disease cell or gene therapy to treat diseases. Whatever it may be, there would undoubtedly be some information related to the field of genetics. Patterns of inheritance of trait in humans have generated tremendous interest. The assessment of the distribution and the gene frequency of the traits form an important basis for evaluating the continuous process of human differentiation. The information on recurrence of a particular trait interests us a lot, like, what would be the stature of a child born to parents of average stature. The study of human genetics has facilitated for treatment and genetic counseling to prevent recurrence of Down's and other syndromes. Human population genetics using mating pattern as a method contributes in the evaluation of inflow and outflow

of genes which are responsible for evolution. Eugenics forms a fundamental part of physical anthropology responsible towards the improvement of populations.

Growth and development in physical anthropology has its own importance, be it studying secular trends (e.g., increase or decrease of weight in the next generation), stages of growth, growth pattern of a population, factors affecting nutritional status and reproductive biology, population variation, all come under the flagship of physical anthropology.

Recent years have witnessed physical anthropology playing undeniable services in the field of dentistry, medicine and industrial research. This clearly is reflection of the basic fact that whenever human body in part or whole needs any explanation be it the form, functional or age changes, physical anthropology plays a vital role. The scope of physical anthropology in the field of forensic science is noteworthy. The various branches of physical anthropology which facilitates forensic scientist in arriving at conclusion are dermatoglyphics, osteology, osteometry, and serology; somatic and genetic characteristics contributing towards the determination of age and sex. Somatological knowledge plays an important role in interpreting the body types for different sports or even in relation to specific disease.

1.5 HISTORY

Early physical anthropologists pondered about the nature and geneses of human races. Variation in human phenotypes mesmerized them. Way back in the seventeenth century, it was widely accepted by the western scholars that humans belonged to a single species, all descendants of Noah and his family. When they came across so many different looking human beings, it struck upon them the diversity among mankind. This was obviously something they had not imagined. With the advent of 18th century, physical anthropology answered this curiosity with its emergence as the scientific study of race, a response to the presence of so many human types.

The founder of physical anthropology was the German physician Johann Friedrich Blumenbach (1752–1840) of Göttingen; he was also regarded as the inventor of craniology, build up enormous collection of human skulls, and thus had right to be an empirical power on the question of human diversity. According to him, mankind could be divided into five races: American, Caucasian, Ethiopian, Malayan and Mongolian.

The very first impression everyone had, was that all contemporary human races were monogenic, which meant that man's origin was from a single gene. James Cowles Prichard (1786-1848), was of the opinion that, as the descendants of Adam became lighter-skinned they attained higher intellects and civilization. With passage of time, all races would become similar to Western Europeans, the race that in his view had progressed farther or more rapidly. It was in late eighteenth and early nineteenth centuries, the proposal that races were polygenic, that is more than one gene, picked up momentum in the scientific circles of Europe especially France and America. The advocates of polygenism were of the view that the extent of human diversity found could not be attributed to the opponents of polygenism as the variation between the races was too much to be

just a resultant of environmental differences and too great for humanity to be attributed to a single species. Therefore, there must have been many species right from the beginning. This human variation which came into limelight was studied using anthropometric measurements (anthropometry) by a Philadelphia physician and advocate of polygenism, Samuel George Morton (1799-1844), in later nineteenth century.

Anthropological Society of Paris, first in the field of Anthropology, was founded in 1859 by a French surgeon, Paul Broca (1824-1880). He set up an anthropological laboratory the previous year, which subsequently became the Centre for a training program for anthropologists. Broca followed the tradition of Samuel Morton. Most of the activities of these early physical anthropologists could be categorized as racial craniology. Anthropometry took lead and spread from Broca's laboratory to other institutions. It became clearer why polygenism was preferred over monogenism. The polygenists were in a position to make their point more acceptable. Broca emphasised that it was incorrect to attribute the huge diversity in races due to degeneration and also argued that it would be degrading to believe the diversity of racial variation as degeneration from a single superior species.

Paul Broca along with other French physical anthropologists intensified their work on cranial anatomy and other small variations. While the German tradition, led by Rudolf Virchow (1821–1902) stressed on the fact that the variation observed in the human form is a result of environment and disease upon the human body, and the lack of fit among race, nation, and culture. The American tradition focused upon the “pacified” aboriginal (Indian) inhabitants of the North American continent, unearthing and gathering skeletons as scientific objects along with artifacts, languages, and culture.

It was Edward Tyson (1650-1708), a London physician and member of the Royal Society, who started the European primate studies and differentiated between the animal, humans, and monkeys by dissecting a chimpanzee. In fact lot of curiosity was generated among people in primate behaviour despite it most of the early scientific investigations were basically anatomical. Thomas Henry Huxley's in *Man's Place in Nature* (1863) endeavored to apply Darwinism to appreciate the origins of human. Thus Primatology focused on anatomy and look for primate evolution from paleontological record. It was Ernst Haeckel (1834-1919) in Germany who published an encyclopedia of primate anatomy and came up with first scientific phylogenetic trees. It was because of these efforts that made us understand what we are today, with anatomy remaining the focal point until after 1900.

Subsequently, with the advent of nineteenth century, it was anthropometry which came more in limelight by becoming more sophisticated under the patronage of Karl Pearson (1857-1936), co-founder and editor of the journal, *Biometrika*. It goes to the credit of Karl Pearson who treated the measurements of bones and bodies to statistical tests which made the exercise more scientific including computations for variation and correlation, and tests of significance for comparing samples. Physical anthropology was devoted to the study of racial determinism—a philosophy that assumed the superiority of Caucasoids in the last half of the nineteenth century.

It was prevalent in the United States after the Civil War (1861–65) that physical anthropology was a mystique medical speciality. But it was Franz Boas (1858–1942) in 1897, an architect of today's face of physical anthropology who used his expertise in measuring schoolchildren, and collecting Inuit skeletons. Boas also propagated changeability of the human form and minimize race in favor of studying culture.

Ales Hrdlicka (1869–1943), a physician, studied physical anthropology in France, whereas Hooton, a Classics Ph.D from the University of Wisconsin, then entered anthropology as an Oxford Rhodes Scholar, under R. R. Marett, and the anatomist Arthur Keith. In the following decades, Hooton trained most American physical anthropologists under his umbrella: like Harry L. Shapiro and Carleton S. Coon whose input to the discipline is unmatched. As the leading US student of race in the 1930s, Earnest Hooton, a protagonist of race in 1930's, tried to differentiate "good" American physical anthropology from "bad" German physical anthropology. Unaware of the conflict of scientific interpretation, the priceless input towards the field of anthropology continued between Germans and Americans, by Eugen Fischer, Fritz Lenz and Erwin Baur.

Right in the middle of twentieth century in 1951, a Hooton alumnus, Sherwood Washburn rediscovered the field with newer focus in physical anthropology; racial typology studies took a backseat and centre was shifted to the study of human microevolution distancing from classification, emphasising evolutionary process and history. Washburn's anthropology ventured to paleoanthropology and primatology. As a result, current anthropology boasts of diverse methodology to get a more vivid picture of animal behaviour, human genetics and medical anatomy. It has taken several roads of development in recognising physical anthropology and giving it a very enviable position in scientific fraternity.

1.6 BRANCHES AND ITS DEVELOPMENT

The growth of physical anthropology has been unparallel. In its nascent stages, physical anthropology was synonym to taking measurements, compute indices and other statistics. Irrespective of the objectives of study, the methods of observation, measurement and comparison remained same. As a result, the approach at that time was stagnant with thrust on taxonomy. This was because the development of theory was not known at that time and so was genetics. Consequently for number of years, classical Physical Anthropology was considered nothing but anthropometry with assumption that with accurate metric values all the solutions would be there. Precisely for this, an agreement on the techniques of measurement became necessary and thus was attempted.

The significance of measurements and indices was certainly well understood in understanding the extent of variability and development in certain traits. Nevertheless, it does not reveal if all could be put in a single biological category on the basis of some traits. To get clarity on evolution, race and constitution, information on number of factors like cranial forms, pigmentation, somatic structures and growth process is essential, thereby requiring the reorientation of the methodology becoming vital. This necessitated the beginning of the analytical phase, thereby initiating a new outlook in Physical anthropology. The new physical anthropology aims to enhance the knowledge of past by the study of present.

Physical anthropology, often called biological anthropology, as has been mentioned earlier specialises in the physical development of the human body and the human species. Its area of function is large as it involves man. Physical Anthropology can be divided into several branches. Conventionally, physical anthropology meant races and anthropometry. But now with passage of time, many sub-branches have arisen due to vast work done in the quest to know about ourselves. This is a continuous process and new branches are evolving depending upon the nature of field area. Some of these include:

Human Growth and Development: This branch of physical anthropology concerns the process of growing to maturity. In biological terms, it involves growth from a one-cell-zygote to an adult human being. Human growth and development specialises in understanding the different stages of growth, patterns of growth and the effect of nutrition, environment and genetic factors influencing growth. The growth studies of different populations not only reflect variation amongst them but also indicate the growth rate of the nation. There has been tremendous progress in the field of human growth and development since the 1940s. The studies have enabled to establish the norms of bone development, sexual maturation so that congenital, nutritional, and other environmental effects can be detected and utilised clinically in children and adolescents. Another contribution of the field is that global nutritional surveys recognised small adult size to be correlated with dietary insufficiency. It is the endeavor of physical anthropologist to apply anthropometric techniques to the study of aging to have an insight into longevity of certain people.

Human Genetics: Human genetics involves the study of inheritance of genes-unit of hereditary, in human beings. It is the common factor of most human traits. It provides information to questions about human nature, understand the diseases and their effective treatment, and also understand genetics of human life. The information on what are the chances of acquiring a trait like blue eyes or cardiac ailment all can be gathered from human genetics. It incorporates a variety of overlapping fields including: classical genetics, cytogenetics, molecular genetics, biochemical genetics, genomics, population genetics, developmental genetics, clinical genetics, and genetic counseling. In fact the rechristening of physical anthropology to biological anthropology is primarily because of inclusion of human genetics so as to understand Human better.

Primatology: It is basically concerned with the study of primates. Anthropologists hope to gain more insight into human nature by studying primates like apes and monkeys. This branch of physical anthropology encompasses the study of the hominids, (general term used for humans and any member of the species of animal we are most closely evolved from), which include all ape-like ancestors of man and the other great apes. Modern primatology boasts of newer and an extremely diverse science, ranging from anatomical studies of primate ancestors and field studies of primates in their natural habitat, to get intrinsic information, to experiments in animal psychology and ape language. This parameter has generated tremendous information on basic human behaviours and their ancestry.

Human Evolution: This branch, as the name suggests, revolves around the origin and evolution of *Homo sapiens* as a distinct species. The word “human” in the framework of human evolution speak of the genus *Homo*. But then how did humans evolve. In order to understand human evolution we study hominids also

as the study of hominids holds importance. It is important to know other disciplines like primatology, archaeology, linguistics and genetics so as to have a better understanding of human evolution.

Palaeoanthropology: Palaeoanthropology is the study of fossil hominid evidences petrified bones and footprints, encompassing the discipline of paleontology. It also involves human osteology which provides historical support by studying the remains of the human evolutionary lineage. It is amongst the forerunners of the fundamental branches of physical anthropology. Paleoanthropology incorporates many disciplines to enrich our knowledge on human evolution as supported by fossils, artifacts, and their geological and burial sites. They accomplish the task by reconstructing from the fossils found in the excavation, the organism or the individual to whom they could probably have belonged. They must be in know how of human and other primate anatomy and the principles of taxonomy, so as to explain their discovery.

Human Osteology: The study of human bones is termed as Human Osteology. Evidences concerning osteology are frequently applied in forensic science. It holds important information in arenas like health, disease, physique, genetics of early populations, identification of unknown remains, criminal investigations, war crimes, etc.

Human Ecology: Ecology is a biological discipline that deals with the interactions between organisms and their environment. This environment is a sum total of the physical environment including temperature, water availability, wind, soil acidity and biological environment which holds influences on an organism. Human adaptation (physiologic, developmental, and genetic) to environmental stresses and variation is part of human ecology. Human being is the most versatile species on earth which can adapt in any environment, be it extreme climate, deserts, polar region, high altitude or even a marooned island. Human species are distributed world wide well adapted in diverse environment. The human group is an ever-increasing population which in return would involve more consumption of resources; therefore better adoption of the Earth's primary production is need of the hour. However, many other human ecological developments are probable in future. The growth of human population and how this growth is accommodated, the way they utilise these resources yet preserve the biodiversity is yet to be comprehended.

Nutritional Anthropology: This branch of physical anthropology enjoys wide horizons describing how particular social and cultural factor place people at risk for nutritional disorder or identifying health problems related to nutrition. Nutritional Anthropology is gaining importance mainly due to concern and consciousness of people towards health. Anthropologists have contributed to the specialised fields of nutrition at a more holistic perspective, based on the historical, direct observation, and documentary accounts. The significance of this field lies in assessing health status of any population.

Molecular Anthropology: Molecular anthropology is a comparatively newer branch of physical anthropology which deals with the molecular analysis. It makes easier to understand the evolutionary links between ancient and modern human populations, as well as between contemporary species. This enables to determine the closeness or distance in relationship between populations or within

populations. The findings of DNA study of primate phylogeny questions the views of the traditional anthropologist that humans are very different from all other animals. Certain similarities in genetic makeup let molecular anthropologists determine whether or not different groups of people share a common geographical origin. This paves way for anthropologists to trace patterns of migration and settlement, which gives an insight as to how contemporary populations have formed and progressed over time. Molecular anthropology plays a very important role in establishing the evolutionary tree of humans and other primates, including closely related species like chimpanzees and gorillas. This is of vital importance as it aids in searching for common ancestors and thus in understanding of human evolution. The coming up of molecular biology that tracked the cracking of the genetic code fascinated physical anthropologists, interested in knowing the proximity between the humans and the apes, and the relationships of other primates to one another and to other creatures. In fact it is claimed that “molecular clocks” have been unearthed to indicate when species diverged from one another.

Forensic Anthropology: This has been one of the most sought after branches of physical anthropology. The term “forensic” refers to the application of this subfield of science to a court of law. Forensic anthropology is the application of the science of physical anthropology and human osteology in a legal scenario; when in a criminal case, victim’s remains are unidentifiable or in the advanced stages of decomposition, forensic anthropology helps in identification of the individual. The techniques of Forensic anthropology helps to assist in the reconstruction of remains, assessment of age, sex, stature, ancestry, and analyse trauma and disease. Forensic anthropology is witnessing rapid growth and recognition, laurels of which goes to anthropologists whose expertise in criminal evidence (fingerprints, blood types, and skeletal remains) are sought. Forensic anthropologists utilise the proficiency of forensic pathologists, odontologists, and homicide investigators to identify a decedent, discover evidence of trauma, and determine the postmortem interval. Though their opinions are taken into consideration by the medical examiner, yet they do not enjoy the legal authority to declare the official cause of death.

Anthropological Genetics: Genetic methods are used to learn about human in the course of its deviation from apes, the magnitude and how hominid population in geographic area originated and the initial migrations of anatomically modern humans. The field of anthropological genetics encompasses patterns of genetic similarity among different human populations to deduce demographic history, including mating structure, the account of people moving from one place to another and mixing with surrounding groups, and population size fluctuations.

Genetic Anthropology: This is a very new branch of scientific study which deals with combining DNA data with available physical evidence and past histories of civilizations. This facilitates scientists to assemble through existing genetic information in elucidating how the modern day Homo sapiens evolved through the millennia.

Physiological Anthropology: The word physiology is from Greek: “physis” which means nature, origin and “logy” means, study. Human physiology is a scientific study of the mechanical, physical and biochemical functions of humans in good health, their organs, and the cells which constitute them. Physiological basis is at the level of organs and systems within systems. It is strongly connected

to anatomy since anatomy is the study of form, while physiology is the study of function of that form.

Dental Anthropology: This branch engages the scientific study of people including their living and extinct primate relatives, using the evidence of teeth. Practicing dentists, anatomists, radiologists, forensic scientists, biochemists and geneticists, archaeologists, paleontologists and zoologists apart from anthropologists are actively working in the field of Dental anthropology.

Anthropometry: Anthropometry as the name suggests consists of Greek word “anthropos” which means man, and “metry” meaning measure. This branch focuses on the understanding of human physical variation as in literal sense anthropometry refers to measurement of humans, and in physical anthropology, it means measuring of the human individual. Anthropometry plays an extensive role in industrial design, clothing design, defence equipments, ergonomics and architecture. To attain perfection in this endeavor statistical data on the variation in body dimensions in population are taken into consideration. These variations in body size can be attributed to changes in life styles, nutrition and ethnic composition of populations and therefore warranting regular updating of anthropometric data collection.

Ergonomics: Ergonomics is derived from two Greek words, “ergon” meaning work, and “nomoi” meaning natural laws, which means the science of work and a person’s relationship to that work. Ergonomics is fundamentally the study of designing equipment and devices that fit the human body, its movements, and how to carry about the work. Proper ergonomic design is necessary to avoid recurrent strain injuries, which can be hazardous later in life. Ergonomics takes into account designing the furniture and technological knowledge such that it appears to be perfect amalgam of the two. In accomplishing so, it takes into account the user’s competence and restrictions in seeking to make certain that tasks, equipment, information and the environment are appropriate to yield efficient results. Ergonomics comprises number of disciplines like anthropometry, biomechanics, mechanical engineering, industrial engineering, industrial designing, physiology and psychology.

Demography: Demography is the scientific study of uniqueness and movement relevant to the human population illustrated by size, growth rate, density, vital statistics, and distribution of a specified population. Demography gains its significance as it is this field that necessitates the study of precise information that may be collected from a population census or vital statistic records. People who study and record this information are referred to as demographers. Demographers must know both how to scientifically obtain information and then interpret it relatively. Demography is the basic statistics of human population which can be applied to any kind of human population which does not remain static, that is, one that changes over time or space in response to birth, migration, aging and death.

Human Diversity: It is concerned with study of human evolution and human biological variation. Human evolution involves the extensive work on the discovery, analysis, and description of fossilized human remains. This mainly aids to identify the differences between humans and their nonhuman ancestors and how did present man emerge. To achieve this, it involves the comparative

analysis of genetic codes. Studies on human variation among contemporary humans are not only dependent on the concept of race, but on principles of genetics also.

Palaeoprimateology: It is well understood that man is a primate evolved from non-human primates. The nonhuman primates are link to human physical history and status as mammals. They also show the continuity in the similarities to the behaviour and mental abilities of human ancestors as gauged by physical anthropologist. The palaeoprimateologists take the assistance of fossil specimens by collecting, describing and interpreting them phylogenetically and functionally.

Population Genetics: Population genetics concerns the genetic structure of populations, the frequencies of alleles (alternate form of a gene) and its genotypes (genetic constitution). An important branch of physical anthropology, it is related to the process of evolution witnessing natural selection, genetic drift, gene flow and mutation. It is the study of allele frequency distribution and change under the influence of the above mentioned evolutionary processes. Population genetics specialises in the genetic constitution and changes overtime in any population. It also encompasses the study of the forces like mutation, migration and intermixture between the groups which have the capability of altering the genetic composition of any population. This enables us to understand the steps towards biological evolution. It concerns the information of the frequencies of genes, genotypes and phenotypes, and the mating systems.

Human Variation: The term human variation is gaining popularity over its historical predecessor “race” in anthropology because of the exploitation of the term. It is suggested to use gene frequencies and biological traits of human populations by their geographic area. This genotypic and phenotypic detail would be understood in terms of historical and closest selective forces in each environment. Its main thrust is focused in an endeavor to interpret given so much of human diversity, a consequence of evolution through a long passage of time and all around the globe.

1.7 SUMMARY

After going through this unit, you must have understood that various definitions of physical anthropology have been given depending upon the focus at that time. It is rather difficult to give precise definition to physical anthropology as it embraces interdisciplinary approach. The mechanisms of biological evolution, genetic inheritance, human adaptability and variation, primatology and the fossil record of human evolution constitute Physical Anthropology reflecting an important scenario in today’s increasingly specialised world of science. It aims for the physical anthropologists to explore human genetics, growth and development and evolutionary history in an attempt to accurately describe human physical structure both in the present and in the past and also investigate how function and behaviour are integrated into the environment in which human beings live. The scope of this discipline is manifold making it indispensable. We realised that the understanding and assessment of the degree of human variability along with the accounting of factors responsible for our current distribution has been of vital concern. Genetics and anthropometry have been used in estimating the detailed cause of individual variation and diversification of the varieties of man. Human variation, a specialised branch of physical anthropology, currently carries

out studies to facilitate in the understanding of reliable history of the origin and evolution of mankind and its varieties; and attempts to evaluate the reasons of human variation. There are different branches of physical anthropology, each maintaining its thrust area and identity.

It is believed that by now you must have realised how fascinating is the field of physical anthropology. It has witnessed a long painstaking journey in its quest to never-ending desire to know about human. Continuously, physical anthropologists are meticulously working to unearth the mysteries of human beings. It is not that they are working in isolation but amazingly involves varied fields resulting in newer concepts and better understanding which you will encounter in the next unit.

Suggested Reading

Boaz, N.T and Almquist, A.J. 1999. *Essentials of Biological Anthropology*, New Jersey, Prentice Hall.

Harrison, G.A., Weiner, J.S., Tanner, J.M. and Barnicot, N.A.1964. *Human Biology*.Oxford University Press

Harrison, G.A, Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds,V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

Reddy, R. 1992. *Physical Anthropology, Evolution and Human Genetics*. Tirupati, V. Indira.

Sarkar, R.M. 2000. *Fundamentals of Physical Anthropology*. Calcutta, Vidyodaya Library Private Limited.

Shukla, B. R.K. and Rastogi, S. 1999. *Physical Anthropology and Human Genetics- An Introduction*. Delhi, Palka Prakashan.

Stein, P. L. and Rowe, B.M. 1974. *Physical Anthropology*. New York, McGraw-Hill.

Sample Questions

- 1) What is physical anthropology and what are its aims and scope?
- 2) Briefly give the history of physical anthropology.
- 3) What are the different branches in physical anthropology? Give a brief outline of each branch.

UNIT 2 RELATIONSHIP WITH OTHER DISCIPLINES

Contents

- 2.1 Introduction
- 2.2 Interdisciplinary and Trandisciplinary Approaches
 - 2.2.1 Forensic Science
 - 2.2.2 Life Sciences
 - 2.2.3 Medical Sciences
 - 2.2.4 Earth Sciences
 - 2.2.5 Human Biology
 - 2.2.6 Environmental Sciences
 - 2.2.7 Social Sciences
 - 2.2.8 Human Engineering and Technology
 - 2.2.9 Physical Sciences
- 2.3 Summary
 - Suggested Reading
 - Sample Questions

Learning Objectives



Once you have studied this unit, you will be able to understand the:

- meaning of interdisciplinary and trandisciplinary approaches;
- its relevance in physical anthropology; and
- relationship with other disciplines.

2.1 INTRODUCTION

In this unit, it will be our endeavour to know what does interdisciplinary and trandisciplinary approaches mean with reference to physical anthropology. As mentioned in the earlier unit that physical anthropology involves other disciplines too, we will also explore in this unit the relationship of anthropology with forensic science, life sciences, medical sciences, earth sciences, human biology, environmental sciences, social sciences, human engineering and technology, and physical sciences.

2.2 INTERDISCIPLINARY AND TRANDISCIPLINARY APPROACHES

Anthropology is a vast field of study, and hence can be seen in association with numerous other fields. Often divided broadly into two branches, anthropology is either the science that deals with the cultural development, characteristics, social customs or beliefs of humankind referred to as cultural anthropology, or the study of human similarity to or divergence from other animals, their growth, evolution, development etc. named as physical anthropology. Physical anthropology is unarguably not an isolated field but incorporates all the branches

of learning that concerns human. Physical anthropologist often comes in close contact with archaeologists in the cross disciplinary area of Palaeoanthropology which is the study of human evolution through fossils and artifacts. Archaeologists may find a fossilized human skull, but the job of describing and studying the specimen falls in the domain of the physical anthropologist. Or physical anthropologist may find it essential to put together their knowledge of skeletal biology with that of cultural and living contexts that the archaeologists had discovered in order to get a holistic picture of the adaptation of past human populations. Physical anthropologist also studies the behaviour of non-human primates and thereby has close intellectual ties with psychologists. Consequently, it is undisputable that there are some strong connections between physical anthropology and other subdisciplines.

2.2.1 Forensic Science

Let me explain how physical anthropology holds coveted position in forensic science. Physical anthropology has always been an acknowledged area of forensic proficiency at least since 1850. Forensic anthropology is the application of the science of physical anthropology associated to the identification of skeletal material (badly decomposed or otherwise unidentified human remains). Main objective of forensic science is to detect the criminal(s) through the evidence obtained from the crime site by means of the study of various bodily remains. It is in this sphere that physical anthropology plays a pivotal role through its various methodologies by identifying the deceased from insignificant remains. The study of blood types, palm and sole prints provides clues in forensic science. Thus, an association with physical anthropology enables in the detection of crime.

Forensic anthropologists often work in combination with forensic pathologists, odontologists and homicide investigators to identify a deceased, ascertain evidence of foul play, and/or the postmortem interval. In addition to supporting in locating and recovering doubtful remains, forensic anthropologists work to agree on the age, sex, ancestry, stature and unique features of a deceased from the skeleton. Forensic anthropologists are often described as “bone detectives” who assist police unravel intricate cases involving unidentified human remains by validating the identity of the victims of accidents, fires, plane crashes, war or crimes such as murder.

What is the role of physical anthropologist in arriving at a conclusion? What is the role expected of a forensic anthropologist in it? It is well known that forensic anthropology utilise the standard methodical procedures established in physical anthropology to identify human remains, thus assist in the unraveling the mystery of crime. A forensic anthropologist can determine if the person was a male or female by reviewing the pelvis, base of the skull, the forehead and the jaw. To elucidate to you further, males usually have a more noticeable brow ridge, eye sockets, and jaw, whereas women have a broader pelvis. Anthropologists are able to approximate the age of the person by examining the suture closures in the skull, joints, bones and teeth. Likewise, a child's skull has more separation between the bone plates. If the skull is found to be smoother, the indications are that it belongs to older person. Forensic scientists use formulas to establish height based on the length of leg and arm bones. The longest bone in human, the femur, is best for this, but inference can also be made from the metacarpals of the hand. The consideration of wrist development for children under thirteen is another

reliable method of determining age. By and large, the estimation of age works best if the victim is under 30 years when the bones are taken into consideration.

Anthropologists are able to calculate approximately the person's weight by the wear on the bones at certain points. Racial identification is possible by probing the dimensions of the nose-width and height. Facial or head hair, when found with the skeleton, can also assist determine race. To give an example, it is known that Caucasian nasal openings are triangular, Negroid's square and those of Mongoloid's diamond-shaped. Negroid femur bones are also straighter than other racial groups. On examination, Anthropologists can also reflect on the occupation of the person. For example, if the person played an instrument such as a flute or clarinet, the teeth and bones around the mouth will be influenced. A carpenter's or a roofer's teeth might be clipped in front where he seized nails in his mouth. Also the ridge where muscle was attached to the bone reflects the persons' physique.

Physical anthropologist can make out whether the person was right or left-handed. Observe carefully, there would be more muscle attachment on the bones on the dominant side. A physical anthropologist can also be adjudging the injury suffered by the deceased that is if ever the deceased injured or fractured a bone during his lifetime and whether his death was aggressive. All these warning signs can be determined by looking for signs of trauma which could possibly be stab marks, marks on the skull, broken bones, and bullets or pellets in or near the body. A physical anthropologist plays a decisive role in determining the time when the individual died. This is evidenced by the amount of soft tissue that is still present which actually is key to determining the time of death. It is established that the females lose one pound of tissue a day during decomposition; while males loose three pounds a day. Acidic soil hastens decomposition whereas the alkaline soil hinders it. A good number of these such as age, sex, race, and height are class characteristics, but some are individual characteristics such as trauma. Court substantiates other evidences or supplements the authentication of other experts along with forensic anthropological identification, to arrive at their verdict.

Police utilise the expertise of physical anthropologists for facial reconstruction, recreating a face by taking clues from the skeleton to help them identify the deceased. When a physical anthropologist is asked to create a reconstruction, he first deduces as much information from the skeleton, including the most basic and vital information such as age, race and sex.

2.2.2 Life Sciences

There are so many branches of science like biology, medicine, anthropology, or ecology, which are invariably related with living organisms and their organisation such as life processes, and relationships to each other along with their environment. All this can be categorized under one roof that is Life Sciences. It is concerned with all fields of science that engage the scientific study of living organisms, like plants, animals, and human beings. But then, when the study of behaviour of organisms, such as that practiced in ethology and psychology is concerned in these disciplines, it is only included when it involves a clearly biological aspect. There is a very strong relationship between biology and medicine which is the main attraction of the life sciences, at the same time its divergence towards technological progress in molecular biology and

biotechnology has led to rapidly increasing of specialisations and often new interdisciplinary fields.

How human beings originated have caused lot of curiosity and has been an attraction for millennia. This aspect forms a core part of physical anthropology. It occupies a significant issue in many systems of mythological and religious belief; however the systematic scientific study of human origins is rather recent. The seventeenth and eighteenth centuries witnessed the advancement in studies in anatomy. While the scientists began concentrating in organising species into genera and speculating on evolution; the others focused their attention to man's relationship with other animals, especially the primates. This led to the explanation to many questions which have been endorsed to the progress that life sciences have made.

Even though anthropology supplies life sciences with their basic fodders, the stepping stones are laying down the fundamentals of evolution, growth, development, and behaviour which are part of life sciences and strengthens it further.

2.2.3 Medical Sciences

Physical anthropology and medical sciences have close proximity and enjoy a close inter- and trans disciplinary relationship. It is understood that physical anthropology is incomplete and programmatic with its specific branches being in close relationship with medical sciences. Physical anthropology significantly contributes in investigating the nature and extent of various diseases, like whether a concerned disease is hereditary that is running as a family trait or non-hereditary. Not only this but also the growth studies relating to their pattern, growth trends, abnormalities and environmental effects are also assessed by physical anthropologists in the backdrop of medical sciences. Study of anatomy forms an integral part of medical sciences and hence can be said to be the scientific study of the morphology of the human body. Medical science in addition includes subjects like physiology which is the study of function and biochemistry - the study of the chemistry of living structures which are complementary basic medical sciences when applied to the human body. Basically it means that each of the fairly recognised principles from the fields of anatomy, morphology, growth, health, biochemistry and physiology are significant specialties in anthropology. Physical anthropology is concerned with the evaluation of the anatomy of various races of humans. Under its purview also comes the morphological distinction with the help of anthropometric dimensions and genomic diversity which are judged through genetic parameters of anthropology. Medical Sciences with such wide spread field facilitates a framework in anatomical, biochemistry and physiological knowledge which helps anthropology intensively and vice versa.

In the following units you will realise that anthropology can be credited to its own strong theoretical and scientific foundations some of which are by far oriented in medicine. The aim of anthropology is to demonstrate rationally what being specifically human is in the most fundamental physiological functions, with medical science defining the standards. This has led to the origin of a new discipline-Medical Anthropology which incorporates both physical anthropology and medical science.

2.2.4 Earth Sciences

Earth science embraces the study of nature of structural pattern of the earth that throws light on its various land forms, its waters, the air that engulfs it, how the rocks are formed, the different strata of the earth and their formation and also includes the geologic, hydrologic, and atmospheric sciences. The perspective of Earth sciences is to recognise the present features and past evolution of the Earth and to exploit this knowledge, wherever found appropriate, for the benefit of humankind, the basic premise on which physical anthropology is based. It gives us great deal of information about the series of events which occurred in the distant past and through these evidences the oldest forms of life can be known that prospered umpteenth number of years ago on earth. This achievement is possible through the systematic study and analysis of the earth's crusts and different strata of earth bearing fossils as evidence, by employing geological methodology. Not only has it held an invaluable contribution towards the understanding of human evolution, but as well of various cultural stages of man especially when the information on time sequence is crucial.

The physical surroundings which are inhabited by humans include the immediate surface of the solid Earth along with the land beneath it and the water and air above it. The facts of life were of concern to the early man rather than with theories, and thus his survival depended on his ability to get metals from the ground which enabled him in producing alloys, for example, bronze from copper and tin, for tools and armor. He was also concerned to find adequate water supplies for creating dwelling sites, and to predict the weather, which had an immense bearing on human life in earlier times than it has today. These situations correspond to the fundamentals of the three principal disciplines of the modern earth sciences. While physical Anthropologists focuses on the evolution of early man, the earth scientist concentrates on the raw material available to this early man which either helped or slowed down their evolutionary process. Only when one is aware of the marvelous complexity of the Earth, it would be easier to appreciate how the world today is growing with environment around and how humans are adapting to this changing earth. Each in its own premise, both physical anthropology and earth science is a comfortable field and together they emphasise on two important features, yet basic questions as to how did life on Earth begin, and from what did man evolve remains a mystery.

Earth Sciences area of specialisation involves with the geologic history of the earth, study of fossils and the fossil record (paleontology), the growing of sedimentary strata accumulated typically over millions of years (stratigraphy), and the isotopic chemistry and age dating of rocks (geochronology). These provide vital input to anthropology.

Similar to physical Anthropology, the applied aspect of earth sciences deals with practical applications beneficial to society. They engage in the study of fossil fuels (oil, natural gas and coal); oil reservoirs; mineral deposits; geothermal energy for electricity and heating; the structure and composition of bedrock for the setting of bridges, nuclear reactors, roads, dams and skyscrapers and other buildings; risk involving rock and mud avalanches, volcanic eruptions, earthquakes, and the collapse of tunnels; and coastal, cliff, and soil erosion. Most of these would have a direct impact on human beings hence come under global anthropology's focus.

2.2.5 Human Biology

Physical anthropology as you have rightly understood is the study of the biological perspectives of man. Undoubtedly its proximity to biological sciences is natural. Let us see how it works, when we are trying to build up sequence of human evolution, physical anthropologists' basic instinct is to compare the biological features of man and with other animals. Now-a-days human genetics forms the integral part of physical anthropology. The focus of physical anthropology on human heredity, factors relating to growth and development has boosted the field of human biology.

2.2.6 Environmental Sciences

Nature holds no significance without the participation of human, similarly the science of nature is incomplete if it is studied without human involvement. Therefore, it becomes imperative for both disciplines namely ecology and anthropology to take part in the discourse on sustainability of working environment that has human involvement. Environmental science is predisposed to focus on the nature front and to realise the human condition while the anthropological sciences tend to focus on their respective specialties and on "nature" as concept, and then consider ecological reality into account. Environmental science and anthropology as disciplines take into account both the nature and human. They go beyond the dualism of nature-culture to a further holistic outlook on ecological and cultural realities in their inbuilt connectedness with humans. Ecoanthropology is dedicated to a large extent by contributing to the analysis and actions towards such a conversion, by taking both the nature comprising the local environmental management and culture defined as ways of living and of making a living to sustain, which are identifiable with environmental sciences. In view of the fact that it is a discipline that has been exploring both the sides, eco-anthropology has the merit to widen its horizon towards "futures".

Anthropology has its applications for future by exploring the conditions adjoining a civilization's endurance or disintegration with respect to its environments by being appreciative of adaptations, weather, biological, behavioural or cultural in reaction to environment. Environmental sciences point towards the adverse conditions an environment can pose to its inhabitants and while anthropology, in all its genuine concern points out the diversity of outstanding characteristics of life supported by different cultures in different environments. The conservation and understanding of its significance to human life and its endurance and hence continued existence are other issues dealt by both disciplines.

2.2.7 Social Sciences

"Social science" is universally used as a flagship embracing number of fields not in the sphere of the natural sciences whereas Anthropology is the holistic "science of man," - a science of the sum of human existence. Anthropology incorporates different aspects of the social sciences and physical anthropology.

Time and again it has been observed that anthropological social sciences give meaning even to minutest difference in rather than deriving the general laws as found in natural sciences. Not only this, it boasts of explaining individual cases through more general principles, like in many fields of psychology. It is rather difficult for anthropology just as in history to easily fit into one of these categories;

but then different branches of anthropology draw on one or more of these fields which concerns human. Essentially, the main objective of anthropology is to grant a holistic account of humans and human nature which corroborates that although anthropologists usually specialise in only one sub-field the biological, linguistic, historic and cultural aspects of any problem are always kept into consideration.

The quest for holism interested most anthropologists to study people in explicitly, exploiting the biogenetic, archaeological and societal data. This would also take into account direct observation of present-day customs which in turn correlates the close relationship it shares with the social sciences. It is not unjustifiable to believe that all human cultures as part of one large, developing global culture, which is a basic contention of social scientists. These dynamic relationships, between what can be observed on the ground, in contrast to what can be observed by assembling many local observations still remains essential in anthropology, be it cultural, biological, linguistic or archaeological.

2.2.8 Human Engineering and Technology

Human engineering and technology applies techniques to living cells to result in a particular product of superior quality. It is basically taking advantage of the resources for the benefit of mankind. The techniques of anthropometry are intensively utilised in the field of “Human engineering” – a term used by the experimental psychologists and applied engineers working on biomechanical problems. In anthropological sense, human engineering indicates the efforts to design and build modern machines which would suit the person working with these. Human engineering is applied in the jet engines – an important implication. The jet flies at a very high altitude and at such height, human body has a tendency to swell up due to reduced atmospheric pressure. Dr. J.P. Henry, a medical physiologist, invented a one piece ‘jacket’ which had perfect fitting, non-stretch garment with air tubes connected to it. This facilitated the situation when the air pressure dropped, air would be introduced in the spaces within the clothing that assisted in the prevention of muscles from expanding. The unit served the function but there was major size drawback. The necessity was that each suit fit like skin from neck to wrists and ankles, but then there was paucity of anthropological data. Anthropological data came in handy and it was found that stature and weight were best correlated with other bodily dimensions and could become the model for complex fitting garments.

2.2.9 Physical Sciences

The life concerns both the organic and inorganic world; Physical science is the systematic study of the inorganic world. It is different from the study of the organic world which is the sphere of biological science. Physical science by and large comprises of four broad areas: astronomy, physics, chemistry and the earth sciences. Each of these is distinguished and is further in turn divided into fields and subfields. On the other hand, Physical anthropology is a biological science that concerns with the adaptations, variability, and evolution of human beings and their living and fossil relatives that is past and present. Unanimously it has been agreed upon by both physical and biological scientists that technological breakthroughs like DNA splicing, spacecraft docking in outer space, and the development of very small computer chips could not have taken place without an enormous amount of basic research to unearth the laws of nature in physical

2.3 SUMMARY

What an amazing concept interdisciplinary and transdisciplinary approach is especially when physical anthropology is concerned. You just read how the different disciplines join hands and work together for the benefit of mankind and yet maintain their own identity. Is it not incredible the way anthropology projects itself. The unit describes the interdisciplinary relation which involves two or more academic disciplines that are usually considered distinct and also trans-disciplinary; i.e., the research approach that crosses many disciplinary boundaries to construct a holistic approach. The following chapter would enlighten how we apply the knowledge of anthropology in practice.

Suggested Reading

Boaz, N.T and Almquist, A.J. 1999. *Essentials of Biological Anthropology*, New Jersey, Prentice Hall.

Harrison, G.A., Weiner, J.S., Tanner, J.M. and Barnicot, N.A.1964. *Human Biology*, Oxford University Press

Harrison, G.A, Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds, V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

Reddy, R. 1992. *Physical Anthropology, Evolution and Human Genetics*. Tirupati, V. Indira.

Sarkar, R.M. 2000. *Fundamentals of Physical Anthropology*, Calcutta, Vidyodaya Library Private Limited.

Shukla B. R.K. and Rastogi, S. 1999. *Physical Anthropology and Human Genetics- An Introduction* Delhi, Palka Prakashan.

Stein, P. L. and Rowe, B.M. 1974. *Physical Anthropology*, New York, McGraw-Hill.

Sample Questions

- 1) What do you understand by interdisciplinary and transdisciplinary approach?
- 2) Give examples of interdisciplinary and transdisciplinary approaches in physical anthropology?
- 3) Explain the relationship of physical anthropology with special reference to forensic science and medical science?

UNIT 3 APPLIED DIMENSIONS-I

Contents

- 3.1 Introduction
- 3.2 Meaning of Applied Physical Anthropology
- 3.3 Applied Physical Anthropology
 - 3.3.1 Designing Equipment
 - 3.3.2 Forensic Anthropology
 - 3.3.3 Epidemiology
 - 3.3.4 Aging
 - 3.3.5 Sports
 - 3.3.6 Public Health
 - 3.3.7 Nutritional Anthropology
- 3.4 Summary
 - Suggested Reading
 - Sample Questions

Learning Objectives



Once you have studied this unit, you will know:

- the meaning of applied physical anthropology;
- how academic knowledge is applied as applications; and
- the application of physical anthropology in designing equipment, forensic anthropology, epidemiology, aging, sports, public health and nutritional anthropology.

3.1 INTRODUCTION

In this unit, we will first discuss the meaning of applied physical anthropology and how it was initiated. Following this, we will read through the anthropological applications in the fields of designing equipment, forensic anthropology, epidemiology, aging, sports, public health and nutritional anthropology.

3.2 MEANING OF APPLIED PHYSICAL ANTHROPOLOGY

Anthropology has achieved the status of being more than just an academic discipline. The recent years reflect an ever increasing awareness of what anthropology has discovered and can discover. The basic of applied anthropology basis lies in making theoretical anthropological knowledge useful. An applied anthropologist can be qualified in any or all the branches of anthropology. Physical Anthropologist exploits their expertise to design clothes and equipments to fit human body and also enjoy significant role in providing forensic support in court. As the perception of evolutionary biology incorporates both the natural and social sciences, it has also influenced such applied areas as medicine, psychotherapy, education and conservation.

The basic objective of all sciences is to apply the results of scientific knowledge in betterment of mankind. The applied physical anthropology is not something new that needs an introduction. The knowledge gained by physical anthropology has been used for getting practical benefits in diverse fields. But then the application of physical anthropological knowledge is far behind the mammoth contributions made by so many people in this field.

Applied anthropology in the United States came into picture when the anthropologists' worked on disadvantaged people in other cultures and realised the need for their improvement. In fact, today anthropologists are involved in understanding and finding solution to the problems in their own society in an endeavor to improve people's lives. Currently, there is demand for applied anthropologists to progressively increase their participation in earlier stages of planning process and in helping in ventures by solving wide range of issues. With the passage of time, our knowledge in the subject has seen phenomenal increase, and this knowledge has culminated in designing many products for applying it for the benefit and welfare of human use such as airplanes and automobiles.

Physical anthropologists have been active in practical applications of their research for several years. Rudolf Virchow, one of the most prominent 19th century German anthropologists regarded as pioneer of social medicine, founded the public health service in Berlin. French anthropologist, Paul Broca's input to medical treatment of brain disorders is unparalleled. Then with the advent of twentieth century, endless applications of physical anthropological research can be boasted of which vary from designing the dimensions of fighter plane cockpits to assisting apprehending criminals to urban planning. Applied physical anthropology is holistic in approach involving evolutionary, cross-cultural, and comparative and population dimensions.

As you all know, anthropology is a population based biological science and is not restricted to an individual. Whatever results are derived, they are based on statistics and its statements are probabilistic as it involves population which is just too diverse. This aspect of anthropological research is of immense importance for physicians or other health professionals to remember while dealing with anthropological data.

Physical anthropology also concerns evolutionary perspectives and the applied aspect of it can facilitate people to bring their living environment into closer similarity with their biological adaptation as human beings. This has foundation in natural selection proceeding through millions of years of evolution; an ideal fit between human adaptive capabilities and the environment as these have also co-evolved. In the following block, we will learn that natural selection plays significant role in the process of evolution. This evolutionary perspective signifies that human beings are the product of a long process of change that has perfected a certain way of solving problems and getting work done.

The demand for applied physical anthropologists is enormously increasing in government agencies, international development agencies, private consulting firms, business, public health organisations, medical schools, law offices, crime investigations, sports, nutrition and designing equipments.

3.3 APPLIED PHYSICAL ANTHROPOLOGY

The thrust of applied physical anthropology aims to construct an explanatory framework for the many physical and behavioural traits of human species within evolutionary and environmental contexts and to seek ways to maximize their function. Here are some examples illustrating the aforementioned.

3.3.1 Designing Equipment

It is not very easy to design any product or equipment especially when magnitude to the extent of diverse human variation is involved. This warrants the participation of the users, anthropologists and the manufacturers in unison with anthropologists playing very crucial role. This all the more gains importance, particularly when the efficiency of equipment is dependent on human variability. Designs that do not take into account human variations result in poor job performance and waste of time. Earlier equipment was designed without taking into account the physical characteristic of the users. Anthropometry concerned with the measurement of human body plays an enviable role in designing equipment as they provide information on the range and variation in body shapes. This holds significance because it affects the utility of equipment, clothing or work space, significantly in designing automobile seating or aeroplane cockpit where reach or field vision is a critical factor.

One of the most momentous applications of anthropometry is designing of defense equipment which dates back to World War II with the contribution of physical anthropologists as the experts of human anatomy. There has been no looking back after that as anthropometric research has played pertinent role in engineering designing of many technologies right from Jet-fighter ejection seats to analysing human posture in zero gravity on Skylab experiences. Anthropometric data with due credit to its accuracy and reliability has been intelligently applied by anthropologists for Air Force by improving the flying efficiency of the pilots thus saving much money on procurement of large number of pilots. Anthropometric techniques have witnessed its wide usage in defence for better results. For example, a gun turret is designed using scientific principle that any extrusion from an aircraft adds air resistance in such a manner that the gunner has all the free movement of his body needed. This not only reduces their discomfort of long occupancy in a cramped enclosure but also increased efficiency of crewmen, and ensured effective means of escape from an aircraft in emergency. A landmark contribution is reflected in improvising the cock-pit size in different types of air craft and designing of various seat configurations for both fighters and bombers which assisted in reducing cockpit fatigue and discomfort by proper body support.

Another noteworthy application is in flight clothing. Anthropologists have contributed in providing sculptor-carved wooden head forms in four statistically derived sizes: extra-large, large, medium and small to the helmet manufacturers as standards to provide correct size-control. Great deal of physical anthropologist's concern also lies in designing of oxygen masks using set of seven statistical sizes and shapes of sculptured face forms for correct fit. These are not restricted to males but body sizes of females are also taken to procure flight clothing and other garments for service women. The ejection seat and car passenger safety modifications have helped crew accommodation in the space capsules as well as

cockpits and seats of advance fighter aircrafts and automobiles thereby reducing the severity of damage during accidents. Talking of jet engines at high altitudes where the jet flies human body, has the tendency to swell up due to reduced atmospheric pressure. Now in such a scenario, clothing for high altitudes has to be designed in a manner that would prevent muscles from expanding. Using the anthropological technique, it was construed that stature and weight generally yield the highest correlations with other body dimensions and were projected to be diagnostic dimensions for complex fitting garments.

In fact after 1942, anthropometric applications were exploited by other fields of human activities to improve work efficiency by reducing discomfort of people. The design requirements include work space design, clothing and personal equipment design. Workplace design includes designing of any space for human occupancy during work, recreation, rest, education, travel, treatment, etc. The intention behind such designing aims to ensure that there is enough operational work space and proper location of controls, displays and devices for the convenience and efficiency of the operator. Designing of automobile interiors, aircraft cockpit, seating apparatus, doors, tunnels, furniture and kitchen are some of the examples where workplace designing is needed for better results. The measurements required in designing workplace include reach limits, body clearance, eye location, etc. The body measurements that are considered for designing clothing and personal equipment are the circumferences, body contours, limb movements etc. Clothing and personal equipment design includes designing of garments, sportswear, press suits, helmets and gloves, knobs, handles, switches, etc., basically to ensure proper fitting and comfortable movement.

3.3.2 Forensic Anthropology

Forensic anthropology is a specialised branch of physical anthropology that is devoted in solving crimes, attracting increasing attention by the public and an increasing number of practitioners. The term Forensic is a Latin word 'Forensis' which means court of law. The term Forensic Anthropology entails the application of anthropological and medical knowledge to queries of law. This science is used in detection of crime. Forensic anthropology is the largest and very popular applied sub discipline of physical anthropology.

The scope of forensic anthropology as an applied discipline in physical anthropology was recognised by C C Show in 1972. By virtue of the fact that Physical anthropologists study osteology, they would be able to contribute considerably in the field of crime. There are two aspects of Forensic Anthropology which hold importance; they are the identification of decomposed or mutilated bodies and the analysis of skeletal and fragmentary remains. Any evidence left at the site even in an unimportant proportion, finger prints, skeletal remains, teeth, saliva, blood or scratches of skin tissues significantly helps the forensic anthropologists to identify the persons involved. Genetics plays a very vital role for Forensic anthropologists in identifying the victim as well as the culprit. Anthropologists are well versed in racial variations, estimation of stature from broken bones and assessment of understanding postmortem skeletal alterations. These features facilitate the crime investigators in positive identification. The accomplishment by forensic anthropologist can be attributed to new developments in its methodological techniques. Due to this, there is an increasing trend of associating anthropologists in evidence discovery and recovery.

3.3.3 Epidemiology

We all know that health and longevity of every individual to a great deal depends on heredity and environment. Diseases reveal the array of triggering factors right from inheritance of genes to the environment of surroundings they live in, which means that disease can occur due to trait running in the family or the environment a person lives in. The last two decades have seen momentum in the contributions that anthropology may be useful to epidemiological study of health and disease. This can be attributed to rise in chronic, non-infectious diseases as important causes of morbidity and mortality during the 20th century. Chronic (long lasting), non-infectious diseases (disease that may be caused by the environment) are influenced by a number of lifestyle variables. These variables are by themselves strongly influenced by social and cultural factors. The past decade witnessed anthropologists and epidemiologists moving together beyond the “harmless neglect” that characterised their prior relationship. Some of the most important collaborations between epidemiology and anthropology concerns impact of culture change and stress, social stratification and spread of various health risks which have increased immensely. Anthropologists have disapproved and have expanded epidemiological notions of risk and vulnerability. Now involving multidisciplinary approaches, anthropologists and epidemiologists have invented measures to increase the validity and reliability of their results. The working together of anthropologists and epidemiologists due to their specialised field area, ensures more nuanced and accurate descriptions of human behaviour and more appropriate and effective interventions. The involvement of epidemiological techniques is exploited for anthropological ends, because disease often spreads along the framework of social structure.

3.3.4 Aging

The field of gerontology is amazingly diverse, warranting massive number of investigations of physical anthropological issues in aging research. It has been experienced that a good number of gerontology topics of actual and/or potential interest are significantly important to physical anthropologists. It has been observed that the physiological changes of aging include a varied mixture of physical decline as would be expected from an evolutionary model. It has been seen that the studies of the prehistoric aging accounts for the estimation of lifespan, which in no way reflects rate of aging. Recent years have witnessed substantial work relating to body composition and aging. These results give an evidence towards the loss of lean tissue with age and relatively constant, though redistribution of fat mass. Though osteoporosis is one of the major concerns in females due to aging, tooth loss in both sexes is also witnessed. Biological age is found to be associated with lifestyle, economic and nutritional status. These factors can be of significance in divulging cause for variation in rates of aging which in turn would be of vital importance. To answer these and many more potential queries physical anthropologists is the best bet.

3.3.5 Sports

Sports, as history shows, has developed to be part of human culture as recreational activity. We cannot deny the role of cultural aspect in sports, but the biological aspect of human is considerably responsible for the performance in any sporting event. The factors like body size, body proportions, physique and nutrition influence the performance in any sporting event. Most of these traits are acquired

through heredity but they are also influenced by environment to a substantial extent. Human psychological factors like motivation, training and nature also play a vital role in moulding the sportive personality to a large extent. It becomes quite obvious that human biological, cultural and psychological aspects are must to understand the environment of sports, thus laying the foundation for anthropological role in the field of sports.

The study of sports is a specialised sub-discipline in physical anthropology christened as Kinanthropometry. This specialisation of physical anthropology assesses the physical structure of individual in relation to gross motor functions or functioning capacity, taking into account maturation, nutrition and body composition. The term Kinanthropometry was coined by Bill Ross in 1972. It was first considered in Olympic Scientific Congress at Quebec in 1976 prior to Montreal Olympic Games in 1978. UNESCO has been instrumental behind most initiatives for development of Kinanthropometry when it founded an International Working Group on Kinanthropometry at Brasilia, working under the International Council of Sports Science and Physical Education.

There are number of factors that are responsible for the performance of an individual in sports. These factors in turn are dependent on both genetic constitution and environment. However, it is undisputable that genetics has a greater role to play in the formation of a phenotype (observable characters arising out of interaction between gene and environment in an individual). Phenotypic variations in size, physique, body composition, metabolic powers, strength, speed and skill, cardio-vascular adaptations are prevailing forces responsible behind a sportsman's feat. Environment to some extent can shape a genotype by way of training and motivation. The goal of Kinanthropometry focuses on selecting the fit genotypes which help individuals attain their fullest potentialities, that means selecting those individuals who possess genetic constitution which is ideal for a particular sport. It is not just muscular strength that is required for coordinating body movements. But the responsibility of physical anthropologist lies in selecting the players who have better potentialities in a particular sport than others; for training and other external influence can change one's morphological status only within the narrow limits set by genotype. Physical anthropologist can also curtail the financial implications by minimizing the expenditure on individuals who because of their unfavorable anthropometric standards are less fit for a particular sport. Physical anthropologist would exercise his discretion to choose an individual ideal for sporting event. It is rather impossible to alter the capacity of the genotype in order to maintain desirable levels of different bio-chemical determinants. Thus, it is imperative to lay more emphasis on the genetically determined morpho-physiological status of the individual to yield good results. We realise that the techniques of Kinanthropometry enabled the anthropologists to classify humans into different somatotype and suggest the right sport for them. The composition of body plays important morphological characteristics essential for sports. Body composition inclusive of muscular, skeletal, fatty tissues are dependent on the environmental influence, sex, socio-economic conditions, occupations, genetic make-up, nutrition and exercise.

Studies on body composition of sportsman hold significance. It has been deduced that athletes with less fat but heavy muscles perform better in certain competitive sports, while those with substantial amount of fat tissues require increased energy due to inert weight, result in endurance in activities like jumping, running, etc.

Moderate quantity of fat aids performance by providing extra buoyancy and reduction of heat loss in water sports. Apart from physique and body composition, somatotype also plays decisive factor for different sports. This in turn is dependent on flexibility of training, motivation factors and psyche. Physical anthropologist plays a constructive role in designing sports equipment using anthropometric techniques suitable for a particular somatotype.

3.3.6 Public Health

Public health refers to the population or community rather than an individual as its focus. This is a rapidly growing field of research and practice within anthropology. Physical anthropology has followed systematic approach to public health by applying the scientific knowledge at a community level in such a way to be an effective practice. Ecology which involves an interaction of population and environment has also an important role to play since it forms bond between biomedicine with biological and cultural anthropology. This provides a significant path of perception to health and disease as dynamic, adaptive, population-based processes. Public health practice unambiguously seeks to contribute to the creation of global health systems that serve the people. The application of anthropological methods to public health problems has been major area of contribution for health and disease amelioration. The wide range of variation in populations can be used to improve the development and measurement of epidemiologic variables.

3.3.7 Nutritional Anthropology

This field is continuously contributing to the field of nutritional sciences especially in defining the nutritional status of persons by making use of the techniques of anthropometry. This area of defining the nutritional status is quite satisfactory as earlier the methods were highly technical and were looking for an internal agreement for their practical use. The application of anthropology and the underlying conjecture for use of anthropometry in nutritional assessment of population is unquestionable. Undeniably it forms the basis to the fact that although heredity contributes to growth, the genotype is competent enough of its different growth potential in different environment. Thus the induction by introducing the specialised sub-discipline within applied physical anthropology called Nutritional Anthropology. Nutritional anthropometry employs three basic measurements age, weight and height. These three basic values hold importance for physical anthropologists since they compute the indices and compare these indices with reference to population or persons. There are basic indices which exhibit geographical variation, to assess the nutritional status. Nutritional anthropologists have provided indicators in terms of cut-off points to assess nutritional status along with the range for different categories. In recent years, international consensus has been achieved to a large extent for defining the nutritional status of an individual with the help of anthropometry. The contribution of heredity in the growth and development cannot be overlooked, yet it is undisputable that the same genotype is responsible for different growth potentialities in different environments. This is the foundation for using anthropometry in nutritional assessment of populations. The health status of any population all over the world can be evaluated and appropriate health plans can then be enforced.

3.4 SUMMARY

This unit must have made an impression that academic knowledge can be best utilised if we are able to use it practically. The different applied aspects of physical anthropology, right from measurements to suit the equipment and furniture designing, clothes, choice in sports, health status and in the health field, reflect its wide spectrum. It is astoundingly fascinating to bring into practice the knowledge of physical anthropology with other disciplines. This corroboration has done wonders for the benefit of mankind. The unit to follow would take you through the journey of physical anthropology along with genetics and am sure you will realise the wonders of applied physical anthropology in understanding mankind.

Suggested Reading

Boaz, N.T and Almquist, A.J. 1999. *Essentials of Biological Anthropology*, New Jersey, Prentice Hall.

Harrison, G.A., Weiner, J.S, Tanner J.M. and Barnicot, N.A. 1964. *Human Biology*, 1964, Oxford University Press

Harrison, G.A, Weiner, J.S., Tanner, J.M., Barnicot, N.A. and Reynolds, V. 1977. *Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology*. Oxford University Press.

Reddy, R. 1992. *Physical Anthropology, Evolution and Human Genetics*. Tirupati, V. Indira.

Sarkar, R.M. 2000. *Fundamentals of Physical Anthropology*, Calcutta, Vidyodaya Library Private Limited.

Shukla B. R.K. and Rastogi, S. 1999. *Physical Anthropology and Human Genetics- An Introduction* Delhi, Palka Prakashan.

Stein, P. L., and Rowe, B.M. 1974. *Physical Anthropology*, New York, McGraw-Hill.

Sample Questions

- 1) What do you understand by the concept of applied physical/biological anthropology?
- 2) Illustrate the application of physical anthropology in designing equipment, sports and forensic anthropology.
- 3) Epidemiology, nutrition, aging and public health have applied component of physical anthropology. How?

UNIT 4 APPLIED DIMENSIONS-II

Contents

- 4.1 Introduction
- 4.2 Paternity Diagnosis
- 4.3 Genetic Counseling
- 4.4 Eugenics
- 4.5 DNA Technology and Its Use in Disease and Medicine
- 4.6 Summary
- References
- Suggested Reading
- Sample Questions

Learning Objectives



It is expected that after reading, you would be able to understand the following applications of Human Genetics:

- paternity diagnosis;
- genetic counseling and eugenics; and
- DNA technology and its use in disease and medicine

4.1 INTRODUCTION

Genetics is the name given to the study of heredity, the process by which characteristics are passed from parents to offspring, so that all organisms including human beings resemble their ancestors. The central concept of genetics is that heredity is controlled by a vast number of factors called genes, which are discrete physical particles present in all living organisms.

Branches of genetics are microbial genetics, mycogenetics, plant genetics, animal genetics, human genetics, population genetics, cytogenetics, biochemical genetics, molecular genetics, clinical genetics etc.

Since the present unit is on human genetics, the definition of human genetics is presented here. Human genetics is concerned with genetically determined resemblances and differences among human beings. In normal human being, the nucleus of each cell contains 46 chromosomes, which comprises 23 pairs. Of each of these chromosome pair, one chromosome is from father and one chromosome is from mother i.e., only one member of each pair is handed on through the reproductive cell (egg or sperm) to each child. Thus, each egg or sperm has 23 chromosomes (McGraw-Hill Science & Technology Encyclopedia, 2005). Twenty two of the 23 chromosome pairs, i.e., the autosomes, are alike in both the sexes, the other pair comprises of the sex chromosomes. A female has a pair of XX and a male has XY chromosomes. Further, Human Genetics has several applications, like Paternity diagnosis, genetic counseling and eugenics, DNA technology and its use in disease and medicine are discussed below.

4.2 PATERNITY DIAGNOSIS

Paternity Diagnosis helps to establish genetic proof whether a man is the biological father of an individual or not. This paternity test is carried out by using DNA analysis. The DNA analysis through DNA fingerprinting offers a more reliable way to determine the genetic parent. Before DNA fingerprinting came into existence, blood group polymorphisms like ABO, MN and Rh systems were most widely used. But using these blood group polymorphisms, a particular person can be excluded as the parent of a child. The exclusion of parentage can be determined with certainty.

But to determine parentage, DNA analysis is the most advanced and accurate technology. This paternity test compares a child's DNA pattern with that of the alleged father to check for evidence of this inheritance. The DNA fingerprinting technique assures the probability of parents to more than 99.9% if the alleged father is biologically related and the probability is 0% when the alleged father is not biologically related to the child.

Now let us briefly familiarise ourselves with the structure of DNA.

DNA: DNA (Deoxyribonucleic acid) is a chemical structure that forms chromosomes. A piece of a chromosome that dictates a particular trait is called a gene. The structure of the DNA molecule was proposed by James Watson and Francis Crick in 1953. DNA is a polymer (a large molecule containing repeated units) composed of a sugar, phosphoric acid and four nitrogen bases. Two of these nitrogen bases are purines, the other two are pyrimidines. The purines bases are adenine (A) and guanine (G) and the pyrimidine bases are thymine (T) and cytosine (C). The two strands of DNA are connected at each base. Each base will only bond with one other base, as follows: Adenine (A) will only bond with thymine (T), and guanine (G) will only bond with cytosine (C). The structure of DNA is presented below in Fig.4.1.

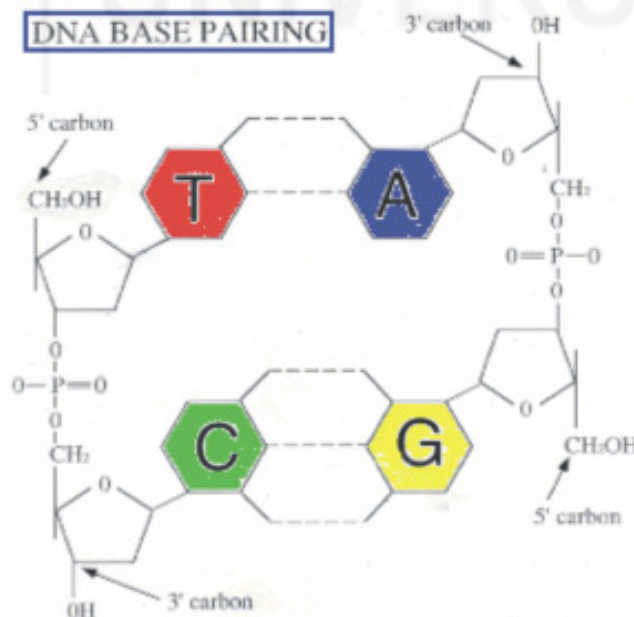


Fig.4.1: DNA Structure

DNA Finger Printing: This is also known as DNA typing or Genetic Fingerprinting.

After knowing the DNA structure, we now briefly familiarise ourselves with the procedure adopted in DNA finger printing:

DNA samples can be extracted from blood, semen, hair roots, bone or saliva. The extracted DNA is then treated with restriction enzymes, which cuts the DNA into smaller fragments by cutting at specific sites. This DNA is then amplified by the technique of Polymerase chain reaction (PCR). By using alkaline chemicals this double stranded DNA splits into single stranded DNA. The DNA fragments are then subjected to agarose gel electrophoresis. The DNA bands so formed are transferred to nylon membrane. This is treated with a radioactively-labelled DNA probe which binds to complementary DNA sequences on the membrane. The excess DNA probe is then washed off. The radioactive DNA pattern is transferred to X-ray film by direct exposure. When developed, the resultant pattern is the DNA finger print.

4.3 GENETIC COUNSELING

Genetic Counseling, as defined by Harper (1984), is “the process by which patients or relatives at risk of a disorder (that may be hereditary) are advised of the consequences of the disorder, the probability of developing and or transmitting it, and the ways in which this may be prevented or ameliorated”. However, the American Society of Human genetics (1975) formulated the definition as “Genetic counseling is a communication process which deals with the human problems associated with the risk of occurrence of a genetic disorder in a family”. This process involves an attempt by one or more appropriately trained persons to help the individual or family to: (i) comprehend the medical facts including the diagnosis, probable course of the disorder, and the available management; (ii) appreciate the way hereditary contributes to the disorder and the risk of recurrence in specified relatives; (iii) understand the alternatives for dealing with the risk of recurrence; (iv) choose a course of action which seems to them appropriate in their view of their risk, their family goals, and their ethical and religious standards and act in accordance with that decision; and (v) to make the best possible adjustment to the disorder in an affected family member and/or to the risk of recurrence of that disorder (Fraser, 1974).

Now let us see how Genetic Counseling is done:

Firstly, it is necessary to identify people suffering from a genetic disease; and this is relatively easy for a trained clinician. But, it is difficult to identify a carrier for genetic disease and in most cases, it is not possible. However, information on the likelihood of an individual being a carrier for a genetic disease can be obtained by the analysis of family pedigree. Thereafter, the prospective parents (either suffering from or suspected to be heterozygous for some genetic disease) are advised about the risk of their would-be children suffering from the same disease. By creating a suitable social environment, such parent may be encouraged to voluntarily abstain from producing children.

Genetic screening

Genetic counseling is essentially a communications process that informs prospective parents about the nature of genetic disorders, about the risk of their

having a genetically defective child, and about the options available to them in dealing with that risk. Or else they can opt to cope with the care of an existing genetically handicapped child. Genetic screening, in contrast, is a routine diagnostic procedure devised to detect those who are carriers of, or who are themselves affected by a hereditary disease. Genetic screening applies to populations rather than to individuals.

The most-widespread application of genetic screening in the United States is for phenylketonuria (PKU). All hospitals in the United States screen newborn babies for PKU by a blood test called Guthrie test.

After genetic screening, if both the parents are heterozygous for a genetic disease and the genotypes of both the prospective parents become known, then it is easier to work out the probability of their child (if they decide to have one) inheriting the disease. This can be done through amniocentesis about two months after conception; i.e., in amniocentesis; the cultured fetal cells are used for determining their karyotype, levels of the critical enzymes and the restriction patterns of DNA. Such an antenatal diagnosis is now available for several genetic diseases and for a variety of chromosomal defects. Such a diagnosis can help the parents to opt for premature termination of abnormal fetus, if they so decide.

Genetic counseling and antenatal diagnosis provides definite relief to the possible parents 'at risk' and thereby reduce the frequency of genetically defective individuals in the population. However, it is unlikely that these measures would eliminate the deleterious alleles from a population. This is so because most genetic defects are recessive and heterozygotes for such alleles. Thus, even after a total ban on reproduction by the homozygotes for such recessive alleles, they would remain in the population through the heterozygotes, therefore, even such an extreme selection would lead to only a slow decline in their frequency. Further, it is not likely that all the couples in any society will willingly submit themselves, at least in the foreseeable future, to these procedures. But genetic counseling has become a routine aspect of medical practice in most developed countries.

It has been advocated that defective genes may be corrected through sophisticated genetic techniques either during the early stages of embryo development (embryo therapy) or in specific tissues of the adult patient (patient therapy); such an approach is referred to as genetic surgery. Embryo therapy involves

- In vitro fertilization of egg
- Production of several copies of the normal allele of the defective gene
- Introduction of this DNA into the zygote or in the cells of the developing embryo and
- Integration of DNA, preferably in place of the defective allele, so that it may function normally.

The aim of patient therapy is to introduce the normal gene into the critical tissue of the patient that is affected by a genetic disease, i.e., the tissue where the concerned gene is required to express itself the most, e.g., pancreas in the case of diabetes. The steps involved in patient therapy are similar to those in embryo therapy. But in this case, cells from the concerned tissues have to be treated in vitro to correct their genetic defects and then reintroduced into the tissue where they may function normally. Techniques for isolation, identification and

multiplication of many human genes are now available, and for many others they are likely to be developed soon. The techniques for gene transfer in eukaryotes are being refined and it may not be a great problem in the near future.

A suggestion has also been made to use highly specific chemical mutagens that will correct the defect in the concerned gene. Such a directed mutagenesis, however, is a dream that may be more difficult to fulfill for the patient and embryo therapies through DNA mediated genetic modifications. Genetic screening and counseling may also lead to certain problems. The cases of mistaken paternity, the problem of confidentiality, delayed counseling are important among them.

4.4 EUGENICS

The term Eugenics was introduced by Francis Galton in 1883. It refers to the improvement of a population by selection of only its 'best' specimens for breeding. This has been practiced both by plant and animal breeders since ancient times. The idea of eugenics was to improve society by screening out and sterilizing people diagnosed as genetically unfit. Those with desirable genes would be given incentives to reproduce. Regardless of the reasons in support of sterilization, restricting an individual's ability to reproduce is viewed as a violation of their constitutional rights. The science of eugenics can also be defined as a science of the well born, improving the inborn qualities of race and obtaining the better heritage of judicious breeding.

Eugenics is of two types, positive and negative:

Positive Eugenics: By encouraging desirable individuals to bear more children and also to produce genetically enhanced children i.e., give them genetic characteristics (genotypes) they ordinarily would not be born with (www.bioethicsanddisability.org). The positive eugenics can be increased by adopting the following measures:

- a) **Encouraging early marriages:** It is a general observation that highly placed persons of the society and those who have high ambitions of the future life devote best part of their youth to achieve ambitious goals. Hence, they get married at a late age. Both, biological and psychological investigations have revealed that the aged persons often lack expressive warmth for the sexual behaviour and their germplasm also lose its strength. Hence, the young persons having the best hereditary traits should be encouraged for early marriages. For this, a few laws should be formulated to avoid the delayed marriages.
- b) **To fund the fit:** Most of the well gifted persons in a society would like to lead a well planned and relaxed life. In order to lead a comfortable life and to avoid unnecessary difficulties in nurturing the children, they wish to have small number of children. Thus, the selected young men and women who have best eugenic value should be encouraged to have more children. H.J.Muller (1890–1967) has suggested that the persons who have best eugenic value should increase their family size. The persons who have best eugenic value besides increasing their family size can otherwise act as father to many more children, and this is possible through artificial insemination. The sperms and eggs of stupendous people should be stored for potential use.

- c) **Fitness and Education:** In a society, the people should be educated about the basic ideology of wellbeing, ecology, human genetics, eugenics and sex. Hence, the children should be properly instructed about basic laws of health and they should be confident to develop a healthy, physically and mentally sound body. The children ignorant about the details of sex may do further harm to the society than others. Therefore, there is a need to have sex education to avoid unwanted behaviour which is not desirable for our country.
- d) **Wastage of germplasm:** By following measures, one can avoid the wastage of best type of germplasm:
 - i) We should select the marriage partners wisely,
 - ii) The nuns and priests, because of religious commitment do not marry. This should be avoided. By allowing these persons to marry, the wastage of the best part of germplasm can be prevented.
- e) **Genetic counselling:** Human being is benefited a lot through genetic counselling. The nature of mutant condition must be informed to the concerned persons. This is the duty of the genetic counselor to enlighten the affected persons. After knowing the problem, the probability of producing affected offspring can be calculated provided it is inherited in a Mendelian fashion. The ultimate judgment of taking a risk is exclusively the accountability of the person concerned.
- f) **Ecological surroundings and their improvement:** To improve eugenically better persons, heredity and environment have played the most important role. Therefore, every individual in society should get better food, good existing circumstances, proper education and health assistance etc., so that his or her genetic behaviour may have the best improvement. This will help in producing fertile offspring.
- g) **Encouraging of genetic research:** The existing knowledge on genetic diseases is not enough as we still have minute information on different human diseases. Hence, further research in the field of cytogenetics should be increased so that we can learn more and more about the man. Therefore, genetic research must be encouraged.

Negative Eugenics: Faulty germplasm from the people can be eliminated with the help of following measures:

- i) **Sexual disconnection:** Colour blindness, night blindness, hemophilia, etc. are some of the sex-linked diseases possessed by the defective persons and these may be regulated by dominant or recessive genes. The defective traits in the population can be checked by sexual disconnection and keeping them away and separated from the public.
- ii) **Sterilization of the defective:** Persons who have defective traits may be advised to go for sterilization. Through sterilization, without disturbing any of his usual functions, we can withdraw a person from his power of reproduction.
- iii) **Immigration and its control:** The unwanted or faulty genes of different races and nationalities may intermingle with the normal germplasm of the people during immigration. The persons with unwanted hereditary traits must not

be permitted to migrate from one place to another. Some laws should be formulated to control the immigration of those persons who have defective genetic traits.

- iv) Marriage regulation: The affluent or well placed persons (who, still, may have numerous faulty genetic characters), are more favored for marriages than those who have eugenically sound hereditary traits but have no money. Because of not having money the eugenically sound persons agree for marriage with the genetically defective people. These people fail to reach the uppermost status in the society due to lack of opportunities.

4.5 DNA TECHNOLOGY AND ITS USE IN DISEASE AND MEDICINE

Recombinant DNA (rDNA) technology, also known as genetic engineering, involves artificial modification of the genetic constitution of a living cell by introduction of foreign DNA through experimental technique. The DNA technology has made a significant contribution in the prevention, diagnosis and treatment of diseases. A few of the applications of recombinant DNA are discussed below:

- i) DNA Probes: DNA probes are short segments of DNA that distinguish corresponding sequences in DNA and hence permit recognition of specific DNA sequences. This technique is mainly helpful in diagnosis. DNA probes can hybridize with specific DNA sequences and permit the recognition of specific parasites. Probes resultant by recombinant DNA methods are extensively used in prenatal detection of disease: for example, in detecting genetic disorders like cystic fibrosis, Huntington disease, sickle-cell anemia etc. In a few cases, probes resultant from the gene itself is used and, in extra cases, restriction fragment length polymorphisms genetically associated to the disease gene are engaged. If the disease gene itself, or a region close to it in the chromosome, differs from the normal chromosome in the positions of one or more cleavage sites for restriction enzymes, then these differences can be detected with southern blot i.e. with the use of cloned DNA from the region as the probe. The genotype of the fetus can, therefore, be determined since the restriction fragments present in its DNA. These techniques are very responsive and can be carried out as soon as tissue from the fetus-or still from the placenta – can be obtained. DNA probes have been developed for Leishmania, Trypanosoma, plasmodium, Schistosoma, Wuchereria and some additional human parasites. DNA probes can also be used to recognise viruses which were previously hard to culture.
- ii) Gene Therapy: The hereditary disease in particular can be treated with Gene therapy. Gene Therapy is the insertion of genes into an individual's cells to treat a disease. Gene therapy normally aims to supplement a faulty mutant allele with a functional one. In the majority gene therapy studies, a normal gene is inserted into the genome to supplement an abnormal disease causing gene. A carrier, called a vector, must be used to deliver the therapeutic gene to the patient's target cells. Presently, the most widespread vector is a virus that has been genetically changed to carry normal human DNA. The vector unloads its genetic material containing the therapeutic human gene into the

target cell. The creation of an efficient protein product from the therapeutic gene restores the target cell to a normal state.

- iii) **Production of hormones and Proteins:** Using DNA technique, the genes responsible for the production of hormones and proteins can be introduced into bacteria by vectors. These genetically changed bacteria produce greater amounts of these substances. The hormones like insulin, human growth hormones, somatostatin, erythropoietin etc. are being produced using this DNA technique. The most important application of genetic engineering is the production of large quantities of particular proteins that are otherwise hard to acquire. Urokinase, are industrially produced today using this DNA technique.
- iv) **Production of vaccines:** The conventional vaccines are inactivated germs or their antigens. There is always a danger of contamination to use such kind of vaccines. However the synthetic vaccines are produced by separation of pure antigens using mono-clonal antibodies. These are specific antibodies produced by Lymphocytes when they hybridize with the concerned cell. The resulting hybridoma (of Lymphocyte and the cell) can produce antibodies constantly. In diagnosis, therapy and also in prevention such antibodies can be used. Synthetic vaccines can also be produced by transferring genes for certain antigens into bacteria. Bacteria produce antibodies in large quantities which can be used as vaccines. The vaccine for Hepatitis virus is manufactured in this manner.
- v) **Diagnosis of Infectious Diseases:** Several diseases are diagnosed by conducting definite tests. The diseases like TB and cancer are being diagnosed using Recombinant DNA technology. The other diseases like measles, small pox and hepatitis can also be diagnosed through these tests. In the diagnosis process, certain pathogens are isolated and identified, and then diagnostic kits are produced (when the genome of the specific pathogen is known to kill it or block its pathogenic activity).

This DNA technique is also used in the diagnosis of AIDS diagnosis, prenatal diagnosis, understanding the molecular basis of diseases like sickle cell anaemia, thalassemia, familial hypercholesterolemia and cystic fibrosis.

4.6 SUMMARY

Genetics is primarily concerned with the understanding of biological properties that are transmitted from parents to offspring. Human genetics is the study of the inherited characters of human beings. The applications of human genetics are many; for instance, paternity diagnosis, genetic counseling, eugenics, DNA technology in disease and medicine. DNA profiling popularly known as DNA fingerprinting is used to establish paternity and distant relationship by tracing their ancestors. Genetic counseling is a process that seeks to assist affected individuals and other individuals at risk of getting an inherited condition; it also helps to understand the nature of the genetic disorder, its transmission and the options available for their management and family planning. Eugenics deals with the application of the laws of genetics for the improvement of human race. The recombinant DNA technology has revolutionized modern biology. It is used in the efficient production of useful proteins, derivation of DNA probes for diagnosis

and in the production of vaccines. Gene therapy is another important application of human genetics, which is useful in introduction of functional genes in individuals suffering from non-functioning of some of their genes. Some infectious diseases, AIDS diagnosis, prenatal diagnosis, molecular basis of diseases, like sickle cell anaemia, thalassemia, familial hypercholesterolemia and cystic fibrosis are also diagnosed through this DNA technique.

References

Fraser, F.C. 1974. Excerpts from “*Genetic Counseling*”. The American Journal of Human Genetics 636-659.

McGraw-Hill Science & Technology Encyclopedia Human Genetics. 2005. Accessed on April 26, 2011.

www.bioethicsanddisability.org accessed on April 18, 2011.

Suggested Reading

Cederbaum, S.D. 1984. *Recombinant DNA in Medicine*. West J Med. 141:210-222

Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. 1993. *An Introduction to Genetic Analysis*. USA W.H. Freeman and Company.

Gupta, V., Singh, J., Bala, R. and Magazine, R. 2003. *Recombinant DNA Therapy in Medicine*. JK practitioner. 10:315-318.

Hartl, D.L. *Basic Genetics*. 1991. Boston, USA Jones and Bartlett Publishers.

Mueller, R.F, Young, I.D. Emery's. 1995. *Elements of Medical Genetics*. New York and London. Churchill Livingstone.

Thompson, J.S. and Thompson, M.W. 2005. *Genetics in Medicine*. Philadelphia and London. WB Saunders Company.

Verma, P.S. and Agarwal, V.K. 1999. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. New Delhi. S. Chand company Ltd.

Uhlmann, W.R, Schuette, J.L and Yashar, B.M. 2009. *A Guide to Genetic Counseling*. New Jersey. Wiley-Blackwell.

Sample Questions

- 1) Define Human Genetics and briefly discuss the applications of Human genetics
- 2) What is DNA Finger Printing? Explain its application in Paternity Diagnosis.
- 3) What is genetic counseling? Explain its process
- 4) Write a note on DNA technology in disease and medicine
- 5) Write short notes on the following
 - a) Eugenics
 - b) DNA Finger printing
 - c) Genetic counseling