SPPY 101/SPPC 101

POSTGRADUATE COURSE

M.Sc. - Psychology /
M.Sc., Counselling Psychology

FIRST YEAR

FIRST SEMESTER

CORE PAPER - I

ADVANCED GENERAL PSYCHOLOGY - 1

INSTITUTE OF DISTANCE EDUCATION

UNIVERSITY OF MADRAS

M.Sc. Psychology /
M.Sc., Counselling Psychology

CORE PAPER - I
ADVANCED GENERAL PSYCHOLOGY-1

FIRST YEAR - FIRST SEMESTER

WELCOME

Warm Greetings.

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I invite you to join the CBCS in Semester System to gain rich knowledge leisurely at your will and wish. Choose the right courses at right times so as to erect your flag of success. We always encourage and enlighten to excel and empower. We are the cross bearers to make you a torch bearer to have a bright future.

With best wishes from mind and heart,

DIRECTOR i/c

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M.A. DEGREE COURSE

FIRST YEAR

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Core Paper - I

ADVANCED GENERAL PSYCHOLOGY - I

SYLLABUS

Objectives: This paper enables students to learn psychological processes in detail and to appreciate different approaches to psychological processes.

UNIT –I:

Definition of psychology: Sub-fields of psychology – Experimental, Biological, Personality, Social, Clinical and Counseling, Development and quantitative psychology - Methods in psychology –Survey, Case Study, Naturalistic, Observation, Experiment.

UNIT – II:

The Nervous system: Communication in the Nervous system and interaction between neuron - Neurotransmitters and its functions - The Spinal cord and its functions - the Brian and its functions -

UNIT-III:

The five senses – its characteristics - Definition of perception - Features of perception - Approaches to perception - Constructional view of perception- Ecological view of perception -Psychophysics. Attention – Determinants of attention - Selective, focused and divided attention.

UNIT –IV:

Definition of Learning - Classical Learning - Instrumental and perant conditioning Learning - Observational Learning - Cognitive Process in Learning.

UNIT –V:

Types of Memory – Stages of Memory – Sensory Memory – Short-term Memory and Long-term Memory – Causes of forgetting – Constructing Memory – Improving Memory.

Reference

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M.A. DEGREE COURSE

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Core Paper - I

ADVANCED GENERAL PSYCHOLOGY - 1

SCHEME OF LESSONS

LESSON 1
INTRODUCTION TO PSYCHOLOGY

INTRODUCTION

Psychology interests people because it asks questions that virtually every aspect of human life. Psychology also affects human lives through its influence laws and public policy. Because psychology affects so many aspects of human life, even people who do not intend to specialize in it need to know something about this dynamic field. In this lesson the meaning of psychology and its major subfields are explained briefly.

LEARNING OBJECTIVES

After completing this lesson you will be able to understand

- the definition of psychology
- the fields of psychology.
- the subfields of psychology

PLAN OF THE LESSON

1.1 Definition of Psychology

The word “psychology comes from the Greek words “psyche , meaning life, and “logos, meaning explanation. Psychology is literally the study of the mind or soul, and people de?ned it that way until the early 1900s. Around 1920, psychologists became disenchanted with the idea of studying the mind. The reason why is that, first, research deals with what we observe, and the mind is unobservable. Second, talking about “the mind” implies it is a thing or object. Mental activity is a process. It is not like the river but like the ?ow of the river; not like the automobile but like the movement of the automobile. Beginning in the early 1900s, psychologists de?ned their ?eld as the study of behavior. So for a compromise, psychology is defined as the systematic study of behavior and experience. Psychology is concerned with the experience and behaviour of the individual. Behaviour is the expression of experience, which belongs to a subject, and which is due to the interaction of subject and object. It implies the duality of subject and object. If there were no subject and object, there would be no experience.

Therefore, Psychology is defined as the scientific study of human behaviour and mental processes. The word human behavior means everything that we do and that can be observed directly. Mental processes refers to the thoughts, feelings, and motives that are not directly observable. Since psychology is a science, systematic methods are used to observe, describe, predict, and explain behavior.

1.2 Fields of Psychology

Psychology is a huge, diverse ?eld that is difficult to summarize. Nevertheless, let’s start with three of the most general statements about psychology. “It Depends.” Hardly anything is true about the behavior of all people at all times. Almost every aspect of behavior depends on age. Behavior also varies with people’s genetics, health, past experiences, and whether they are currently awake or asleep. In some ways, behavior differs between males and females or from one culture to another. Some aspects depend on the time of day, the temperature of the room, or how recently someone ate. The way people answer a question depends on exactly how the question is worded, what other questions they have already answered, and who is asking the question. When I describe “it depends” as a general truth of psychology, you may think I am suggesting that psychology has no real answers. On the contrary, “it depends” is a serious point. The key is to know what it depends on.

Psychology as a field of enquiry has grown in many directions, during its journey for more than hundred years. In contemporary times a number of specialized fields which focuses on the area of application have developed. The emergence of different fields in psychology indicates the importance and relevance of these areas in our daily life.

During the 20th century, the focus of psychology was on solving psychological problems, such as mental disorders and social disturbances. Generally, psychologists were associated with the changing of bad behaviors and problematic mental processes; however, psychologists also study and work with psychologically healthy people.

1.3 Subfields of Psychology

Psychology is a meeting ground for different disciplines. Association for Psychological Science president John Cacioppo (2007) described psychology as a hub scientific discipline. The tribe of psychology is united by a common quest: describing and explaining behavior and the mind underlying it through their diverse activities, from biological experimentation to cultural comparisons. Thus, it’s a perfect home for those with wide-ranging interests.

A person with an undergraduate degree in psychology will be able to apply the knowledge of behaviors and mental processes to a variety of job possibilities in business, service areas, and research. However, having a graduate degree in psychology expands job opportunities and options. A student considering graduate studies in psychology has many areas of specialization from which to choose. Psychology’s main fields include basic research, applied research, clinical science and its applications.

Psychology's subfields encompass basic research (often done by biological, developmental, cognitive, personality, and social psychologists), applied research (sometimes conducted by industrial/ organizational psychologists), and clinical science and applications (the work of counseling psychologists and clinical psychologists).

Some psychologists conduct basic research that builds psychology’s knowledgebase.

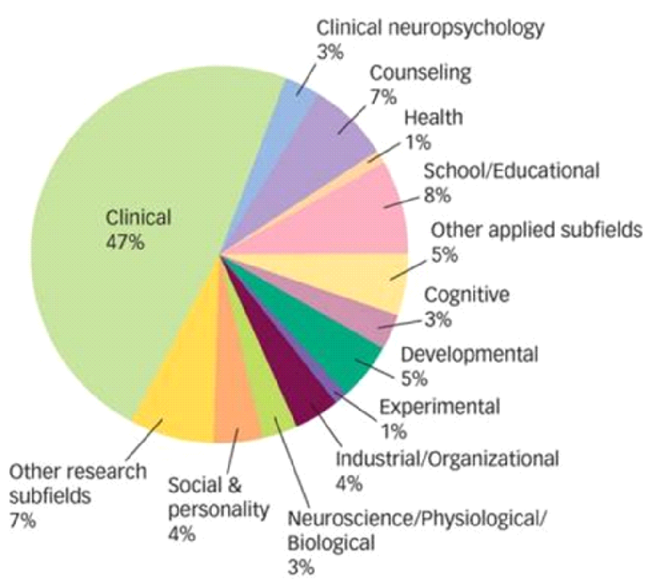
- biological psychologists explore the links between brain and mind.
- developmental psychologists studying our changing abilities from womb to tomb.
- cognitive psychologists experimenting with how we perceive, think, and solve problems.

- personality psychologists investigating our persistent traits.
- social psychologists exploring how we view and affect one another.

These psychologists also may conduct applied research that tackles practical problems. So do other psychologists, including industrial/organizational psychologists, who use psychology's concepts and methods in the workplace to help organizations and companies select and train employees, boost morale and productivity, design products, and implement systems.

Psychology is also a helping profession devoted to such practical issues as how to have a happy marriage, how to overcome anxiety or depression, and how to raise thriving children. As a science, psychology at its best bases such interventions on evidence of effectiveness.

Counseling psychologists help people to cope with challenges and crises (including academic, vocational, and marital issues) and to improve their personal and social functioning. Clinical psychologists assess and treat mental, emotional, and behavior disorders (APA, 2003). Both counseling and clinical psychologists administer and interpret tests, provide counseling and therapy, and sometimes conduct basic and applied research. By contrast, psychiatrists, who also often provide psychotherapy, are medical doctors licensed to prescribe drugs and otherwise treat physical causes of psychological disorders. Let us see each subfield in detail. It is easy to understand the subfields of psychology if you look at some of the basic questions about behaviour that they address.



Diagrametic representation of subfields of psychology

1.3.1 Biological Psychology:

In the most fundamental sense, people are biological organisms. Biological psychology is the study of the biological substrates of behavior and mental processes. Biological psychology is also known as behavioral neuroscience. Behavioral neuroscience is the subfield of psychology that mainly examines how the brain and the nervous system—but other biological processes as well—determine behavior. Thus, neuroscientists consider how our bodies influence our behavior. For example, they may examine the link between specific sites in the brain and the muscular tremors of people affected by Parkinson's disease or attempt to determine how our emotions are related to physical sensations.

This sub field of psychology, the biological psychology includes different specialties like physiological psychology, cognitive neuroscience and neuro psychology. Physiological psychologists study the neural, genetic, and cellular mechanisms that underlie specific behaviors such as learning, memory and fear response susing animal models, typically rats. Cognitive neuroscientists study the psychological processes in humans by investigating the neural correlates of the psychological processes using neural imaging tools. Neuro-psychologists determines the specific characteristics and the extent of cognitive deficits due to brain damage or disease by conducting psychological assessments.

1.3.2 Clinical Psychology:

Clinical psychology is the study and application of psychology to understand, prevent, and relieve psychologically based distress or dysfunction and also helps to promote subjective well-being and personal development. Though clinical psychologists engage in research, teaching, consultation, forensic testimony, program development and administration, its main focus is, psychological assessment and psychotherapy. Clinical psychologists promote psychological health in individuals, groups, and organizations.

Some clinical psychologists specialize in specific psychological disorders. Others treat a range of disorders, from adjustment difficulties to severe psychopathology. Clinical psychologists might engage in research, teaching, assessment, and consultation. Some hold workshops and lectures on psychological issues for other professionals or for the public. Clinical psychologists work in a variety of settings, including private practice, mental health service organizations, schools, universities, industries, legal systems, medical systems, counseling centers, government agencies, and military services.

To become a clinical psychologist, you will need to earn a doctorate from a clinical psychology program. The APA sets the standards for clinical psychology graduate programs, offering accreditation (official recognition) to those who meet their standards. Clinical psychology is primarily concerned with diagnosis and treatment of various psychological disorders. Clinical psychologists are trained in psychotherapeutic techniques, using which they treat people suffering from psychological disorders. Mild problems pertaining to adjustment in social and emotional life are handled by counseling psychologists.

Counseling psychologists help people adjust to life transitions or make life-style changes. This field is very similar to clinical psychology, except that counseling psychologists typically help people with adjustment problems rather than severe psychopathology. Like clinical psychologists, counseling psychologists conduct therapy and provide assessments to individuals and groups. Counseling psychologist, would emphasize the clients' strengths, helping clients cope during a transitional time using their own skills, interests, and abilities. Counseling psychologist also provides specialized services to deal with marital problems, stress oriented problems and career choice. Clinical-neuro psychologists focus on the clinical management of patients with brain.

Clinical psychology is considered as a regulated mental health profession in many countries. Clinical psychologists perform their work using several therapeutic approaches, all of which involve a formal relationship enclosed by professional and client (usually an individual, couple, family, or small group). To form a therapeutic alliance, to explore the nature of psychological problems, and encourage the new methods of thinking, feeling, or behaving, the therapeutic approaches and practices are associated with different theoretical perspectives and employ different procedures.

Four major theoretical perspectives generally employed are psychodynamic, cognitive behavioral, existential–humanistic, and systems or family therapy. With an increased understanding of issues concerning culture, gender, spirituality, and sexual orientation, the integration of the different therapeutic approaches are on the rise. With the advent of more robust research findings concerning psychotherapy, there is proof that most of the major therapies are in relation to equal effectiveness, with the key common element being a strong therapeutic alliance. Because of this, more training programs and psychologists are now adopting an eclectic therapeutic orientation.

1.3.3 Health Psychology:

Health psychologists are researchers and practitioners concerned with psychology's contribution to promoting health and preventing disease. As applied psychologists or clinicians, they may help individuals lead healthier lives by designing, conducting, and evaluating programs to stop smoking, lose weight, improve sleep, manage pain, treat associated psychosocial problems with chronic and terminal illness, or prevent the spread of sexually transmitted infections. As researchers and clinicians, they identify conditions and practices associated with health and illness to help create effective interventions. In public service, health psychologists study and work to improve government policies and health-care systems. Health psychologists are employed in hospital, medical school, rehabilitation center, public health agency, college or university, or, if they are also a clinical psychologist, in private practice.

1.3.4 Experimental Psychology:

Experimental psychologists are a diverse group of scientists who investigate a variety of basic behavioral processes in research involving humans and/or other animals. Prominent areas of study in experimental research include comparative methods of science, motivation, learning, thought, attention, learning, memory, perception, and language. Most experimental psychologists identify with a particular subfield such as cognitive psychology, depending on their area of study. It is also important to note that the experimental method for conducting research studies is not limited to the field of experimental psychology, as many other subfields rely on experimental methodology to conduct studies. Experimental psychologists work in an academic setting, teaching courses and supervising students' research in addition to conducting their own research using experimental methodology. Or they might be employed by a research institution, zoo, business, industry affiliate, or government agency.

1.3.5Cognitive Psychology:

Cognitive psychologists study thought processes and focus on such topics as perception, language, attention, problem solving, memory, judgment and decision making, forgetting, and intelligence. Recent areas of research interest include designing computer-based models of thought processes and identifying biological correlates of cognition. As a cognitive psychologist, you might work as a professor, industrial consultant, or human factors specialist in an educational or business setting.

Adherents of cognitive psychology argue for an information processing model of mental function, informed through functionalism and experimental psychology. On a broader level, cognitive science is an interdisciplinary enterprise of cognitive psychologists, cognitive neuroscientists, researchers in artificial intelligence, linguists, human–computer interaction, computational neuroscience, logicians and social scientists. Computational models are sometimes used to simulate phenomena of interest. Computational models give a tool for studying the functional organization of the mind whereas neuroscience gives measures of brain activity.

1.3.6 Developmental Psychology:

A baby producing her first smile . . . taking his first step . . . saying its first word. These universal milestones in development are also singularly special and unique for each person. Developmental psychology studies how people grow and change from the moment of conception through death. It seeks to understand how people come to perceive, understand, and act within the world and how these processes change as they age.

Developmental psychologists conduct research in age-related behavioral changes and apply their scientific knowledge to educational, child care, policy, and related settings. Developmental psychologists investigate the changes across a broad range of topics, including the biological, social, psychological, and cognitive aspects of development. Developmental psychology informs a number of applied fields, including educational psychology, school psychology, child psychopathology, and gerontology. The field also informs public policy in areas such as education and childcare reform, maternal and child health and attachment and adoption. You would probably specialize in behavior during infancy, childhood, adolescence, or middle or late adulthood. Your work setting could be an educational institution, day-care center, youth group program, or senior center.

Developmental psychologists do this by focusing on cognitive, affective, moral, social, or neural development. To study children, researchers uses a number of unique research methods to create observations in natural settings or to engage them in experimental tasks. These tasks may include games and activities that are both enjoyable for the child and scientifically useful, and researchers have even devised clever methods to study the mental processes of infants. In addition to studying children, developmental psychologists also study aging and processes throughout the life span, especially at other times of rapid change (such as adolescence and old age). Developmental psychologists draw on the full range of psychological theories to inform their research.

1.3.7 Educational and school Psychology:

Educational psychologists mainly focuses their study on how humans learn in educational settings, the effectiveness of educational interventions, the psychology of teaching, and the social psychology of schools as organizations. The work of child psychologists such as Lev Vygotsky, Jean Piaget, Bernard Luskin, and Jerome Bruner has been influential in creating teaching methods and educational practices.

Educational psychologists study the relationship between learning and our physical and social environments. They study the psychological processes involved in learning and develop strategies for enhancing the learning process. As an educational psychologist, you might work in a university—in a psychology department or a school of education. Educational psychologists conduct basic research on topics related to learning or develop innovative methods of teaching to enhance the learning process. They also design effective tests including measures of aptitude and achievement. They are employed by a school or government agency or charged with designing and implementing effective employee-training programs in a business setting.

This field of psychology is mainly concerned with academic performance. It studies the role of various factors which influence learning processes in classroom setting. It focuses on assessing the aptitude, skills and intellectual potential of the students and evaluating their performance. An educational psychologist also helps students to overcome learning difficulties. Educational psychology is incorporated in teacher education programs in places such as North America, Australia, and New Zealand.

School psychologists are involved in the assessment of and intervention for children in educational settings. School psychologists combines principles from educational psychology and clinical psychology to understand and treat students with learning disabilities; to foster the intellectual growth of gifted students; to facilitate pro-social behaviors in adolescents; and otherwise to promote safe, supportive, and effective learning environments.

School psychologists are trained in educational and behavioral assessment, intervention, prevention, and consultation, and several have extensive training in research. They diagnose and treat cognitive, social, and emotional problems that may negatively influence children's learning or overall functioning at school. A school psychologist collaborate with teachers, parents, and administrators, making recommendations to improve student learning. They may also work in an academic setting, a federal or state government agency, a child guidance center, or a behavioral research laboratory.

1.3.8 Evolutionary Psychology:

Evolutionary psychology considers how behavior is influenced by our genetic inheritance from our ancestors. The evolutionary approach suggests that the chemical coding of information in our cells not only determines traits such as hair color and race but also holds the key to understand a broad variety of behaviors that helped our ancestors survive and reproduce. Evolutionary psychology stems from Charles Darwin's arguments in his groundbreaking 1859 book, On the Origin of Species. Darwin suggested that a process of natural selection leads to the survival of the fittest and the development of traits that enable a species to adapt to its environment.

Evolutionary psychologists take Darwin's arguments a step further. They argue that our genetic inheritance determines not only physical traits such as skin and eye color but certain personality traits and social behaviors as well. For example, evolutionary psychologists suggest that behavior such as shyness, jealousy, and cross cultural similarities in qualities desired in potential mates are at least partially determined by genetics, presumably because such behavior helped increase the survival rate of humans' ancient relatives (Buss, 2003; Sefcek, Brumbach, & Vasquez, 2007). Although they are increasingly popular, evolutionary explanations of behavior have stirred controversy. By suggesting that many significant behaviors unfold automatically, because they are wired into the human species, evolutionary approaches minimize the role of environmental and social forces. Still, the evolutionary approach has stimulated a significant amount of research on how our biological inheritance influences our traits and behaviors (Begley, 2005; Buss, 2004; Neher, 2006).

Evolutionary psychologists study the psychological traits—such as memory, perception, or language—from a modern evolutionary perspective. It seeks to identify which human psychological traits are evolved adaptations, that is, the functional products of natural selection or sexual selection. From the point of evolutionary psychologists, the recurrent problems in human ancestral environments are solved through the evolution of psychological adaptations. Through focusing on the evolution of psychological traits and their adaptive functions, it offers complementary explanations for the mostly proximate or developmental explanations urbanized through other areas of psychology (that is, it focuses mostly on ultimate or "why?" questions, rather than proximate or "how?" questions).

1.3.8.1 Behavioral Genetics:

Behavioral genetics is another rapidly growing area in psychology which focuses on the biological mechanisms, such as genes and chromosomes, that enable inherited behavior to unfold. Behavioral genetics seeks to understand how we might inherit certain behavioral traits and how the environment influences whether we actually display such traits (Bjorklund & Ellis, 2005; Moffitt & Caspi, 2007; Rende, 2007).

1.3.9 Industrial–organizational Psychology:

The psychological study of people at work is known as industrial/organizational (I/O) psychology. It deals with such issues as hiring the right person for a job, training people for jobs, developing work teams, determining salaries and bonuses, providing feedback to workers about their performance, planning an organizational structure, and organizing the workplace so that workers will be productive and satis?ed. I/O psychologists study the behavior of both the individual and the organization, including the impact of economic conditions and government regulations.

Industrial/organizational (I/O) psychologists study the relationship between people and their working environments. They may develop new ways to increase productivity, improve personnel selection, or promote job satisfaction in a business setting. Their interests include organizational structure and change, consumer behavior, and personnel selection and training. I/O psychologists conduct workplace training or provide organizational analysis and development. They work in business, industry, the government, or a college or university. Or they may be self-employed as a consultant or work for a management counseling firm.

Industrial and organizational psychology (I–O) applies psychological concepts and methods to optimize human potential in the workplace. Personnel psychology, a subfield of I–O psychology, applies the methods and principles of psychology in selecting and evaluating workers. I–O psychology's other subfield, organizational psychology, examines the effects of work environments and management styles on worker motivation, job satisfaction, and productivity. This field is concerned with application of psychological principles and models to study the selection and performance of employees in organizational settings. It also studies the concepts of leadership, motivation, job satisfaction and performance appraisal.

1.3.10 Personality Psychology:

Personality psychology is concerned with enduring patterns of behavior, thought, and emotion—commonly referred to as personality—in individuals. Theories of personality vary crossways different psychological schools and orientations. They carry different assumptions in relation to the issues as the role of the unconscious and the importance of childhood experience. According to Freud, personality is based on the dynamic interactions of the id, ego, and super-ego. The number of proposed traits has varied widely. An early model, proposed through Hans Eysenck, suggested that there are three traits which comprise human personality: extraversion–introversion, neuroticism, and psychoticism. Raymond Cattell proposed a theory of 16 personality factors. Dimensional models of personality are getting increasing support, and some version of dimensional assessment will be incorporated in the forthcoming DSM-V.

1.3.11 Social Psychology:

Our complex networks of social interrelationships are the focus for many subfields of psychology. For example, social psychology is the study of how people's thoughts, feelings, and actions are affected by others. Social psychologists are interested in our interactions with others. It studies how humans think in relation to each other and how they relate to each other. Social psychologists study such topics as the influence of others on an individual's behavior (e.g. conventionality, persuasion), and the formation of beliefs, attitudes, and stereotypes in relation to the other people.

Social psychologists study how our beliefs, feelings, and behaviors are affected by and influence other people. They study topics such as attitudes, aggression, prejudice, interpersonal attraction, group behavior, and leadership. A social psychologist work in a college or university faculty member. They might also work in organizational consultation, marketing research, or other applied psychology fields including social neuroscience. Some social psychologists work for hospitals, federal agencies, or businesses performing applied research.

Social cognition fuses elements of social and cognitive psychology in order to understand how people process, keeps in mind, or distort social information. The study of group dynamics reveals information in relation to the nature and potential optimization of leadership, communication, and other phenomena that emerge at least at the micro social level. In recent years, several social psychologists have become increasingly interested in implicit measures, mediational models, and the interaction of both person and social variables in accounting for behavior. The study of human society is a potentially valuable source of information in relation to the causes of psychiatric disorder. Some of the sociological concepts applied to psychiatric disorders are the social role, sick role, social class, life event, culture, migration, social, and total institution.

1.3.12 Community Psychology:

Community psychologists move beyond focusing on specific individuals or families and deal with broad problems of mental health in community settings. These psychologists believe that human behavior is powerfully influenced by the interaction between people and their physical, social, political, and economic environments. They seek to improve individual functioning by enhancing environmental settings to promote psychological health.

Community psychologists focus on prevention, promotion of positive mental health, and crisis intervention, with special attention to the problems of underserved groups and ethnic minorities. Given the shared emphasis on prevention, some community psychologists collaborate with professionals in other areas, such as public health. The work settings of a community psychologist include federal, state, and local departments of mental health, corrections, and welfare systems. They also conduct research or help evaluate research in health service settings, serve as an independent consultant for a private or government agency, or teach and consult as a college or university faculty member.

1.3.13 Positive Psychology:

Positive psychology derives from Maslow's humanistic psychology. Positive psychology is a discipline that utilizes proof -based scientific methods to study factors that contribute to human happiness and strength. Different from clinical psychology, positive psychology is concerned with improving the mental well-being of healthy clients. Positive psychological interventions now have received tentative support for their beneficial effects on clients. In 2010 Clinical Psychological Review published a special issue devoted to positive psychological interventions, such as gratitude journaling and the physical expression of gratitude. There is, though, a need for further research on the effects of interventions. Positive psychological interventions have been limited in scope, but their effects are thought to be superior to that of placebos, especially with regard to helping people with body image problems.

1.3.14 Abnormal Psychology:

This branch of psychology tries to describe, assess, predict and control those categories of behaviors which are considered as unusual and non-normative. It also deals with various categories of psychological disorders which affect the mental health of the individual. It assesses abnormality in the individual through standardized psycho-diagnostic tools and suggests problem specific treatment.

1.3.15 Environmental Psychology:

This field is concerned with the study of interaction between physical environment and human behaviour. It studies the impact of noise, heat, humidity, pollution and crowding on human performance. It also focuses on the impact of physical environment on psychological health of individuals. Health Psychology: This field focuses on the impact of various psychological factors (e.g. stress) on the onset progress and treatment of illness. It also deals with various life style diseases such as hypertension, coronary heart disease, cancer and diabetes.

1.3.16 Psychometric Quantitative psychology:

Psychometric and quantitative psychologists study the methods and techniques used to acquire psychological knowledge. A psychometrician may update existing neurocognitive or personality tests or devise new tests for use in clinical and school settings or in business and industry. These psychologists also administer, score, and interpret such tests. Quantitative psychologists collaborate with researchers to design, analyze, and interpret the results of research programs. A psychometric or quantitative psychologist should be well trained in research methods, statistics, and computer technology. They are most likely be employed by a university or college, testing company, private research firm, or government agency.

1.3.17 Rehabilitation Psychology:

Rehabilitation psychologists are researchers and practitioners who work with people who have lost optimal functioning after an accident, illness, or other event. A rehabilitation psychologist work in a medical rehabilitation institution or hospital. They also work in a medical school, university, state or federal vocational rehabilitation agency, or in private practice serving people with physical disabilities.

1.4 Emerging Fields:

In addition to the fields mentioned above a number of new areas have emerged. Some of these fields are sports psychology, military psychology, aviation psychology, forensic psychology, peace psychology, neuropsychology, political psychology, and feminist psychology. Let us see a few of them in detail.

1.4.1 Forensic Psychology:

Forensic psychologists apply psychological principles to legal issues. They conduct research on the interface of law and psychology, help to create public policies related to mental health, help law-enforcement agencies in criminal investigations or assist in forensic consultation involving jury selection and deliberation research. They also provide therapy and assessment to assist the legal community. Some forensic psychologists hold law degrees and provide clients with legal services as well. Although most forensic psychologists are clinical psychologists, they might have expertise in other areas of psychology, such as social or cognitive psychology. Forensic psychologists work in a university psychology department, law school, research organization, community mental health agency, law-enforcement agency, court, or correctional setting.

1.4.2 Neuro psychology:

Neuropsychologists investigate the relationship between neurological processes (structure and function of the brain) and behavior. Neuropsychologists assess, diagnose, or treat disorders related to the central nervous system, such as Alzheimer's disease or stroke. They also evaluate individuals for evidence of head injuries, learning and developmental disabilities such as autism and other psychiatric disorders including ADHD. A clinical neuropsychologist work in the neurology, neurosurgery, or psychiatric unit of a hospital. Neuropsychologists also work in academic settings, where they conduct research and teach.

1.4.3 Sport Psychology:

Sport psychologists study the psychological factors that influence, and are influenced by, participation in sports and other physical activities. Professional activities of sports psychologists include coach education, athlete preparation, as well as research and teaching. Sports psychologists who also have a clinical or counseling degree can apply those skills to working with individuals with psychological problems such as anxiety or substance-abuse problems that might interfere with optimal performance. They may also work as part of a team or organization or in a private capacity.

1.5 Conclusion:

With perspectives ranging from the biological to the social, and with settings from the laboratory to the clinic, psychology relates to many fields, ranging from mathematics to biology to sociology to philosophy. And more and more, psychology's methods and findings aid other disciplines. Psychologists teach in medical schools, law schools, and theological seminaries, and they work in hospitals, factories, and corporate offices. They engage in interdisciplinary studies, such as psychohistory (the psychological analysis of historical characters), psycholinguistics (the study of language and thinking), and psychoceramics (the study of crackpots). Psychology also influences modern culture. Knowledge transforms us. Learning about the solar system and the germ theory of disease alters the way people think and act. Learning psychology's findings also changes people: They less often judge psychological disorders as moral failings, treatable by punishment and ostracism. They less often regard and treat women as men's mental inferiors. They less often view and rear children as ignorant, willful beasts in need of taming. "In each case," notes Morton Hunt (1990, p. 206), "knowledge has modified attitudes, and, through them, behavior." Once aware of psychology's well-researched ideas—about how body and mind connect, how a child's mind grows, how we construct our perceptions, how were member (and misremember) our experiences, how people across the world differ (and are alike)—your mind may never again be quite the same.

1.6 Summary

Psychology is a systematic and scientific study of mental processes, experiences and behaviors - both overt and covert – as they take place in a socio-cultural setting. The scope of psychology is wide as it addresses a variety of issues related to mental and behavioral functioning of the individuals. Study of psychology helps us to develop a basic understanding about human nature and facilitates dealing with a number of personal and social problems. Psychology has a number of specialized fields of study. Each field helps us understand human behavior in specific domain.

1.7 KEY WORDS:

::Abnormal Psychology describe, assess, predict and control those categories of behavior which are considered as unusual and non-normative

::Behavioral genetics

focuses on the biological mechanisms, such as genes and chromosomes, that enable inherited behavior to unfold.

:: Biological psychology

the study of the biological substrates of behavior and mental processes

:: Clinical psychology

study and application of psychology to understand, prevent, and relieve psychologically based distress or dysfunction and also helps to promote subjective well-being and personal development

::Cognitive neuroscience

study the psychological processes in humans by investigating the neural correlates of the psychological processes using neural imaging tools.

:: Cognitive psychology

study thought processes and focus on such topics as perception, language, attention, problem solving, memory, judgment and decision making, forgetting, and intelligence.

::Community Psychology

deal with broad problems of mental health in community settings.

::Counseling psychologist

help people adjust to life transitions or make life-style changes

::Developmental psychology

studies how people grow and change from the moment of conception through death.

::Educational psychology

study on how humans learn in educational settings, the effectiveness of educational interventions, the psychology of teaching, and the social psychology of schools as organizations

::Environmental Psychology

study of interaction between physical environment and human behaviour.

::Evolutionary Psychology

considers how behavior is influenced by our genetic inheritance from our ancestors.

::Experimental psychology

investigate a variety of basic behavioral processes in research involving humans and/or other animals

::Forensic psychology

apply psychological principles to legal issues.

::Health psychology

contributes to promoting health and preventing disease.

::Industrial–organizational Psychology

the psychological study of people at work

::Neuropsychologist

investigate the relationship between neurological processes (structure and function of the brain) and behavior.

::Personality psychology

concerned with enduring patterns of behavior, thought, and emotion—commonly referred to as personality—in individuals.

::Positive psychology

discipline that utilizes proof -based scientific methods to study factors that contribute to human happiness and strength.

::Psychology

the scientific study of human behaviour and mental processes.

::Psychometric and quantitative psychology

study the methods and techniques used to acquire psychological knowledge.

::Rehabilitation psychologist

work with people who have lost optimal functioning after an accident, illness, or other event.::School psychologist involved in the assessment of and intervention for children in educational settings.

::social psychologist

study of how people’s thoughts, feelings, and actions are affected by others.

::Sport Psychologist

study the psychological factors that influence, and are influenced by, participation in sports and other physical activities

1.8 7Check Your Progress

(1) Psychology is best defined as the

(a) study of perception and memory.

(b) investigation of the human psyche.

(c) scientific study of conscious and unconscious processes.

(d) scientific study of behavior and mental processes.

(2) Research into the mental processes associated with the learning and use of language is most closely aligned with which of the following subfields of psychology?

(a) cognitive

(b) educational

(c) social

(d) clinical

(3) Chemical changes in the brain associated with anxiety would be of most interest to a(n)

(a) evolutionary psychologist.

(b) cognitive psychologist.

(c) sociocultural psychologist.

(d) behavioral neuroscientist.

(4) The most widely practiced specialization in psychology is

(a) experimental psychology.

(b) physiological psychology.

(c) forensic psychology.

(d) clinical and counseling psychology

(5) What is the main difference between a clinical psychologist and a psychiatrist?

(a) their education

(b) their theoretical approach

(c) their research interests

(d) their number of publications

1.9 ANSWERS TO CHECK YOUR PROGRESS

1. (d)
2. (a)
3. (d)
4. (d)
5. (a)

1.10 MODEL QUESTIONS

1. Define psychology.
2. Describe any two fields of psychology and indicate their applications?

LESSON 2
METHODS OF PSYCHOLOGY

INTRODUCTION

The starting point of any science is description. In everyday life, all of us observe and describe people, often drawing conclusions about why they behave as they do. Professional psychologists do much the same, though more objectively and systematically. Most of the researches in psychology starts with description: What happens and under what circumstances? In this lesson you will learn in detail about the major methods used by psychologists.

LEARNING OBJECTIVES

At the end of this unit you will be able to understand

- the different research methods and explain their advantages and disadvantages
- the uses of correlational research
- the procedures of experimental research

PLAN OF THE LESSON

Psychologists use different methods of investigation, each with its advantages and disadvantages. The four main methods commonly used in psychological research are : the (true) experimental method, the quasi-experimental method, the observational method (sometimes called the survey or correlational method), and the case study method. Let’s ?rst examine several kinds of observational studies. Later we consider experiments, which are designed to illuminate cause-and-effect relationships.

2.1 Naturalistic Observations

A naturalistic observation is a careful examination of what happens under more or less natural conditions. For example, biologist Jane Goodall (1971) spent years observing chimpanzees in the wild, recording their food habits, their social interactions, their gestures, and their whole way of life. Similarly, psychologists sometimes try to observe human behavior “as an outsider.”

2.1.1The survey (or correlational) method

A survey is a study of the prevalence of certain beliefs, attitudes, or behaviors based on people’s responses to questions. Surveys are common in Western society. You will also frequently read survey results in the newspaper or hear them reported on television.

The survey method is commonly used only to identify the naturally occurring patterning of variables in the ‘real world’ rather than to explain those patterns (though often people want to put an explanatory gloss on them). So to examine whether absence makes the heart grow fonder we could conduct a survey to see if people who are separated from their partners because of travelling away from home (group A) say more positive things about their partners than people who never travel away from home without their partners (group B).

This might be an interesting exercise, but the validity of any causal statements made on the basis of such ?ndings would be very limited. For example, if we found from our survey that group A said more positive things about their partners when they were travelling than group B, it would be impossible to demonstrate conclusively that absence was the cause of the difference between groups A and B. In other words, while our survey could show us that absence is associated with a fonder heart, it could not conclusively show that absence actually causes the heart to grow fonder.

It is quite possible (odd as it may sound) that the sorts of people who travel away from home without their partners are simply those that like their partners more (so fondness makes the heart go absent). Or perhaps both fondness and absence are caused by something else – for example, social class (i.e. being wealthy makes people both fond and absent). In large part, then, surveys rely on methodologies that identify relationships between variables but do not allow us to make conclusive causal inferences.You should be aware of the ways in which survey results can be misleading.

2.1.1.1 Sampling

Getting a random or representative sample is important in research, particularly with surveys.

In 1936 the Literary Digest mailed 10 million postcards, asking people their choice for president of the United States. Of the 2 million responses, 57% preferred the Republican candidate, Alfred Landon.Later that year, the Democratic candidate, Franklin Roosevelt, defeated Landon by a wide margin. The problem was that the Literary Digest had selected names from the telephone book and automobile registration lists. In 1936, at the end of the Great Depression, few poor people (who were mostly Democrats) owned telephones or cars. With any survey, researchers should acknowledge the limitations of their sample.

Even if one had a random sample of all adults in an entire country, the results apply only to that country at the time of the survey. It would be unwarranted to draw conclusions about other countries or other times.

2.1.1.2 The Seriousness of Those Being Interviewed

When you answer a survey, do you carefully consider your answers, or do you answer impulsively? In one survey, only 45% of the respondents said they believed in the existence of intelligent life on other planets. However, a few questions later on the survey, 82% said they believed the U.S. government was “hiding evidence of intelligent life in space” (Emery, 1997). Did 37% of the people really think that the U.S. government is hiding evidence of something that doesn’t exist? More likely, they were answering without much thought. Here’s another example: Which of the following programs would you most like to see on television reruns? Rate your choices from highest (1) to lowest (10). __ South Park __ Xena, Warrior Princess __ Lost __ The X-Files __ Cheers __ Teletubbies __ Seinfeld __ Space Doctor __ I Love Lucy __ Homicide

When this survey was conducted with students of North Carolina State University, nearly all did exactly what has been asked—they gave every program a rating, including Space Doctor, a program that never existed. Most rated it toward the bottom, but more than 10% rated it in the top ?ve, and a few ranked it as their top choice. (This survey was inspired by an old Candid Camera episode in which interviewers asked people their opinions of the nonexistent program Space Doctor and received many con?dent replies.) Students who rated Space Doctor did nothing wrong, of course. They have been asked to rank the programs, and they did. The fault lies with anyone who interprets such survey results as if they represented informed opinions. People frequently express opinions based on little or no knowledge.

2.1.1.3 The Wording of the Questions

Let's start with a little demonstration. Please answer these two questions:

1. I oppose raising taxes. (Circle one.) 1 2 3 4 5 6 7 Strongly agree Strongly disagree
2. I make it a practice to never lie. (Circle one.) 1 2 3 4 5 6 7 Strongly agree Strongly disagree Now cover up those answers and reply to these similar questions:
3. I would be willing to pay a few extra dollars in taxes to provide high-quality education to all children. (Circle one.) 1 2 3 4 5 6 7 Strongly agree Strongly disagree
4. Like all human beings, I occasionally tell a white lie. (Circle one.) 1 2 3 4 5 6 7 Strongly agree Strongly disagree

Some odd survey results merely reflect the fact that people did not take the questions seriously or did not understand the questions.

Most students at one college indicated agreement to all four items (Madson, 2005).

Note that item 1 contradicts 3, and 2 contradicts 4. You can't be opposed to raising taxes and in favor of raising taxes. You can't be honest all the time and occasionally lie. However, the wording of a question changes its connotation. Question 3 talks about raising taxes "a few extra dollars" for a worthy cause. That differs from raising taxes in general by some unknown amount for unknown reasons. Similarly, depending on what you mean by a "white lie," you might tell one occasionally while still insisting that you "make it a practice to never lie"—at least not much. Still, the point is that someone can bias your answers one way or the other by rewording a question.

Here is another example. Some students are offered the ?rst pair of questions, and others are offered the second pair:

1. Suppose your professor tells you your rank in the class so far, on a scale from 1st percentile (worst) to 99th percentile (best). How would you feel if you were told you were in the 10th percentile? (Circle one.) 1 (worst) 2 3 4 5 6 7 (best) How would you feel if you were told you were in the 90th percentile? 1 (worst) 2 3 4 5 6 7 (best)

2. Suppose your professor tells you your rank in the class so far, on a scale from 1st percentile (worst) to 99th percentile (best). How would you feel if you were told you were in the 91st percentile? (Circle one.) 1 (worst) 2 3 4 5 6 7 (best) How would you feel if you were told you were in the 99th percentile? 1 (worst) 2 3 4 5 6 7 (best)

On the average, students offered the ?rst pair of questions rated their happiness as 6.46 if they were told they were in the 90th percentile. Students offered the second pair of questions rated their happiness as 5.89 if they were told they were in the 91st percentile (Hsee& Tang, 2007). Obviously, it doesn’t make sense to be happier about being in the 90th percentile than the 91st. The wording of the question sets up an implicit comparison: The 90th percentile is much better than the 10th, but the 91st is worse than the 99th. In short, the next time you hear the results of some survey, be skeptical. Ask how the question was worded and what choices were offered. Even a slightly different wording could yield a different percentage.

2.1.1.4 Surveyor Biases

Sometimes, an organization words the questions of a survey to encourage the answers they hope to receive. Here is an example: According to a 1993 survey, 92% of high school boys and 98% of high school girls said they were victims of sexual harassment (Shogren, 1993). Shocking, isn’t it? However, perhaps the designers of the survey wanted to show that sexual harassment is prevalent. The survey de?ned sexual harassment by a long list of acts ranging from serious offenses (e.g., having someone rip your clothes off in public) to minor annoyances. For example, if you didn’t like the sexual scribbling on the restroom wall, you could consider yourself sexually harassed. If you tried to make yourself look sexually attractive (as most teenagers do, right?) and then attracted a suggestive look from someone you didn’t want to attract, that stare would count as sexual harassment. (Does it mean to say about those who said they weren’t sexually harassed! They liked all the scribbling on the restroom walls? No one ever looked at them in a sexual way?) Sexual harassment is, of course, a serious problem, but a survey that combines major and minor offenses is likely to mislead. Therefore when carrying out a survey research and generalizing the results of the survey, the researcher should be very cautious and be aware of the influence of the above mentioned factors.

2.2 Correlation Method

Another type of research is a correlational study. A correlation is a measure of the relationship between two variables. (we already know that a variable is anything measurable that differs among individuals, such as age, years of education, or reading speed.) A correlational study is a procedure in which investigators measure the correlation between two variables without controlling either of them. For example, investigators have observed correlations between people's height and weight. Similarly, one can ?nd a correlation between scores on personality tests and how many friends someone has.

2.2.1 The Correlation Coefficient

We would probably ?nd a strong positive correlation between hours per week reading and scores on a vocabulary test. We would expect a lower correlation between reading hours and scores on a chemistry test. To measure the strength of a correlation, researchers use a correlation coeffcient, a mathematical estimate of the relationship between two variables. The coeffcient can range from +1 to -1.

A correlation coeffcient indicates how accurately we can use a measurement of one variable to predict another. A correlation coeffcient of +1 for example, means that as one variable increases, the other increases also. A correlation coeffcient of -1 means that as one variable increases, the other decreases. A correlation of either +1 or -1 enables us to make perfect predictions of one variable from measurements of the other one. (In psychology you probably will never see a perfect +1 or -1 correlation coefficient.) A negative correlation is just as useful as a positive correlation and can indicate just as strong a relationship. In nations where people eat more seafood, depression is less common, so seafood consumption is negatively correlated with depression.

A 0 correlation indicates that measurements of one variable have no linear relationship to measurements of the other variable. As one variable goes up, the other does not consistently go up or down. A correlation near 0 can mean that two variables really are unrelated or that one or both of them were poorly measured. (If something is inaccurately measured, we can hardly expect it to predict anything else.)

2.2.2 Illusory Correlations

Sometimes with unsystematic observations, we “see” a correlation that doesn’t really exist. For example, many people believe that consuming sugar makes children hyperactive. However, extensive research found little effect of sugar on activity levels, and some studies found that sugar calms behavior (Milich, Wolraich, & Lindgren, 1986; Wolraich et al., 1994).

How, then, do we handle reports that sugar makes children hyperactive? Researchers watched two sets of mothers with their 5- to 7-year-old sons after telling one group that they had given the sons sugar and the other that they had given the sons a placebo. In fact, they had given both a placebo. The mothers who thought their sons had been given sugar rated their sons hyperactive during the observation period, whereas the other mothers did not (Hoover & Milich, 1994). That is, people see what they expect to see. When people expect to see a connection between two events (e.g., sugar and activity levels), they remember the cases that support the connection and disregard the exceptions, thus perceiving an illusory correlation, an apparent relationship based on casual observations of unrelated or weakly related events. Many stereotypes about groups of people can be regarded as illusory correlations.

2.2.3 Correlation and Causation

A correlation tells us how strongly two variables are related to each other. It does not tell us why. If two variables—let’s call them A and B—are positively correlated, it could be that A causes B, B causes A, or some third variable, C, causes both of them. Therefore, a correlational study does not justify a cause-and-effect conclusion. For example, there is a strong positive correlation between the number of books people own about chess and how good they are at playing chess. Does owning chess books make someone a better chess player? Does being a good chess player cause someone to buy chess books? Both hypotheses are partly true. People who start to like chess usually buy chess books, which improve their game. As they get better, they become even more interested and buy more books. But neither the chess books nor the skill exactly causes the other. “Then what good is a correlation?” The simplest answer is that correlations help us make useful predictions. If your friend has just challenged you to a game of chess, you could scan your friend’s bookshelves and estimate your chances of winning.

Following are the three more examples to illustrate why we cannot draw conclusions regarding cause and effect from correlational data

- Unmarried men are more likely than married men to spend time in a mental hospital or prison. That is, marriage is negatively correlated with men's mental illness and criminal activity. Does the correlation mean that marriage leads to mental health and good social adjustment? Or does it mean that the men in mental hospitals and prisons are unlikely to marry? (The second conclusion is certainly true. The ?rst may be also.)
- According to one study, people who sleep about 7 hours a night are less likely to die within the next few years than those who sleep either more or less (Kripke, Gar?nkel, Wingard, Klauber, &Marler, 2002). It's easy to believe that sleep deprivation impairs your health, but should we conclude (as some people did) that sleeping too much also impairs your health? Here is an alternative explanation: People who already have life-threatening illnesses tend to sleep more than healthy people. So perhaps illness causes extra sleep rather than extra sleep causing illness. Or perhaps advancing age increases the probability of both illness and extra sleep. (The study included people ranging from young adulthood through age 101!)
- On the average, the more often parents spank their children, the worse their children misbehave. Does this correlation indicate that spankings lead to misbehavior? Possibly, but an alternative explanation is that the parents resorted to spanking because their children were already misbehaving (Larzelere, Kuhn, & Johnson, 2004). Yet another possibility is that the parents had genes for "hostile" behavior that led them to spank, and the children inherited those genes, which led to misbehaviors.

Describing behavior is a first step toward predicting it. Surveys and naturalistic observations often show us that one trait or behavior is related to another. In such cases, we say the two correlate. A statistical measure (the correlation coefficient) helps us figure how closely two things vary together, and thus how well either one predicts the other.

Again, the results suggest cause and effect. Nevertheless, the point to remember is: We should almost always be skeptical of causal conclusions that anyone draws from a correlational study. To determine causation, an investigator needs to manipulate one of the variables directly through a research design known as an experiment. When an investigator manipulates one variable and then observes corresponding changes in another variable, a conclusion about causation can be justified, presuming, of course, that the experiment is well designed.

2.3 The case study method

Most of the above methods are used for studies involving large numbers of participants. But what if only a few are available? How, for example, would you do research if you were interested in the reading difficulties of people with particular forms of brain damage? To investigate questions like this, researchers often resort to the case study method, which involves intensive analysis of a very small sample. Among the oldest research methods, the case study examines one individual in depth in hopes of revealing things true of us all.

Some examples:

Much of our early knowledge about the brain came from case studies of individuals who suffered a particular impairment after damage to a certain brain region.

Jean Piaget taught us about children's thinking after carefully observing and questioning only a few children.

Studies of only a few chimpanzees have revealed their capacity for understanding and language. Intensive case studies are sometimes very revealing.

Case studies often suggest directions for further study, and they show us what can happen. But individual cases may mislead us if the individual being studied is atypical. Unrepresentative information can lead to mistaken judgments and false conclusions. Case studies have particular problems (often with reliability), but some of the most famous studies in psychology have used this method – in particular the work of Freud.

Indeed, anytime a researcher mentions a finding ("Smokers die younger: 95 percent of men over 85 are non smokers") someone is sure to offer a contradictory anecdote ("Well, I have an uncle who smoked two packs a day and lived to be 89"). As psychologist Gordon Allport (1954, p. 9) said, "Given a thimbleful (meaning a drop) of [dramatic] facts we rush to make generalizations as large as a tub."

2.3.1 Case Histories

Some fascinating conditions are rare. For example, some people are almost completely insensitive to pain. People with Capgras syndrome believe that some of their relatives have been replaced with impostors, who look, sound, and act like the real people. People with Cotard's syndrome insist that they are dead or do not exist. A psychologist who encounters someone with a rare condition may report a case history, a thorough description of the person, including abilities and disabilities, medical condition, life history, unusual experiences, and whatever else seems relevant. It is, of course, possible to report a case history of any person, not just the unusual, but the unusual cases attract more attention.

A case history is a kind of naturalistic observation, but we distinguish it because it focuses on a single individual. A case history can be valuable, but it runs the risk of being just an anecdote. Unless other observers examine this person or someone similar, we are at the mercy of the original investigator, who may have overlooked important points, exaggerated, or misunderstood. A good case history guides further research, but we should interpret a single report cautiously.

2.4 Qualitative approach

When researchers report and comment on behaviour, without attempting to quantify it, they are using a qualitative research method. This involves attempts to understand behaviour by doing more than merely converting evidence into numbers. Qualitative methods can include coding, grouping and collecting observations without assigning actual numbers to the observation. So a qualitative analysis of the speed of animals might result in the statement that the cheetah is a fast land animal, and a quantitative analysis might involve comparing the maximum speed of animals over (say) 20 meters.

To take an example of human behaviour, you probably take a qualitative approach to the friendliness of the people you meet. In other words, you probably judge people as relatively friendly or unfriendly, but you would be unlikely to come up with a number that expresses their friendliness quotient. Qualitative techniques are sometimes used in the initial stages of quantitative research programs to complement the quantitative techniques, but they are also used by psychologists who challenge conventional approaches to psychological research. This may be because they believe that the conventional methods are inadequate for addressing the richness and complexity of human behaviour. In turn, many mainstream psychologists are critical of qualitative methods. The point to remember is that Individual cases can suggest fruitful ideas. But to discern the general truths that cover individual cases, we must answer questions with other research methods.

2.5 The experimental method

An experiment is a study in which the investigator manipulates at least one variable while measuring at least one other variable. To do this, the researcher examines participants' responses in the presence and the absence of the manipulation. Researchers measure the language skills of some 5-year-old children, provide them with a 6-month special training program, and then ?nd that the children have increased their language skills. Can we conclude that the training program was effective? No, because the children probably would have improved their language during 6 months even without the training.

Instead of a before-and-after study, a better design is to compare two groups: An investigator might assemble a group of 5-year-old children, randomly divide them into two groups, and provide the training for one group (the experimental group) and not the other (the control group). Someone, preferably a blind observer, evaluates the language skills of the two groups. If the two groups become different in some consistent way, then the difference is probably the result of the experimental procedure.

With an experiment, as with any research, we should beware of generalizing the results too far. If the researchers studied 5-year-old children in the United States, the results might not apply, or might not apply equally well, to children in another country or even to children in the same country many years later. We gain con?dence in the generalizability of the results if researchers obtain similar results from a variety of samples, especially if they come from different cultures.

Experimental control is used to make the different situations identical in every respect except for the presence or absence of the manipulation. Experiments can involve different people in each situation or the same people in different situations. People who take part in experiments are called participants or subjects.

Here is an example. To test the effect of a new training method (a manipulation) on memory, we might take 100 people and expose half of them to the new method. To get accurate result, we would assign participants to the two groups on a random basis (e.g. by the toss of a coin). The ?rst group is called the experimental group, as it is subjected to a relevant experimental treatment. The other half of our participants would not be exposed to the new training method. As they receive no experimental treatment, they are referred to as a control group (discussed in more detail below). After administering the treatment, we would measure the performance of the two groups on a memory task and then compare the results. The various levels of treatment in an experiment (including the control) are referred to as conditions.

This experiment has two conditions and a between-subjects design(because the design involves making comparisons between different participants in different conditions). Note, however, that the same question could also have been addressed in a with in subjects design, which would involve comparing the memory performance of the same people with and without the new training method. The two basic designs have different strengths and weaknesses.

2.5.1 Variable

A variable is simply something that changes or varies (is not constant). The different conditions in the experiment make up the independent variable (or IV), sometimes called the treatment variable. In true experiments, the independent variable is systematically manipulated or varied by the experimenter. Experiments can (and typically do) have more than one independent variable.

Experiments also involve at least one dependent variable (or DV). This is an outcome or measurement variable, and it is this variable that the experimenters are interested in observing and which provides them with data. In our last example, the dependent variable is the level of memory performance. Use the initial letter 'd' to remember the link between the dependent variable and the data it provides.

Experiments examine the effect of one or more independent variables on some measurable behavior, called the dependent variable because it can vary depending on what takes place during the experiment. Both variables are given precise operational definitions, which specify the procedures that manipulate the independent variable or measure the dependent variable. These definitions answer the "What do you mean?" question with a level of precision that enables others to repeat the study.

2.5.2 Control

Control is the basis of experimental design. It involves making different conditions identical in every respect except the treatment (i.e. the independent variable). In a between-subjects experiment, this is achieved by a process of random assignment of participants to the different conditions. For example, people should be assigned at random (e.g. on the basis of coin tossing), rather than putting, say, the first 50 people in one condition and the second 50 in another. This practice rules out the possibility that there are systematic differences in, say, intelligence, personality or age between the groups. If there is a difference in results obtained from measuring the dependent variable for each group, and we have equated the groups in every respect by means of random assignment, we can infer that the difference must be due to our manipulation of the independent variable.

2.5.3 Random sample

To obtain a representative sample—say, of the students at any college or university, you would choose a random sample, in which every person in the entire group has an equal chance of participating. This means you would not send each student a questionnaire. (The conscientious people who return it would not be a random sample.) Rather, you might number the names in the general student listing and then use a random number generator to pick the participants for your survey.

Large representative samples are better than small ones, but a small representative sample of 100 is better than an unrepresentative sample of 500. Political pollsters sample voters in national election surveys just this way. Using only 1500 randomly sampled people, drawn from all areas of a country, they can provide a remarkably accurate snapshot of the nation's opinions. Without random sampling, large samples—including call-in phone samples and TV or Web site polls—often merely give misleading results.

To know how effective a therapy really is, researchers must control for a possible placebo effect. The double-blind procedure is one way to create an experimental group, in which people receive the treatment, and a contrasting control group that does not receive the treatment. By randomly assigning people to these conditions, researchers can be fairly certain the two groups are otherwise identical. Random assignment roughly equalizes the two groups in age, attitudes, and every other characteristic. With random assignment it can be concluded that any later differences between people in the experimental and control groups will usually be the result of the treatment

2.6 The quasi-experimental method

In quasi-experimental studies the independent variable is not (or cannot be) manipulated as such, and so assignment to experimental groups cannot be random. The fact that no manipulation occurs interferes dramatically with our ability to make conclusive causal inferences. Examples of independent variables that cannot be manipulated by an experimenter includes gender and age. Obviously experimenters cannot change the gender or age of participants, but they can compare the responses of groups of people with different ages or of different genders. Compared to the experimental method, there is no real control over the independent variable, so we cannot conclude that it is necessarily responsible for any change in the dependent variable. On this basis, the quasi-experimental method actually has more in common with survey methodology than with the experimental method. It has all the weaknesses of the experimental method, but it lacks the main strength. In practice, it is often conducted in conjunction with the experimental method. For example, in our learning study we might compare the effect of the new training method on both men and women.

2.7 Experiment Vs Survey

One common, but mistaken, belief is that the difference between surveys and experiments is a question of location, with surveys being conducted in the community and experiments in the laboratory. This is often the case, but not always. Experiments can be conducted outside laboratories, and surveys can be conducted in them.

The main differences between experiments and surveys relate to the sorts of questions that each can answer. As we suggested earlier, experiments tend to be concerned with establishing causal relationships between variables, and they achieve this by randomly assigning participants to different treatment conditions. Surveys, on the other hand, tend to be concerned with measuring naturally occurring and enduring relationships between variables. Researchers who use surveys usually want to generalize from the sample data they obtain to a wider population. They do this by using the sample to estimate the characteristics of the population they are interested in. Why choose to carry out a survey rather than an experiment? Two reasons: sometimes we are only interested in observing relationships, and sometimes manipulations simply are not possible.

Surveys can also allow researchers to eliminate some causal links. If there is no relationship (at least in the survey environment) between variables, this allows us to conclude that one does not cause the other. For example, if no relationship is found between age and intelligence, then it is impossible for intelligence to cause age, or vice versa (bearing in mind that a relationship could be concealed by a third, or background, variable).

Correlational research cannot control for all possible factors. But researchers can isolate cause and effect with an experiment. Experiments enable a researcher to focus on the possible effects of one or more factors by (1) manipulating the factors of interest and (2) holding constant (“controlling”) other factors.

2.8 Conclusion

Conducting research is a formal and systematic exercise. The success of the research process depends on a confluence of conceptual, meta-theoretical, methodological, and statistical skills. Psychologists use a wide array of research methods which includes Observation, experimental and correlation. Depending on the nature of the research , the suitable methodology should be applied. Each method has its own advantages and disadvantages.

2.9 SUMMARY

Descriptive, correlational, and experimental research are the methods used in the study of psychology. Descriptive methods include case studies, surveys, and naturalistic observation. The goal of these designs is to get a picture of the current thoughts, feelings, or behaviors in a given group of people. Correlational research method find out the relationship between two or more variables. The variables may be presented on a scatter plot to visually show the relationships. The Pearson Correlation Coefficient (r) is a measure of the strength of linear relationship between two variables. Common-causal variables may cause both the predictor and outcome variable in a correlational design, producing a spurious relationship. The possibility of common-causal variables makes it impossible to draw causal conclusions from correlational research methods. Experimental research involves the manipulation of an independent variable and the measurement of a dependent variable. Random assignment to conditions is normally used to create initial equivalence between the groups, allowing researchers to draw causal conclusions.

2.10 KEY WORDS

::between-subjects design

a research study involving a systematic manipulation of an independent variable with different participants being exposed to different levels of that variable

::case study method

research method that involves a single participant or small group of participants who are typically studied quite intensively.

::condition

a situation in a research study in which participants are all treated the same way.

::control group

in an experiment, the group that is not exposed to the treatment; contrasts with the experimental group and serves as a comparison for evaluating the effect of the treatment.

::correlation

a measure of the extent to which two factors vary together, and thus of how well either factor predicts the other.

::correlation coefficient

a statistical index of the relationship between two things (from -1 to +1).

::dependent variable

the variable in which a researcher is interested in monitoring effects or outcomes

::double-blind procedure

an experimental procedure in which both the research participants and the research staff are ignorant (blind) about whether the research participants have received the treatment or a placebo. Commonly used in drug-evaluation studies.

::experiment

a research method in which an investigator manipulates one or more factors (independent variables) to observe the effect on some behavior or mental process (the dependent variable). By random assignment of participants, the experimenter aims to control other relevant factors.

::experimental control

the method of ensuring that the groups being studied are the same except for the manipulation or treatment under investigation

::experimental group

in an experiment, the group that is exposed to the treatment, that is, to one version of the independent variable.

::independent variable

the treatment variable manipulated in an experiment, or the causal variable believed to be responsible for particular effects or outcomes

::manipulation

the process of systematically varying an independent variable across different experimental conditions (sometimes referred to as the experimental treatment or intervention)

::naturalistic observation

observing and recording behavior in naturally occurring situations without trying to manipulate and control the situation.

::placebo [pluh-SEE-bo; Latin for "I shall please"] effect

experimental results caused by expectations alone; any effect on behavior caused by the administration of an inert substance or condition, which the recipient assumes is an active agent.

::population

all the cases in a group being studied, from which samples may be drawn. (Note: Except for national studies, this does not refer to a country's whole population.)

::random assignment

assigning participants to experimental and control groups by chance, thus minimizing preexisting differences between those assigned to the different groups.

::random sample

a sample that fairly represents a population because each member has an equal chance of inclusion.

::treatment

the experimental manipulation of the independent variable

::Variable

A variable is simply something that changes or varies (is not constant).

::within-subjects design

a research design in which the same participants are exposed to different levels of the independent variable

2.11 CHECK YOUR PROGRESS

1. In which method of study of psychology, independent and dependent variable are important elements.
   (a) Introspection Method
   (b) Experimental Method
   (c) Observational Method
   (d) Case History Method
2. In _________ method of study in psychology, passive study and analysis of human behaviour is usually done.
   (a) Introspection Method
   (b) Experimental Method
   (c) Observational Method
   (d) Genetic Method
3. In the simplest experimental method, 'E' manipulates _________.
   (a) One Variable
   (b) Two Variables
   (c) Three Variables
   (d) Four Variables
4. The only way psychologists can establish cause-and-effect relationships through research is by
   (a) case studies
   (b) Naturalistic observation
   (c) Experiments
   (d) Correlational research

5. Random assignment is based on
   (a) Chance
   (b) Experimenter bias
   (c) Participant choice
   (d) The hypothesis in question

6. The change that an experimenter deliberately produces in a situation is called
   (a) Experimental manipulation
   (b) Randomization
   (c) Replication
   (d) Control group

2.12 ANSWERS TO CHECK YOUR PROGRESS

(1) b

(2) c

(3) a

(4) c

(5) a

(6) a

2.13 Model Questions

1. Explain the experimental method in detail.
2. What is the difference between experimental method and survey?
3. Explain correlational research.

LESSON 3
NERVOUS SYSTEM

INTRODUCTION

There is a great deal about the emergence of complex psychological processes from brain.In this unit, all aspects of behaviour and mental functioning can be better understood with some knowledge of the underlying biological processes. To start, let's consider the cellular foundations of the nervous system.

LEARNING OBJECTIVES

At the end of this lesson you will be able to understand

- the major parts of the nervous system and its principal components.
- the most important functions of these components.
- the parts of a nerve cell and how it functions.
- how nerve cells communicate with each other.

PLAN OF THE LESSON

3.1 INTRODUCTION

To LIVE is to take in information from the world and the body's tissues, to make decisions, and to send back information and orders to the body's tissues. All this happens through our body's speedy electrochemical communications network, our nervous system. The nervous system can be divided into two major regions: the central and peripheral nervous systems. The central nervous system (CNS) is the brain and spinal cord, and the peripheral nervous system (PNS) is everything else (Figure 3.1)

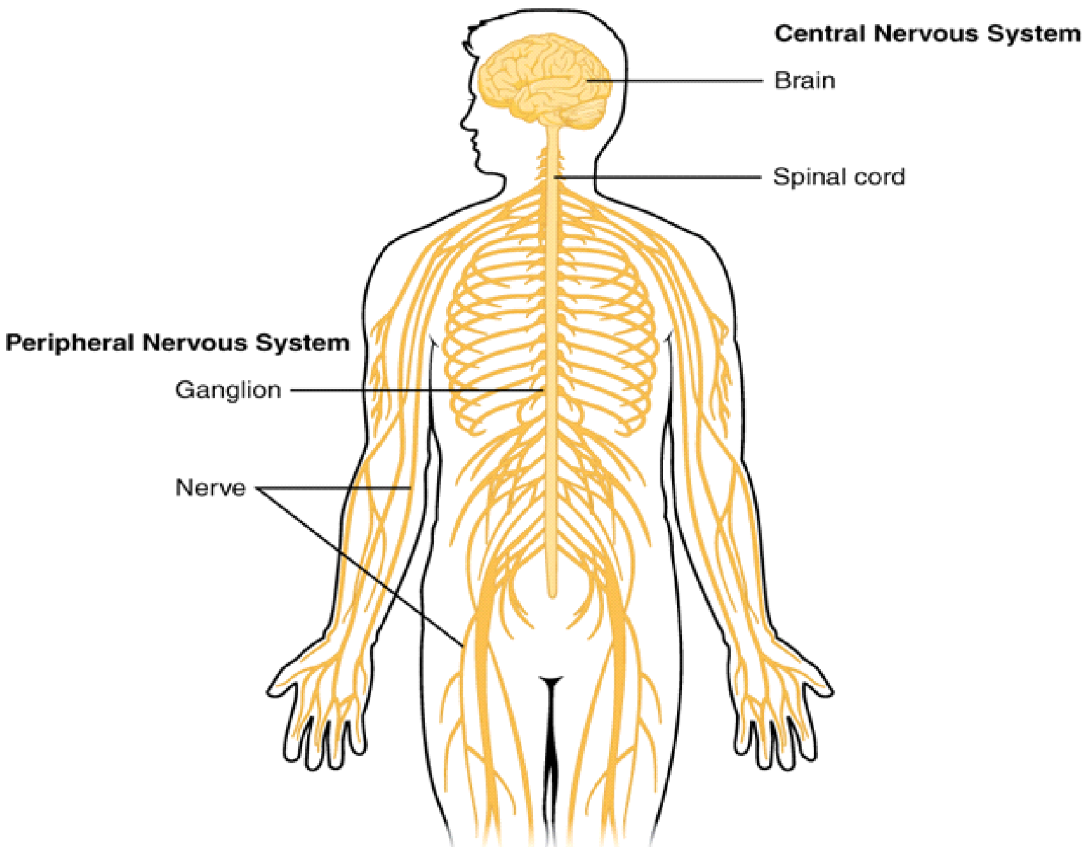


Figure 3.1

The brain is contained within the cranial cavity of the skull, and the spinal cord is contained within the vertebral cavity of the vertebral column. It is too simple to say that the CNS is what is inside these two cavities and the peripheral nervous system is outside of them, but that is one way to start to think about it. In actuality, there are some elements of the peripheral nervous system that are within the cranial or vertebral cavities. The peripheral nervous system is so named because it is on the periphery—meaning beyond the brain and spinal cord. The central nervous system (CNS), communicates with the body's sensory receptors, muscles, and glands via the peripheral nervous system (PNS).

The Major Divisions of the Nervous System	
Central Nervous System (CNS)	Peripheral Nervous System (PNS)
BrainNerves	Spinal cord Peripheral ganglia

TABLE 3.1

The brain has two primary functions: the control of behaviour and the regulation of the body's physiological processes. The brain cannot act alone – it needs to receive information from the body's sense receptors and it must be connected with the muscles and glands of the body if it is to affect behaviour and physiological processes. The spinal cord is a long, thin collection of nerve cells attached to the base of the brain and running the length of the spinal column. It contains circuits of nerve cells that control some simple reflexes, such as automatically pulling away from a painfully hot object. The central nervous system communicates with the rest of the body through the nerves – bundles of fibres that transmit information in and out of the central nervous system. The nerves, which are attached to the spinal cord and to the base of the brain, make up the peripheral nervous system.

3.2 THE STRUCTURE OF NEURONS

To describe the functional divisions of the nervous system, it is important to understand the structure of a neuron.

3.2.1 Glial cells – more than just glue

Neurons are the basic unit of the whole of the nervous system. Neurons operate alongside various other types of cells, whose activity can be essential to normal neuronal function. Even in the brain, only about 10 per cent of the cells are neurons. Most are glial cells, which fall into several different classes, each with its own function. There are astrocytes, oligodendrocytes (in the central nervous system), microglia and ependymal cells. (The word ending -cyte means 'cell'.)

Glia (or neuroglia), the other major components of the nervous system, do not transmit information over long distances as neurons do, although they do exchange chemicals with adjacent neurons.Glial cells were once thought of as the structural glue (that is what glia means in Greek) that holds the neurons in place, but their roles are proving to be far more complex.

There are several types of glia with different functions in the brain (Haydon, 2001). The star-shaped astrocytes wrap around the presynaptic terminals of a group of functionally related axons, synchronize the activity of the axons, enabling them to send messages by taking up chemicals released by axons and then releasing them back to axons.. Astrocytes also remove waste material created when neurons die and control the amount of blood fiow to each brain area . An additional function is that during periods of heightened activity in some brain area, astrocytes dilate the blood vessels to bring more nutrients into that area. Furthermore, astrocytes release chemicals that modify the activity of neighboring neurons.

Astrocytes do more than just support neurons. They are an important contributor to information processing. Microglia, very small cells, also remove waste material as well as viruses, fungi, and other microorganisms. In effect, they function like part of the immune system . Oligodendrocytes (OL-i-go-DEN-druh-sites) in the brain and spinal cord and Schwann cells in the periphery are specialized types of glia that build the myelin sheaths that surround and insulate certain vertebrate axons. Radial glia guide the migration of neurons and their axons and dendrites during embryonic development. When embryological development finishes, most radial glia differentiate into neurons,and a smaller number differentiate into astrocytes and oligodendrocytes .

3.2.2 Neurons:The three components of neurons

Neurons come in many shapes – or morphologies – which give them their different functions. For example, projection neurons have fibres that connect them to other parts of the nervous system. Even within this category, there are many different morphologies, but all projection neurons share some basic similarities. Generally neuron have three essential components (see figure 3.2). (1) The cell body, (2) Dendrites and (3) Axon

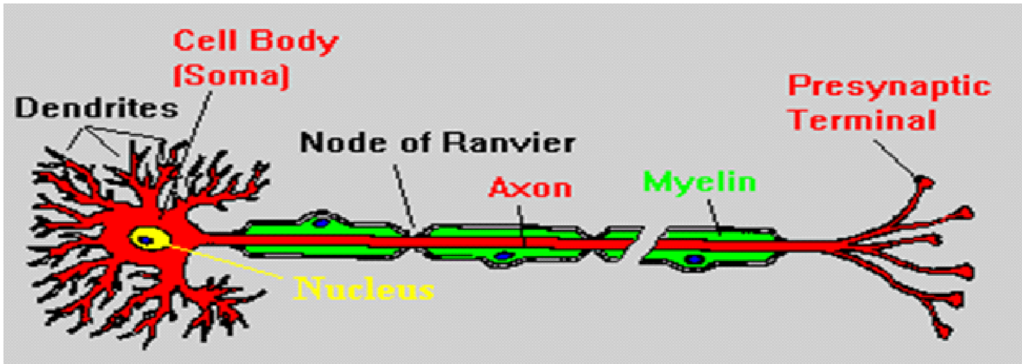


Figure 3.2

3.2.2.1 The cell body

The most prominent part of the neuron is the cell body or soma. The cell bodyor soma contains the nucleus, ribosomes, mitochondria, and other structures found in most cells. Much of the metabolic work of the neuron occurs here. Cell bodies of neurons range in diameter from 0.005 mm to 0.1 mm in mammals and up to a full millimeter in certain invertebrates. Like the dendrites, the cell body is covered with synapses on its surface in many neurons.

The cell body is filled with a watery liquid called cytoplasm and contains a number of organelles. The largest of these organelles is the nucleus, which contains the cell's chromosomes. Other organelles are responsible for converting nutrients into fuel for the cell, constructing proteins, and removing waste materials. The heart of the neuron is the cell body, where the cell's metabolic activities take place. Input from other neurons typically comes via the dendrites.

3.2.2.2 Dendrites

These can be a relatively simple cluster of fine, fibre-like extensions from the cell body, or highly complex branches like the twigs and leaves of a tree. Dendrites are branching fibers that get narrower near their ends. (The term dendrite comes from a Greek root word meaning "tree"; a dendrite is shaped like a tree.) The dendrite's surface is lined with specialized synaptic receptors, at which the dendrite receives information from other neurons.

The greater the surface area of a dendrite, the more information it can receive. Some dendrites branch widely and therefore have a large surface area. Some also contain dendritic spines, the short outgrowths that increase the surface area available for synapses. The shape of dendrites varies enormously from one neuron to another and can even vary from one time to another for a given neuron. The shape of the dendrite has much to do with how the dendrite combines different kinds of input. The output of the neuron is transmitted via its axon to the dendrites of other neurons, or other targets such as muscles.

3.2.2.3 Axon

The axon is a thin fiber of constant diameter, in most cases longer than the dendrites. (The term axon comes from a Greek word meaning “axis.”) The axon is the information sender of the neuron, conveying an impulse toward other neurons or an organ or muscle. Many vertebrate axons are covered with an insulating material called a myelin sheath with interruptions known as nodes of Ranvier (RAHN-vee-ay).

An axon has many branches, each of which swells at its tip, forming a presynaptic terminal, also known as an end bulb or bouton (French for “button”). At this point the axon releases chemicals that cross through the junction between one neuron and the next. A neuron can have any number of dendrites, but no more than one axon, which may have branches. In most cases, branches of the axon depart from its trunk far from the cell body, near the terminals.

Axons can be very long, reaching right down the spinal cord, or so short that it is difficult to tell them apart from the dendrites. Nerve cells with such short axons are called interneurons rather than projection neurons, because all their connections are local. Some neurons have just a single axon, although it may still make contact with a number of different target cells by branching out towards its end. Other cells have axons that are split into quite separate axon collaterals, each of which may go to an entirely different target structure.

3.2.3 Other terms associated with neurons

Neurons are also referred as afferent, efferent, and intrinsic. An afferent axon brings information into a structure; an efferent axon carries information away from a structure. Every sensory neuron is an afferent to the rest of the nervous system, and every motor neuron is an efferent from the nervous system. Within the nervous system, a given neuron is an efferent from one structure and an afferent to another. (You can remember that efferent starts wiThe as in exit; afferent starts with a as in admission.) For example, an axon that is efferent from the thalamus may be afferent to the cerebral cortex. If a cell’s dendrites and axon are entirely contained within a single structure, the cell is an interneuron or intrinsic neuron of that structure. For example, an intrinsic neuron of the thalamus has its axon and all its dendrites within the thalamus.

3.2.4 Variations Among Neurons

Neurons vary enormously in size, shape, and function. The shape of a given neuron determines its connections with other neurons and thereby determines its contribution to the nervous system. Neurons with wider branching connect with more neurons. Neurons are distinguished from other cells by their shape. The larger neurons have these components: dendrites, a soma (cell body), an axon, and presynaptic terminals. (The tiniest neurons lack axons, and some lack well-defined dendrites.)

A motor neuron has its soma in the spinal cord. It receives excitation from other neurons through its dendrites and conducts impulses along its axon to a muscle. A sensory neuron is specialized at one end to be highly sensitive to a particular type of stimulation, such as light, sound, or touch. The sensory neuron is a neuron conducting touch information from the skin to the spinal cord. Tiny branches lead directly from the receptors into the axon, and the cell's soma is located on a little stalk off the main trunk.

The function of a neuron relates to its shape. For example, the widely branching dendrites of the Purkinje cell of the cerebellum enable it to receive input from a huge number of axons. By contrast, certain cells in the retina have only short branches on their dendrites and therefore pool input from only a few sources.

3.3 Communication in the neuron: The Resting Potential of the Neuron

The membrane of a neuron maintains an electrical gradient, a difference in electrical charge between the inside and outside of the cell. This membrane which is covering all parts of a neuron is about 8 nanometers (nm) thick (just less than 0.00001 mm), composed of two layers (an inner layer and an outer layer) of phospholipid molecules (containing chains of fatty acids and a phosphate group). Embedded among the phospholipids are cylindrical protein molecules (see Figure 2.3). The structure of the membrane provides it with a good combination of fiexibility and firmness and retards the fiow of chemicals between the inside and the outside of the cell.

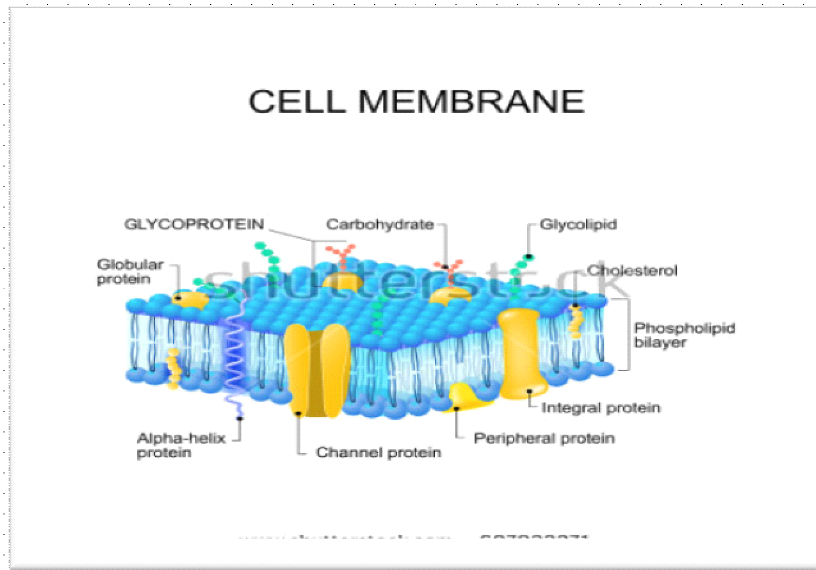


Figure 3.3

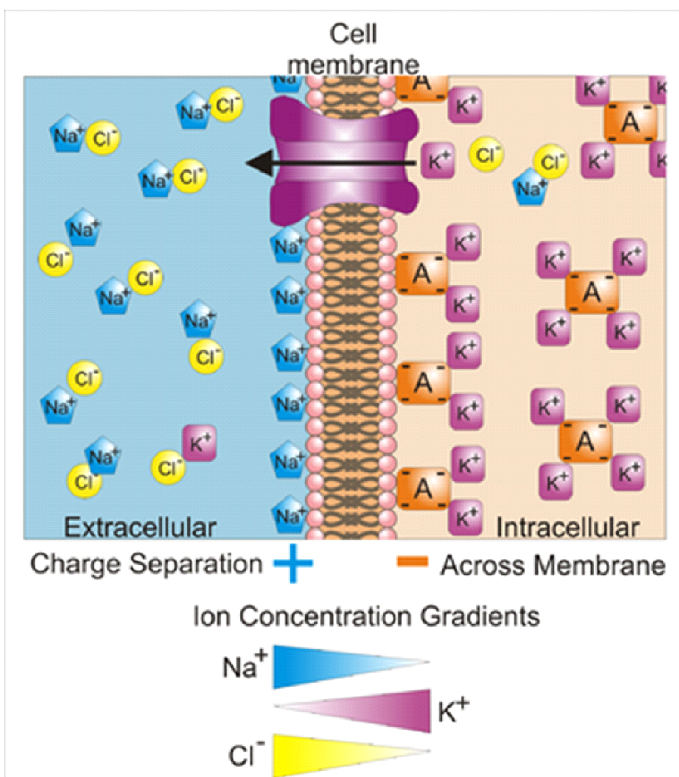


Figure 3.4

An electrical polarization, meaning a difference in electrical charge between two locations is maintained by the membrane in the absence of any outside disturbance. The neuron inside the membrane has a slightly negative electrical potential with respect to the outside, mainly because of negatively charged proteins inside the cell. This difference in voltage in a resting neuron is called the resting potential. The resting potential is mainly the result of negatively charged proteins inside the cell. A typical level electrical charge in a neuron during resting potential is –70 millivolts (mV), but it varies from one neuron to another.(Figure 3.4)

3.3.1 Forces Acting on Sodium and Potassium Ions

If the electrically charged ions could fiow freely across the membrane, the membrane would depolarize at once. But, since the membrane of neuron is selectively permeable; that is, only some chemicals can pass through it more freely than others. Most of the large or electrically charged ions and molecules cannot cross the membrane at all. Oxygen, carbon dioxide, urea, and water cross freely through channels that are always open. A few biologically important ions, such as sodium, potassium, calcium, and chloride, cross through membrane channels (or gates) that are sometimes open and sometimes closed.

During the resting potential the sodium channels remains closed, preventing almost all sodium fiow. Certain kinds of stimulation can open the sodium channels. Potassium channels are nearly but not entirely closed, when the membrane is at rest, allowing the potassium to fiow slowly. The sodium-potassium pump, a protein complex, repeatedly transports three sodium ions out of the cell while drawing two potassium ions into it. The sodium-potassium pump is an active transport requiring energy. As a result of the sodium-potassium pump, sodium ions are 10 times more concentrated outside the membrane than inside, and potassium ions are similarly more concentrated inside than outside.

The sodium-potassium pump is effective only because of the selective permeability of the membrane, which prevents the sodium ions that were pumped out of the neuron from leaking right back in again. As it is, the sodium ions that are pumped out stay out. However, some of the potassiumions pumped into the neuron do leak out, carrying a positive charge with them. That leakage increases the electrical gradient across the membrane.

When the neuron is at rest, two forces (the electrical gradient and the concentration gradient) act on sodium, both tending to push it into the cell. First, let us consider the electrical gradient. Sodium is positively charged and the inside of the cell is negatively charged. Opposite electrical charges attract, so the electrical gradient tends to pull sodium into the cell. Second, when we consider the concentration gradient, the difference in distribution of ions across the membrane. Sodium is more concentrated outside than inside, so just by the laws of probability, sodium is more likely to enter the cell than to leave it. (By analogy, imagine two rooms connected by a door. There are 100 cats are in room A and only 10 in room B. Cats are more likely to move from A to B than from B to A. The same principle applies to the movement of ions across a membrane.) Given that both the electrical gradient and the concentration gradient tend to move sodium ions into the cell, sodium would move rapidly if it could. However, the sodium channels are closed when the membrane is at rest, and almost no sodium fiows except for the sodium pushed out of the cell by the sodium-potassium pump.

Potassium is subject to competing forces. Potassium is positively charged and the inside of the cell is negatively charged, so the electrical gradient tends to pull potassium in. However, potassium is more concentrated inside the cell than outside, so the concentration gradient tends to drive it out. If the potassium channels were wide open, potassium would have a moderate net fiow out of the cell. That is, the electrical gradient and concentration gradient for potassium are almost in balance, but not quite. The sodium-potassium pump keeps pulling potassium in, so the two gradients cannot get completely in balance. The cell has negative ions, too. Negatively charged proteins inside the cell are responsible for the membrane's polarization. Chloride ions, being negatively charged, are mainly outside the cell. In most neurons, the concentration gradient and electrical gradient balance, so opening chloride channels produces little effect when the membrane is at rest. However, chloride fiow is important when the membrane's polarization changes, ions pumped into the neuron do leak out, carrying a positive charge with them. That leakage increases the electrical gradient across the membrane. (Figure 3.5)

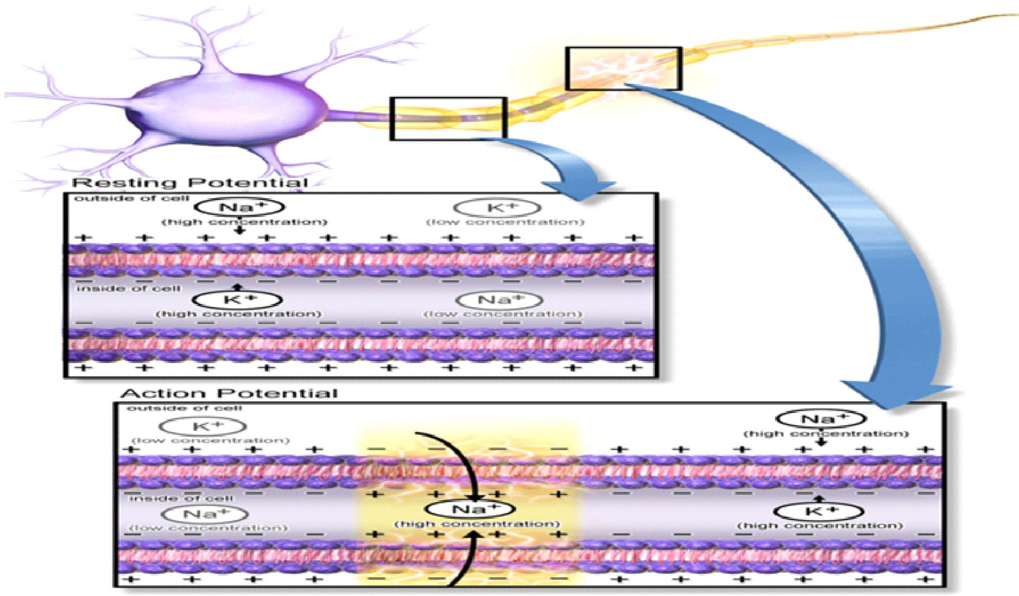


Figure 3.5

The resting potential prepares the neuron to respond rapidly. Excitation of the neuron opens channels that let sodium enter the cell explosively. Because the membrane did its work in advance by maintaining the concentration gradient for sodium, the cell is prepared to respond strongly and rapidly to a stimulus. The resting potential of a neuron can be compared to a poised bow and arrow: An archer who pulls the bow in advance and then waits, is ready to fire as soon as the appropriate moment comes. Evolution has applied the same strategy to the neuron.

3.4 The Action Potential

The resting potential remains stable until the neuron is stimulated. Ordinarily, stimulation of the neuron takes place at synapses. In the laboratory, it is also possible to stimulate a neuron by inserting an electrode into it and applying current. A neuron's electrical potential can be recorded with a microelectrode. When an axon's membrane is at rest, the recordings show a negative potential inside the axon. When negative charge is applied using another electrode, we can further increase the negative charge inside the neuron. This change is called hyperpolarization, which means increased polarization. As soon as the artificial stimulation ceases, the charge returns to its original resting level.

3.4.1 The Molecular Basis of the Action Potential

Both the electrical gradient and the concentration gradient tend to drive sodium ions into the neuron. If sodium ions could fiow freely across the membrane, they would enter rapidly. The membrane proteins that control sodium entry are voltage-gated channels, membrane channels whose permeability depends on the voltage difference across the membrane. At the resting potential, the channels are closed. As the membrane becomes depolarized, the sodium channels begin to open and sodium fiows more freely.

If the depolarization is less than the threshold, sodium crosses the membrane only slightly more than usual. When the potential across the membrane reaches threshold, the sodium channels open wide. Sodium ions rush into the neuron explosively until the electrical potential across the membrane passes beyond zero to a reversed polarity, as shown in the following diagram (3.1):

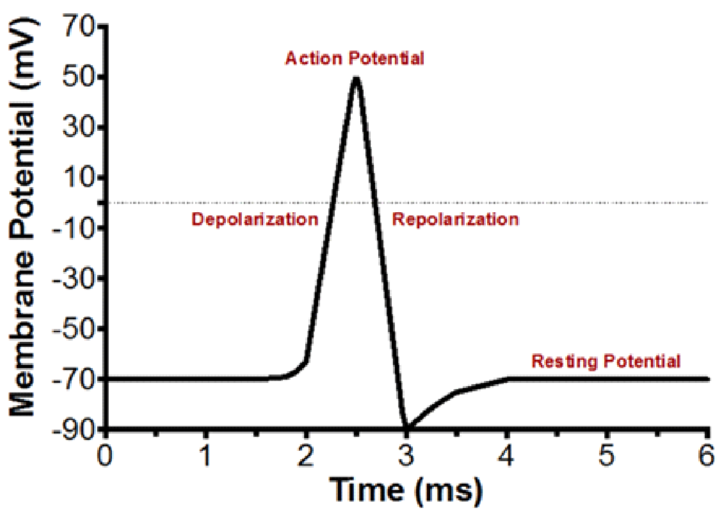


Diagram 3.1

Compared to the total number of sodium ions in and around the axon, fewer than 1% of them cross the membrane during an action potential. Even at the peak of the action potential, sodium ions continue to be far more concentrated outside the neuron than inside. Because of the persisting concentration gradient, sodium ions should still tend to diffuse into the cell. However, at the peak of the action potential, the sodium gates quickly close and resist reopening for about the next millisecond.

After the peak of the action potential, the voltage gated potassium channels open and brings the membrane back to its original state of polarization. When the potassium gates opens, potassium ions fiow out of the axon simply because they are much more concentrated inside than outside and they are no longer held inside by a negative charge. As they fiow out of the axon, they carry with them a positive charge. Because the potassium channels open wider than usual and remain open after the sodium channels close, enough potassium ions leave to drive the membrane beyond the normal resting level to a temporary hyperpolarization. Meanwhile, negatively charged chloride ions, which are more concentrated outside the membrane, are no longer repelled by a negative charge within the cell, so they tend to fiow inward.

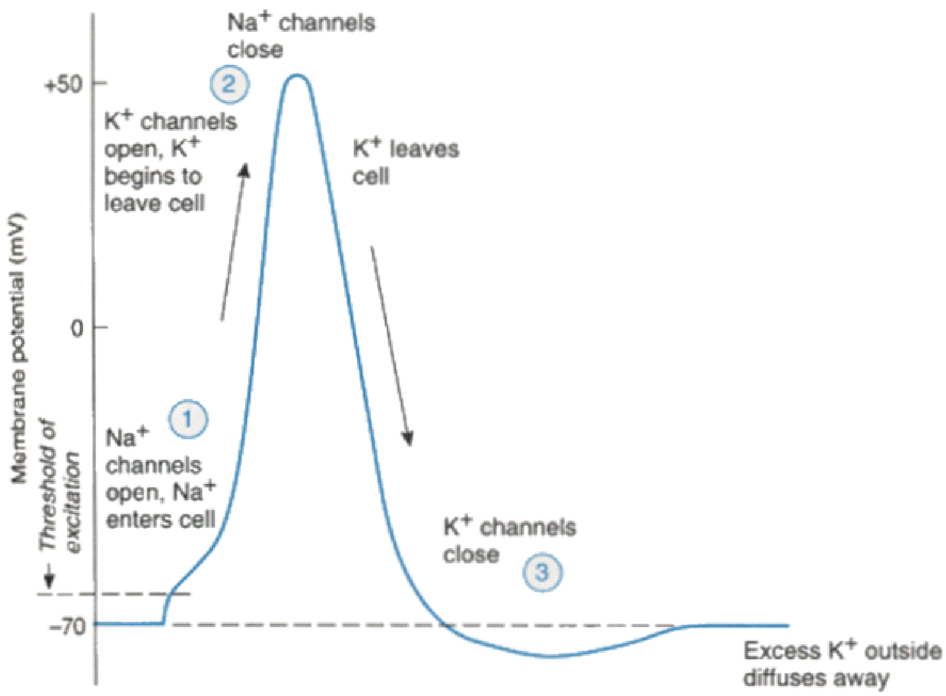


Diagram 3.2

Diagram 3.2 summarizes the key movements of ions during an action potential. At the end of this process, the membrane has returned to its resting potential, but the inside of the neuron has slightly more sodium ions and slightly fewer potassium ions than before. Eventually, the sodium-potassium pump restores the original distribution of ions, but that process takes time. Although the amplitude, velocity, and shape of action potentials are consistent over time for a given axon, they vary from one neuron to another.

The all-or-none law puts constraints on how an axon can send a message. To signal the difference between a weak stimulus and a strong stimulus, the axon can't send bigger or faster action potentials. All it can change is the timing. By analogy, suppose you agree to exchange coded messages with someone who can see your window when you fiick the lights on and off. The two of you might agree, for example, to indicate some kind of danger by the frequency of fiashes. (The more fiashes, the more danger.) Much of the brain's signaling follows this principle; more frequent action potentials signal a greater intensity of stimulus. You could also convey information by a rhythm. Flash-fiash . . . [long pause] . . . fiash-fiash might mean something different from Flash . . . [pause] . . . fiash . . . [pause] . . . fiash . . . [pause] . . . fiash. In some cases, the nervous system uses this kind of coding. For example, an axon might show one rhythm of responses for sweet tastes and a different rhythm for bitter tastes.

3.4.2 The Refractory Period

Immediately after an action potential, the cell is in a refractory period during which it resists the production of further action potentials. In the first part of this period, the absolute refractory period, the membrane cannot produce an action potential, regardless of the stimulation. During the second part, the relative refractory period, a stronger than usual stimulus is necessary to initiate an action potential.

The refractory period has two mechanisms: The sodium channels are closed, and potassium is fiowing out of the cell at a faster than usual rate. Most of the neurons that have been tested have an absolute refractory period of about 1 ms and a relative refractory period of another 2–4 ms. (For example in the toilet analogy, there is a short time right after you fiush a toilet when you cannot make it fiush again—an absolute refractory period. Then follows a period when it is possible but diffcult to fiush it again—a relative refractory period—before it returns to normal.)

3.4.3 The All-or-None Law

Action potentials occur only in axons and cell bodies. When the voltage across an axon membrane reaches a certain level of depolarization (the threshold), voltage-gated sodium channels open wide to let sodium enter rapidly, and the incoming sodium depolarizes the membrane still further. Dendrites can depolarize also, but they don't have voltage-gated sodium channels, so opening the channels a little, letting in a little sodium, doesn't cause them to open even more and let in still more sodium. Thus, dendrites don't have action potentials. If the dendrites depolarize the cell enough, its axon produces an action potential.

For a given neuron, all action potentials are approximately equal in amplitude (intensity) and velocity under normal circumstances. This is all-or-none law: The amplitude and velocity of an action potential are independent of the intensity of the stimulus that initiated it. By analogy, imagine fiushing a toilet: You have to make a press of at least a certain strength (the threshold), but pressing harder does not make the toilet fiush any faster or more vigorously.

3.4.4 Propagation of the Action Potential

Up to this point, we have seen how the action potential occurs at one point on the axon. Now let us see how it moves down the axon. It is important for axons to convey impulses without any loss of strength over distance. In a motor neuron, an action potential begins on the axon hillock, a swelling where the axon exits the soma. Each point along the membrane regenerates the action potential in much the same way that it was generated initially.

During the action potential, sodium ions enter a point on the axon. Temporarily, that location is positively charged in comparison with neighboring areas along the axon. The positive ions fiow down the axon and across the membrane. Other things being equal, the greater the diameter of the axon, the faster the ions fiow (because of decreased resistance). The positive charges now inside the membrane slightly depolarize the adjacent areas of the membrane,(as shown in Figure 3.6) causing the next area to reach its threshold and open the voltage-gated sodium channels. Therefore, the membrane regenerates the action potential at that point. In this manner, the action potential travels like a wave along the axon.

The term propagation of the action potential describes the transmission of an action potential down an axon. The propagation of an animal species is the production of off spring; in a sense, the action potential gives birth to a new action potential at each point along the axon. In this manner, the action potential can be just as strong at the end of the axon as it was at the beginning. The action potential is much slower than electrical conduction because it requires the diffusion of sodium ions at successive points along the axon.

Let's examine Figure 3.6 for a moment. What is to prevent the electrical charge from fiowing in the direction opposite to that, in which the action potential is travelingfi Nothing. In fact, the electrical charge does fiow in both directions. In that case, what prevents an action potential near the center of an axon from reinvading the areas that it has just passedfi The answer is that the areas just passed are still in their refractory period.

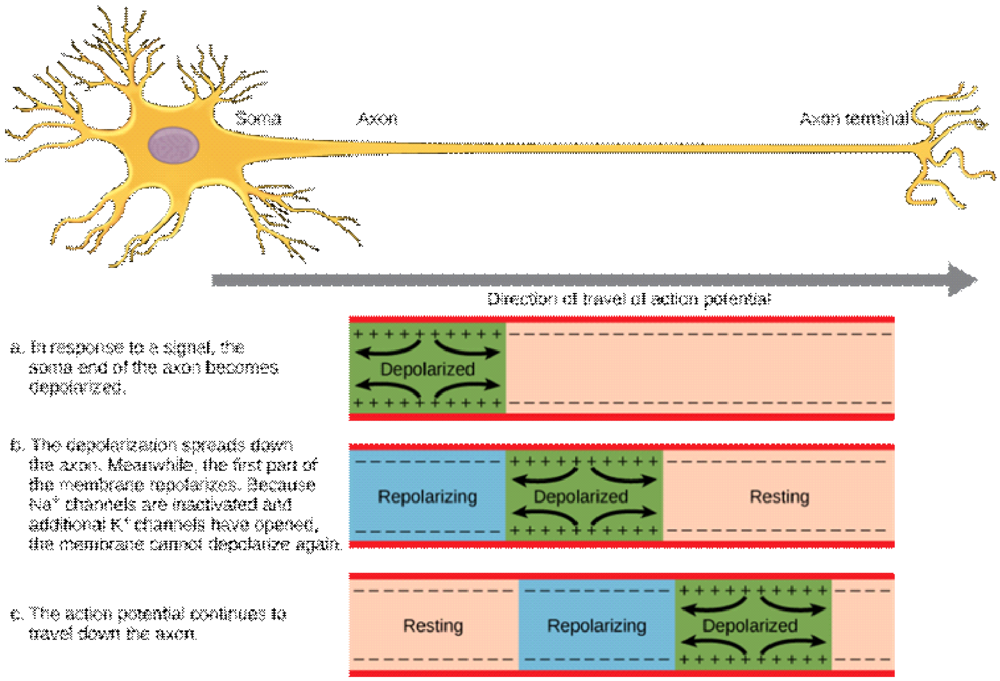


Figure 3.6

3.4.5 The Myelin Sheath and Saltatory Conduction

In the thinnest axons, action potentials travel at a velocity of less than 1 m/s. Increasing the diameter increases conduction velocity up to about 10 m/s. At that speed, an impulse along an axon to or from a giraffe's foot takes about half a second. To increase the speed up to about 100 m/s, vertebrate axons evolved a special mechanism: sheaths of myelin, an insulating material composed of fats and proteins. Consider the following analogy. Suppose my job is to take written messages over a distance of 3 kilometers (km) without using any mechanical device. Taking each message and running with it would be reliable but slow, like the propagation of an action potential along an unmyelinated axon. If I tied each message to a ball and threw it, I could increase the speed, but my throws would travel only a small fraction of the 3 km. The ideal compromise is to station people at moderate distances along the 3 km and throw the message-bearing ball from person to person until it reaches its destination. The principle behind myelinated axons, those covered with a myelin sheath, is the same.

Myelinated axons, found only in vertebrates, are covered with fats and proteins. The myelin sheath is interrupted periodically by short sections of axon called nodes of Ranvier

(Figure 3.7) Each node is only about 1 micrometer wide. Suppose an action potential starts at the axon hillock and propagates along the axon until it reaches the first myelin segment. The action potential cannot regenerate along the membrane between nodes because sodium channels are virtually absent between nodes.

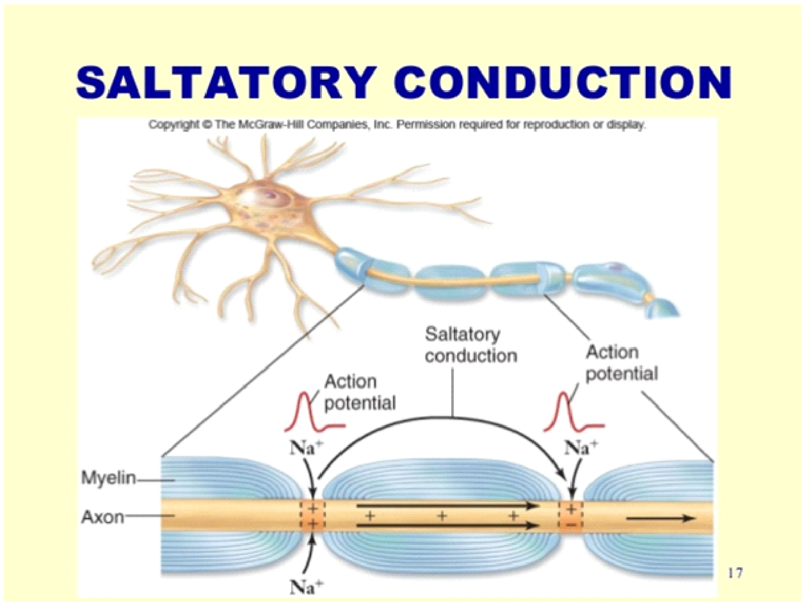


Figure 3.7

After an action potential occurs at a node, sodium ions enter the axon and diffuse within the axon, repelling positive ions that were already present and pushing a chain of positive ions along the axon to the next node, where they regenerate the action potential. This flow of ions is considerably faster than the regeneration of an action potential at each point along the axon. The jumping of action potentials from node to node is referred to as saltatory conduction, from the Latin word saltare, meaning “to jump.”

In addition to providing rapid conduction of impulses, saltatory conduction conserves energy: Instead of admitting sodium ions at every point along the axon and then having to pump them out via the sodium-potassium pump, a myelinated axon admits sodium only at its nodes. Multiple sclerosis is one of several demyelinating diseases, in which the immune system attacks myelin sheaths. An axon that never had a myelin sheath conducts impulses, though at a relatively slow speed. An axon that has lost its myelin is not the same. When myelin forms along an axon, the axon loses its sodium channels under the myelin. If the axon loses myelin, it still lacks sodium channels in the areas previously covered with myelin, and most action potentials die out between one node and the next. People with multiple sclerosis suffer a variety of impairments, ranging from visual impairments to poor muscle coordination.

3.5 Graded Potentials

Neurons without axons exchange information only with their closest neighbors and are therefore known as local neurons. A local neuron receives information from other neurons and produces graded potentials, membrane potentials that vary in magnitude without following the all-or-none law. When a local neuron is stimulated, it depolarizes or hyperpolarizes in proportion to the intensity of the stimulus. The change in membrane potential is conducted to adjacent areas of the cell, in all directions, gradually decaying as it travels. Those various areas of the cell contact other neurons, which they excite or inhibit through synapses.

3.6 Communication with Other Cells: Synapses

Neurons communicate with other cells through synapses, by means of a process known as synaptic transmission. A synapse is the junction of a terminal button of one neuron and the membrane of another cell—another neuron or a cell in a muscle, a gland, or an internal organ. Let us first consider synapses between one neuron and another. The terminal button belongs to the presynaptic neuron—the neuron "before the synapse" that sends the message. When terminal buttons become active, they release a chemical called a neurotransmitter.

The neuron that receives the message (that detects the neurotransmitter) is called the postsynaptic neuron—the neuron "after the synapse." A neuron receives messages from many terminal buttons, and in turn its terminal buttons form synapses with other neurons. There are two basic types of synapses: excitatory synapses and inhibitory synapses. Excitatory synapses do just what their name implies—when the axon fires, the terminal buttons release a neurotransmitter that excites the postsynaptic neurons with which they form synapses. The effect of this excitation is to increase the rate of firing of the axons of the postsynaptic neurons. Inhibitory synapses do just the opposite—when they are activated, they lower the rate at which these axons fire. The rate at which a particular axon fires is determined by the activity of all the synapses on the dendrites and soma of the cell. If the excitatory synapses are more active, the axon will fire at a high rate. If the inhibitory synapses are more active, it will fire at a low rate or perhaps not at all.

The neurotransmitter causes reactions in the postsynaptic neuron that either excite or inhibit it. These reactions are triggered by special sub microscopic protein molecules embedded in the postsynaptic membrane called neurotransmitter receptors. A molecule of a neurotransmitter binds with its receptor the way a particular key fits in a particular lock. After their release from a terminal button, molecules of a neurotransmitter diffuse across the synaptic cleft, bind with the receptors, and activate them. Once they are activated, the receptors produce excitatory or inhibitory effects on the postsynaptic neuron. They do so by opening ion channels.

Most ion channels found at excitatory synapses permit sodium ions to enter the postsynaptic membrane; most of those found at inhibitory synapses permit potassium ions to leave. The excitation or inhibition produced by a synapse is short-lived; the effects soon pass away, usually in a fraction of a second. At most synapses the effects are terminated by a process called reuptake. Molecules of the neurotransmitter are released and are quickly taken up again by the terminal button, so the neurotransmitter has only a short time to stimulate the postsynaptic receptors. The rate at which the terminal button takes back the neurotransmitter determines how prolonged the effects of the chemical on the postsynaptic neuron will be. The faster the neurotransmitter is taken back, the shorter its effects will be on the postsynaptic neuron.

3.6.1 A simple neural circuit

The ‘neural wiring diagram’ for a simpler reflexes that are triggered by certain kinds of sensory stimuli. For example, when your finger touches a painfully hot object, your hand withdraws. A simple withdrawal reflex, which is triggered by a noxious stimulus (such as contact with a hot object), requires three types of neuron. Sensory neurons detect the noxious stimulus and convey this information to the spinal cord. Interneurons, located entirely within the brain or spinal cord, receive the sensory information and in turn stimulate the motor neurons that cause the appropriate muscle to contract. The sequence is simple and straightforward. A noxious stimulus applied to the skin produces a burst of action potentials in the sensory neurons. Their axons fire, and their terminal buttons, located within the spinal cord, release an excitatory transmitter substance. The chemical stimulates the interneurons and causes them to fire. The interneurons excite the motor neurons, and these neurons cause the muscle to contract.

The next example adds a bit of complexity to the circuit. Imagine that you have removed a hot casserole dish from the oven. As you move over to the table to put it down, the heat begins to penetrate the rather thin oven gloves you are using. The pain caused by the hot dish triggers a withdrawal reflex that tends to make you drop it. And yet you manage to keep hold of it long enough to get to the table and put it down. The answer is that the activity of a neuron depends on the relative activity of the excitatory and inhibitory synapses on it. The pain from the hot casserole dish increases the activity of excitatory synapses on the motor neurons, which tends to cause the hand to open. However, this excitation is counteracted by inhibition from another source – the brain.

The brain contains neural circuits that recognize what a disaster it would be if you dropped the casserole dish on the floor. These neural circuits send information to the spinal cord that prevents the withdrawal reflex from making you drop the dish. An axon from a neuron in the brain reaches the spinal cord, where it forms a synapse with an inhibitory interneuron. When the neuron in the brain becomes active, it excites this inhibitory interneuron. The interneuron releases an inhibitory transmitter substance, which decreases the rate of firing of the motor neuron, preventing your hand from opening. This circuit provides an example of a contest between two competing tendencies: to drop the casserole dish and to hold onto it. Complex decisions about behaviour are made within the brain by much more complicated circuits of neurons, but the basic principles remain the same.

3.8 Conclusion

The cell body of a neuron is the site of synthesis and degradation of virtually all neuronal proteins and membranes. Axons are long processes specialized for the conduction of action potentials away from the neuronal cell body. Action potentials are sudden membrane depolarizations followed by a rapid repolarization. They originate at the axon hillock and move toward axon terminals, where the electric impulse is transmitted to other cells via an electric or chemical synapse Most neurons have multiple dendrites, which receive chemical signals from the axon termini of other neurons. When an action potential reaches a chemical synapse, a neurotransmitter is released into the synaptic cleft. Binding of the neurotransmitter to receptors on the postsynaptic cell changes the ion permeability and thus the electric potential of the postsynaptic plasma membrane. Neurons are organized into circuits. In a reflex arc, such as the knee-jerk reflex, interneurons connect multiple sensory and motor neurons, allowing one sensory neuron to affect multiple motor neurons. One muscle can be stimulated to contract while another is inhibited from contracting.

3.9 SUMMARY:

The nervous system is the basis of all that we refer to as psychological--thoughts, feelings, moods, behaviors. Nervous system consists of two major regions: the central nervous system consisting of brain and spinal cord and the peripheral nervous system. The most fundamental structure of the nervous system is a single cell called a neuron. The neurons are different from other cells of the body in that they are capable of carrying signals and relaying information. Although neurons play different roles and come in a variety of sizes and shapes, all can be described in terms of the same functional parts, including dendrites, axons, and axon terminals. Some neurons bring sensory information to the brain, others carry commands from the brain to muscles and glands, and still others serve communication functions entirely within the brain and spinal cord. A neuron's dendrites receive incoming information; its axon carries the information to other cells through axon terminals, which send a chemical messenger to other cells. The signals carried by the neurons take the form of electrical impulses, or action potentials, which involve the movement of electrically charged particles across the cell's membrane. These movements result in changes in the electrical balance across the membrane, carrying the impulses down the axon to the axon terminal, where, through synaptic transmission, the neuron sends messages to other cells. In synaptic transmission, minute quantities of chemical messengers called neurotransmitters flow across a tiny gap between cells, called the synapse. Upon reaching the cell that is receiving information, neurotransmitter molecules bind to special receptor sites and in that fashion affect the electrical balance of the receiving cell.

3.10 KEY WORDS

:: Absolute refractory period:

The period immediately following the firing of a nerve fiber when it cannot be stimulated no matter how great a stimulus is applied.

:: Action potential:

A rapid rise and subsequent fall in voltage or membrane potential across a cellular membrane with a characteristic pattern.

:: All-or-none Law:

The amplitude and velocity of an action potential are independent.

:: Axon:

Tube like long extension from the end of a neuron that carries messages to other cells through the neuron.

:: Concentration gradient:

The process of particles, which are sometimes called solutes, moving through a solution or gas from an area with a higher number of particles to an area with a lower number of particles.

:: Dendrites:

Cluster of fibers at one end of a neuron that receives messages from other neurons.

:: Depolarization:

Movement of a cell's membrane potential to a more positive value (i.e. movement closer to zero from resting membrane potential).

:: Electrical gradience :

Difference in charge across a membrane.

:: Glia:

The structural glue (that is what glia means in Greek) that holds the neurons in place

:: Hyper polarization:

Increased polarization

:: Myelin sheath:

axons protective coating, made of fat and protein. Its function is to prevent messages from short circulating by insulating the axons.

:: Polarization:

A difference in electrical charge between two locations, maintained by the membrane in the absence of any outside disturbance.

:: Refractory period:

Period immediately following stimulation during which a nerve or muscle is unresponsive to further stimulation.

:: Relative refractory period:

Is when the neuron is able to respond to a stimulus but needs a stronger than normal stimulus in order to do so and is longer in duration.

:: Resting potential:

The imbalance of electrical charge existing between the interior of electrically excitable neurons (nerve cells) and their surroundings. The resting potential of electrically excitable cells lies in the range of -60 to -95 millivolts (1 millivolt = 0.001 volt), with the inside of the cell negatively charged.

:: Saltatory conduction:

The propagation of action potentials along myelinated axons from one node of Ranvier to the next node, increasing the conduction velocity of action potentials.

:: Selective permeability:

Only some chemicals can pass through more freely than others.

:: Synapse:

The junction of a terminal button of one neuron and the membrane of another cell—another neuron or a cell in a muscle, a gland, or an internal organ.

:: Terminal buttons:

Small branches at the end of an axon that relay massages to other cells. Electrical messages travel through neuron beginning with detection of messages by General Psychology 43 dendrites, continue into the cell body (nucleus) and pass down the axon.

3.11 CHECK YOUR PROGRESS

1. The chief structural and functional units of the nervous system.________
2. The name of the neuron that conducts an impulse from a receptor organ to the CNS is ______________.
3 The neuron that transmits impulses from the CNS to an effector, such as amuscle or gland is called as ________
4. The name of the neuron that function as integrating centre, located between sensory neuron and a motor neuron is _________
5. The lipoprotein material that forms a sheath like covering around some nerve is known as________
6. ____________ is the fiber that conducts a nerve impulse away from a neuron cell body.
7. The name of the nerve fiber that transmits impulses toward a neuron cell body is __________
8. ____________________ is the portion of a nerve cell that includes a cytoplasmic mass and a nucleolus, and from which the nerve fibers extend.
9. Impulses travel much more rapidly along which neurons?
10. Which sheath of neuron is particularly good conductor of electric impulse?
11. Name the active transport mechanism that concentrates sodium ions on the outside of a plasma membrane and potassium ions on the inside of the membrane.
12. What is the measuring unit of resting membrane potential?
13. What is the normal resting membrane potential?
14. Name the type of nerve impulse conduction in which the impulse seems to jump from one neuro fibril node to the next.
15. Name the junction between the axon of one neuron and the dendrite of another neuron or effector cell.
16. Name the neuron carrying the action potential toward a synapse.
17. Name the chemical substance that the terminal end of an axon secretes that either stimulates or inhibits a muscle fiber contraction or an impulse in another neuron.

3.12 ANSWERS TO CHECK YOUR PROGRESS

1. Neurons
2. Interneuron
3. Motor neuron
4. Inter neuron
5. Myelin
6. Axon
7. Dendrite
8. Cell body
9. Myelinated neurons
10. Myelin sheath
11. Sodium Potassium pump.
12. Millivolts
13. -70mv
14. Saltatory conduction
15. Synapse
16. Presynaptic neuron
17. Neuro transmitter.

3.13 MODEL QUESTIONS:

1. Explain the molecular basis of resting potential.
2. Describe the different types of neurons.
3. Explain the structure of neuron.

LESSON - 4

NEUROTRANSMITTERS AND ITS FUNCTIONS

INTRODUCTION

The previous lesson explains how electrical signals are generated and propagated along the axon. It also covered how the action potential is communicated between the neurons. If we compare neurons to electrical circuits, the understanding of neuronal activity in its target is clear. Each wire in a circuit connects to the next wire in a circuit and current ?ows uninterrupted through all of them. But very few neurons are connected together in this way. Instead, communication between neurons usually relies on neurochemical transmission. This lesson explains the neurochemical transmission through neurotransmitters.

OBJECTIVES OF THE LESSON

At the end of this lesson you will be able to understand

- The common neurotransmitters.
- the effects of neurotransmitters in the body.
- the effect of altered concentrations of specific neurotransmitters upon the system.

PLAN OF THE LESSON

4.1 Definition of a Neurotransmitter

4.2 Process of neurotransmission

4.3 Difference between neurotransmission and other chemical signaling

4.4 Characteristics of neurotransmitters

4.5 Classification of neurotransmitters

4.6 Types of Neurotransmitters

4.7 Functions of neurotransmitters

4.8 Monoamines

4.9 Histamine

4.10 Drugs

4.11 Effect of neurotransmitter dysfunction

4.1 Definition of a Neurotransmitter

Neurotransmitters are types of hormones in the brain that transmit information from one neuron to another. They are made by amino acids. Neurotransmitters control major body functions including movement, emotional response, and the physical ability to experience pleasure and pain. They are produced in the terminal buttons (bulbs) of the neurons and stored in the synaptic vesicles. Their action is local when released into synapses to affect adjacent neurons, muscles, or glands. The action of these chemicals is due to the three-dimensional shape of the chemical molecules. Receptors at various sites only allow for particularly shaped molecules to trigger changes at the cellular membranes that then allow for channels in the membranes to open and allow ions to enter. This, in turn, alters the electrochemical charge of the cell relative to the surrounding environment, resulting in action potentials and neural transmission.

Neurotransmitters transmit the nerve impulse from the pre-synaptic neuron to the post-synaptic neuron through the synapse. Neurotransmitters are synthesized by the ribosome of the pre-synaptic neurons and stored in a synaptic vesicle in the cytoplasm of the pre-synaptic neuron. When a nerve impulse (action potential) stimulates the pre-synaptic neuron, it causes the opening of the calcium channels in the cell membrane of the pre-synaptic neurons. These calcium ions enter the cell and cause the synaptic vesicles to fuse with the pre-synaptic membrane and therefore releases the neurotransmitters into the synaptic cleft which is the space between two neurons.

In the post-synaptic cell membrane of the receiving neuron, there are many receptors for the neurotransmitters. These receptors are basically large protein molecules to which the neurotransmitters bind. Think of the neurotransmitters and the receptors as “locks and keys”. Certain keys fit into certain locks. It is the same with neurotransmitters and receptors.

When a neurotransmitter binds with a receptor, it either excites or inhibits the post-synaptic neurons. In the case of excitation, the neurotransmitter causes the post-synaptic neuron to generate an action potential and in the case of inhibition, the neurotransmitter prevents the post-synaptic neuron from generating an action potential.

Because neurotransmitters have two general effects on postsynaptic membranes—excitatory or inhibitory—it is expected that there would be two kinds of neurotransmitters. But in reality there are many different kinds—several dozen, at least. In the brain most synaptic communication is accomplished by two neurotransmitters: glutamate, which has excitatory effects, and GABA, which has inhibitory effects. (GABA stands for gamma-amino butyric acid.) Almost every neuron in the brain receives excitatory input from terminal buttons that secrete glutamate and inhibitory input from terminal buttons that secrete GABA.

The other neuro transmitters, in general, have modulating effects rather than information transmitting effects. That is, the release of neurotransmitters other than glutamate and GABA tends to activate or inhibit entire circuits of neurons that are involved in particular brain functions. These effects include facilitation of learning, control of wakefulness and vigilance, suppression of impulsive behaviors, and suppression or enhancement of anxiety.

4.2 Process of neurotransmission

To understand the effect of neurotransmitters, we must first understand what occurs in the process of neurotransmission. We will start with an oversimplified version for better understanding and then follow up with a more detailed explanation. A nerve impulse, which is an electrical signal, travels along the neural pathway until it reaches the end. At this point the electrical signal is converted to a chemical signal. This area, which converts the electrical signal into chemical signal, is called a synapse. The chemical signal is called a neurotransmitter. The nerve impulse then reaches the neuron on the other side, and once again becomes an electrical signal.

The arrival of a nerve impulse (or action potential) triggers the release of a neurotransmitter. This triggering occurs through an unusually rapid process of cellular secretion, also known as exocytosis. (Figure 4.1)

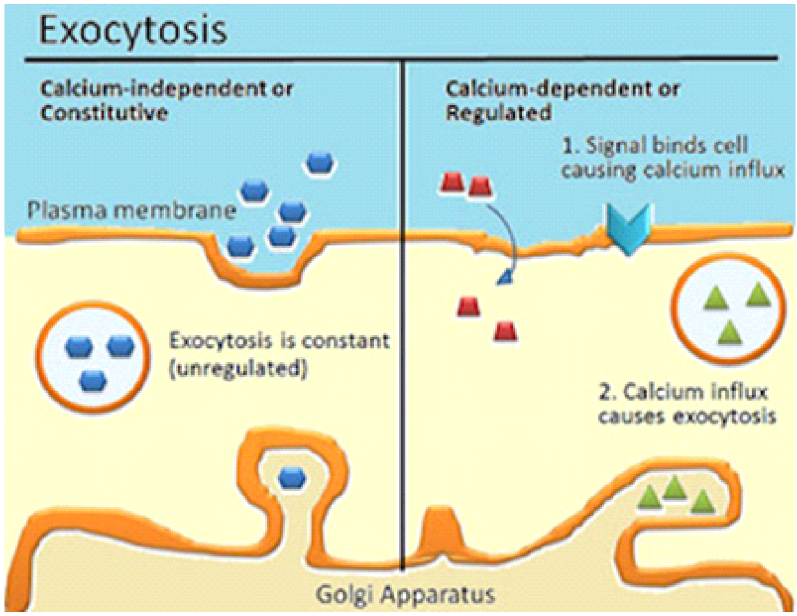


Figure 4.1

Within the presynaptic nerve terminal, vesicles containing neurotransmitter are anchored and ready at the synaptic membrane. Neurotransmitters are packaged into vesicles that cluster beneath the membrane on the presynaptic side of a synapse. When they are released into the synaptic cleft, they bind to receptors located in the membrane on the postsynaptic side of the synapse. The release of neurotransmitters is most commonly driven by arrival of an action potential at the synapse, but may also be driven by graded electrical potentials. Also, there is often a low level of "baseline" release even in the absence of electrical stimulation.

The arriving action potential produces an influx of calcium ions through voltage dependent, calcium-selective ion channels at the down stroke of the action potential (tail current). Calcium ions then trigger a biochemical flood which results in vesicles releasing their contents (neurotransmitters) in to the synaptic cleft within 180 microseconds of calcium entry. As calcium ions enter into the presynaptic neuron, they bind with the proteins found within the membranes of the synaptic vesicles that allow the vesicles to "anchor."

Triggered by the binding of the calcium ions, the synaptic vesicle proteins begin to move apart. This results in the creation of a fusion pore, which allows for the release of neurotransmitter into the synapse. The membrane added by this fusion is later retrieved by endocytosis and recycled for the formation of fresh neurotransmitter-filled vesicles. (Figure 4.2)

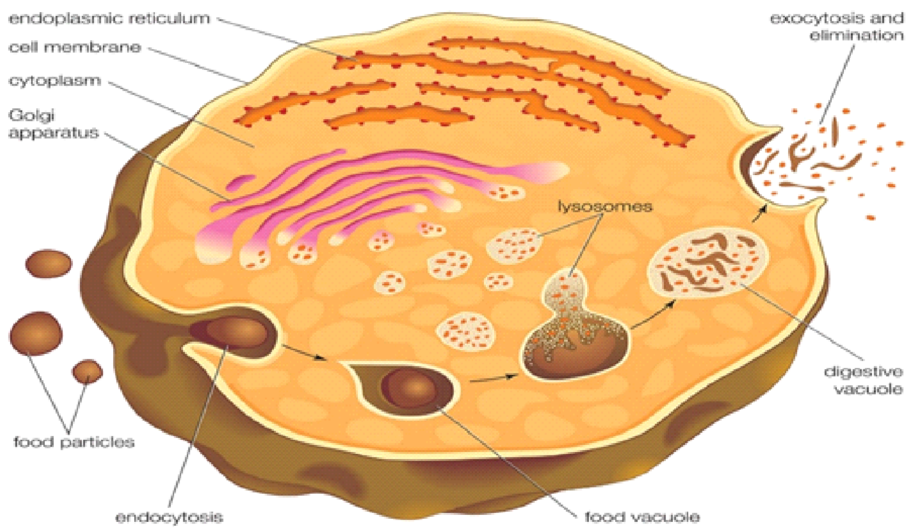


Figure 4.2

4.2.1 Receptor Binding

Receptors on the opposite side of the synaptic gap bind neurotransmitter molecules and respond by opening nearby ion channels in the postsynaptic cell membrane, causing ions to rush in or out and changing the local transmembrane potential of the cell. Generally the 'lock and key' hypothesis is used to illustrate the interaction between a neurotransmitter and its receptor. The key (the neurotransmitter) can only unlock (activate) a lock (the receptor) if it fits perfectly into the keyhole (neurotransmitter binding site) of the lock.

Receptors and auto receptors are sensitive to the neurotransmitter concentration in the synaptic cleft. Auto receptors regulate the release of the neurotransmitter from the presynaptic neuron – when these presynaptic receptors are fully occupied, neurotransmitter production is stopped. Almost every neurotransmitter can bind to more than one type of receptor, and each neurotransmitter can initiate different signals at the postsynaptic neuron. This all adds to the complexity of chemical signaling.

Binding of a neurotransmitter to its receptor on the postsynaptic membrane can activate channels in the postsynaptic neuron resulting in a change in the membrane potential. This initiates an excitatory or inhibitory postsynaptic potential that changes the excitability of the postsynaptic neuron and initiates an action potential. The resulting change in voltage is called a postsynaptic potential. In general, the result is excitatory, in the case of depolarizing currents, or inhibitory in the case of hyperpolarizing currents. Whether a synapse is excitatory or inhibitory depends on what type(s) of ion channel conduct the postsynaptic current display(s), which in turn is a function of the type of receptors and neurotransmitter employed at the synapse. (Figure 4.3)

► **Seven Processes in Neurotransmitter Action**

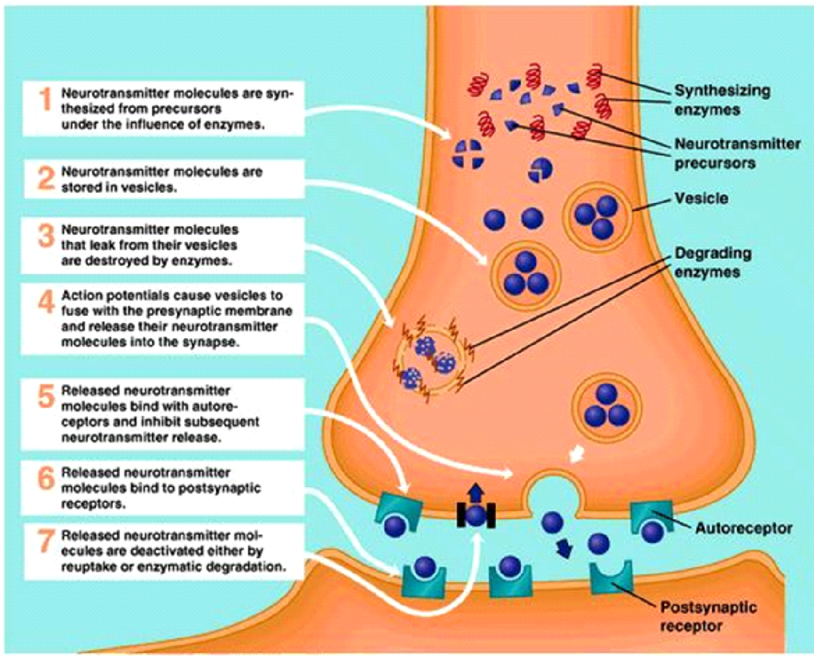


Figure 4.3

In this way, the electrical signal or impulse is transmitted down the neuronal pathway. Once the action potential is initiated, the transmitter must then be rapidly removed from the synaptic cleft, to enable the postsynaptic cell to engage in another cycle of signal generation. The release of a neurotransmitter from its nerve terminal is not only dependent upon the passage of an action potential, but also on the inter synaptic concentration of the transmitter. This is known as presynaptic inhibition.

At certain synapses, such as noradrenergic, GABAergic, dopaminergic and serotonergic synapses, the release of the neurotransmitter may be reduced by the presence of high concentrations of the transmitter in the synaptic cleft. The release of a neurotransmitter can also be affected by a variety of other neurotransmitters; for example, stimulation of serotonin receptors on noradrenergic terminals can lead to an enhanced release of noradrenaline. Such receptors are termed heteroreceptors. (Figure 4.4)

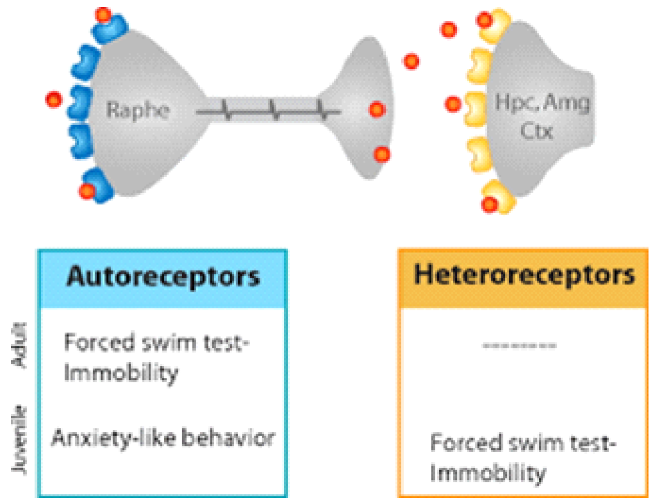


Figure 4.4

Neurons and synapses occur in specific patterns in the brain, giving rise to complex neuronal circuits. This results in the specialization of different regions of the brain for different functions and allows us to integrate information such as sound, vision, smell, taste and touch. Each neurotransmitter is made by a small number of neurons whose cell bodies are clustered in specific areas of the brain. For example, noradrenaline is synthesized mainly by neurons in the brainstem, specifically in the locus coeruleus, which is situated in the pons; the cell bodies of the dopamine neurons are clustered in a few brain regions, most importantly those deep within the midbrain. However, the axons of these neurons extend throughout the brain and influence almost the entire organ.

4.2.2 Termination

After a neurotransmitter molecule binds to a receptor molecule, it does not stay bound forever: sooner or later it is shaken loose by random temperature-related jiggling. Once the neurotransmitter breaks loose, it can either drift away, or bind again to another receptor molecule. The pool of neurotransmitter molecules undergoing this binding-loosening cycle steadily diminishes, however. Neurotransmitter molecules are typically removed in one of two ways, depending on the type of synapse: either they are taken up by the presynaptic cell (and then processed for re-release during a later action potential), or else they are broken down by special enzymes. The time course of these "clearing" processes varies greatly for different types of synapses, ranging from a few tenths of a millisecond for the fastest, to several seconds for the slowest.

Neurotransmitters must be broken down once it reaches the post-synaptic cell to prevent further excitatory or inhibitory signal transduction. For example, acetylcholine, (ACH) (an excitatory neurotransmitter), is broken down by acetyl cholinesterase (AchE). Choline is taken up and recycled by the pre-synaptic neuron to synthesize more ACH. Other neurotransmitters such as dopamine are able to diffuse away from their targeted synaptic junctions and are eliminated from the body via the kidneys, or destroyed in the liver. Each neurotransmitter has very specific degradation pathways at regulatory points, which may be the target of the body's own regulatory system or recreational drugs.

4.3 Difference between neurotransmission and other chemical signaling

There are many other signaling system of chemicals such as hormones, neurohormones, and paracrine signalling in the human body. However neurotransmitters have advantages in having a greater degree of amplification and control of the signal. It also lengthens the time of cellular integration from milliseconds to minutes and even hours. While hormones are mainly synthesized in gland, neurotransmitters are synthesized and released from neurons. Neurotransmitters are, as far as we know, only released in response to an electrical signal. There are many mechanisms that must exist to terminate the action of the neurotransmitters such as chemical deactivation, recapture (endocytosis), glial uptake and diffusion.

4.4 Characteristics of neurotransmitters

A chemical can be classified as a neurotransmitter if it meets the following conditions:

- There are precursors and/or synthesis enzymes located in the presynaptic side of the synapse.
- The chemical is present in the presynaptic element.
- It is available in sufficient quantity in the presynaptic neuron to affect the postsynaptic neuron;

- There are postsynaptic receptors and the chemical is able to bind to them.
- A biochemical mechanism for inactivation is present.

4.5 Classification of neurotransmitters

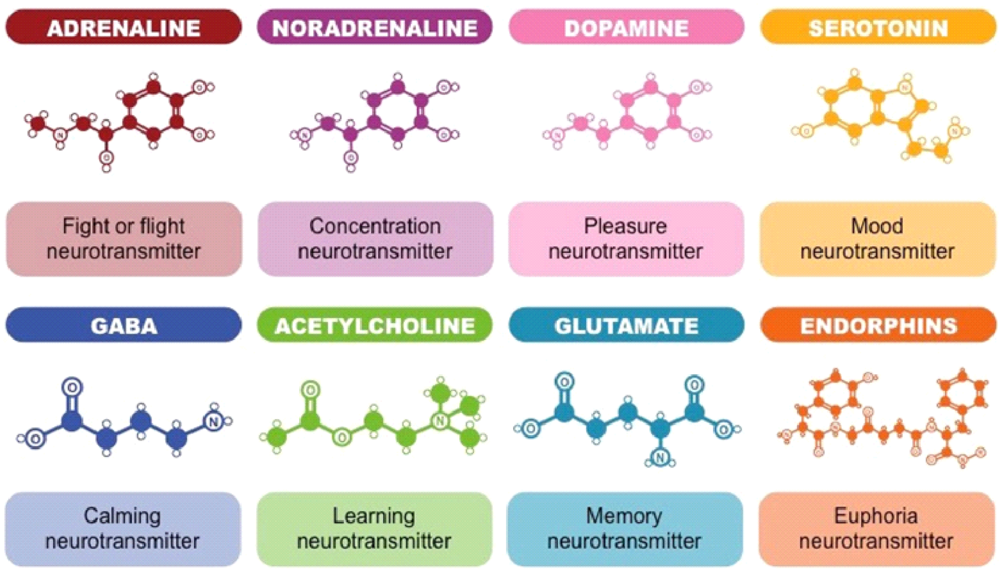
There are many different ways to classify neurotransmitters. Dividing them into amino acids, peptides, and monoamines is sufficient for some purposes. Approximately ten "small-molecule neurotransmitters" are known:

- Acetylcholine (ACh)
- Monoamines: norepinephrine (NE), dopamine (DA), serotonin (5-HT), melatonin
- Amino acids: glutamate, gamma aminobutyric acid (GABA), aspartate, glycine, histamine
- Purines: Adenosine, ATP, GTP, and their derivatives

In addition, over 50 neuroactive peptides have been found, and new ones are discovered on a regular basis. Many of these are "co-released" along with a small molecule transmitter, but in some cases a peptide is the primary transmitter at a synapse. Single ions, such as synaptically released zinc, are also considered neurotransmitters by some, as are a few gaseous molecules such as nitric oxide (NO) and carbon monoxide (CO). These are not neurotransmitters by the strict definition, however, because although they have all been shown experimentally to be released by presynaptic terminals in an activity-dependent way, they are not packaged into vesicles.

Not all neurotransmitters are equally important. By far the most prevalent transmitter is glutamate, which is used at well over 90% of the synapses in the human brain. The next most prevalent is GABA, which is used at more than 90% of the synapses that don't use glutamate. However, that even though other transmitters are used in far fewer synapses, they may be very important functionally: the great majority of psychoactive drugs exert their effects by altering the actions of some neurotransmitter system, and the great majority of these act through transmitters other than glutamate or GABA. Addictive drugs such as cocaine, amphetamine, and heroin, for example, exert their effects primarily on the dopamine system.

4.6 Types of Neurotransmitters



Neurotransmitters can be broadly classified into two categories; excitatory and inhibitory. Some neurotransmitters can serve both functions. Some neurotransmitters are commonly described as "excitatory" or "inhibitory". It is important to understand what these terms mean. The only thing that a neurotransmitter does directly is to activate one or more types of receptors. The effect on the postsynaptic cell depends entirely on the properties of the receptors. It so happens that for some neurotransmitters (for example, glutamate), the most important receptors all have excitatory effects: that is, they increase the probability that the target cell will fire an action potential. For other neurotransmitters (such as GABA), the most important receptors all have inhibitory effects.

There are, however, other important neurotransmitters, such as acetylcholine, for which both excitatory and inhibitory receptors exist; and there are some types of receptors that activate complex metabolic pathways in the postsynaptic cell to produce effects that cannot appropriately be called either excitatory or inhibitory.

4.6.1 Excitatory neurotransmitters

Excitatory neurotransmitters are the nervous system's "on switches", increasing the likelihood that an excitatory signal is sent. They act like a car's accelerator, revving up the engine. Excitatory transmitters regulate many of the body's most basic functions including: thought processes, the body's fight or flight response, motor movement and higher thinking. Physiologically, the excitatory transmitters act as the body's natural stimulants, generally serving to promote alertness, energy, and activity. Common excitatory neurotransmitters are

- Dopamine
- Histamine
- Norepinephrine
- Epinephrine
- Glutamate
- Acetylcholine

4.6.2 Inhibitory neurotransmitters

Without a functioning inhibitory system to put on the brakes, things can get out of control. Inhibitory neurotransmitters are the nervous system's "off switches", decreasing the likelihood that an excitatory signal is sent. Excitation in the brain must be balanced with inhibition. Too much excitation can lead to restlessness, irritability, insomnia, and even seizures. Inhibitory transmitters regulate the activity of the excitatory neurotransmitters, much like the brakes on a car. The inhibitory system slows things down. Physiologically, the inhibitory transmitters act as the body's natural tranquilizers, generally serving to induce sleep, promote calmness, and decrease aggression. Most common inhibitory neurotransmitters are :

- GABA
- Dopamine
- Serotonin
- Acetylcholine
- Taurine

4.7 Functions of neurotransmitters

As many as 200 neurotransmitters are postulated, but we will discuss only a few of the better known and most prominent in detail. The most familiar neurotransmitters, which are thought to play a role in mood regulation, are serotonin, norepinephrine, dopamine, acetylcholine, and GABA.

4.7.1 Acetylcholine:

Acetylcholine is distinguished as the transmitter at the neuromuscular junction connecting motor nerves to muscles. Acetylcholine release can be excitatory or inhibitory depending on the type of tissue and the nature of the receptor with which it interacts. It plays numerous roles in the nervous system. Its primary action is to stimulate the skeletal muscular system. It is the neurotransmitter used to cause voluntary muscle contraction or relaxation in the muscles. In the brain, acetylcholine is involved in learning and memory.

Acetylcholine is a small molecule transmitter that is also found in the hippocampus and prefrontal cortex. The hippocampus is responsible for memory and memory retrieval. The paralytic arrow-poison curare acts by blocking transmission of signals at the (motor nerve to muscle) synapses. Blocking acetylcholine results in muscle paralysis, including the diaphragm. Insecticides, and nerve gases also have their effects by way of blocking normal acetylcholine functioning.

Acetylcholine also operates in many regions of the brain, but using different types of receptors. Alzheimer’s disease is associated with a lack of acetylcholine in certain regions of the brain. The chemical compound acetylcholine (often abbreviated ACh) is a neurotransmitter in both the peripheral nervous system (PNS) and central nervous system (CNS) in many organisms including humans. Acetylcholine is one of many neurotransmitters in the autonomic nervous system (ANS) and the only neurotransmitter used in the somatic nervous system. It is also the neurotransmitter in all autonomic ganglia.

Because all muscular movement is accomplished by the release of acetylcholine, it is not surprise to learn that the immune systems of people with myasthenia gravis attack acetylcholine receptors. The axons and terminal buttons of acetyl cholinergic neurons are distributed widely throughout the brain.

Two drugs, botulinum toxin and the venom of the black widow spider, affect the release of acetylcholine. Botulinum toxin, produced by a bacterium that can grow in improperly canned food, prevents the release of ACh. The drug is an extremely potent poison; someone once calculated that a teaspoonful of pure botulinum toxin could kill the world’s entire human population. Extremely dilute solutions of this drug, usually referred to as botox, can be injected into people’s facial muscles to stop muscular contractions that are causing wrinkles. Black widow spider venom has the opposite effect: It stimulates the release of ACh.

4.7.1.1 Functions

Acetylcholine has functions both in the peripheral nervous system (PNS) and in the central nervous system (CNS) as a neuromodulator. In the PNS, acetylcholine activates muscles, and is a major neurotransmitter in the autonomic nervous system. In the CNS, acetylcholine and the associated neurons form a neurotransmitter system, the cholinergic system, which tends to cause excitatory actions.

In PNS When acetylcholine binds to acetylcholine receptors on skeletal muscle fibers, it opens ligand gated sodium channels in the cell membrane. Sodium ions then enter the muscle cell, stimulating muscle contraction. In CNS In the central nervous system, ACh has a variety of effects as a neuromodulator, e.g., for plasticity and excitability. Other effects are arousal and reward. Damage to the cholinergic system in the brain has been suggested to play a role in the memory deficits associated with Alzheimer's Disease.

The disease myasthenia gravis, characterized by muscle weakness and fatigue, occurs when the body inappropriately produces antibodies against acetylcholine nicotinic receptors, and thus inhibits proper acetylcholine signal transmission. Over time, the motor end plate is destroyed. Drugs that competitively inhibit acetylcholinesterase (e.g., neostigmine, physostigmine, or primarily mestinon) are effective in treating this disorder. They allow endogenously-released acetylcholine more time to interact with its respective receptor before being inactivated by acetylcholinesterase in the gap junction. Blocking, hindering or mimicking the action of acetylcholine has many uses in medicine. Drugs acting on the acetylcholine system are either agonists to the receptors, stimulating the system, or antagonists, inhibiting it.

4.7.2 Enkephalins/Endorphins

Endorphins are endogenous opioid polypeptide compounds. They are produced by the pituitary gland and the hypothalamus in vertebrates during strenuous exercise, excitement, and orgasm, and they resemble the opiates in their abilities to produce analgesia and a sense of well-being. Endorphins work as "natural fever relievers", whose effects may be enhanced by other medications. The term "endorphin" implies a pharmacological activity (analogous to the activity of the corticosteroid category of biochemicals) as opposed to a specific chemical formulation. It consists of two parts: endo- and -orphin; these are short forms of the words endogenous and morphine, intended to mean "a morphine like substance originating from within the body."

When a nerve impulse reaches the spinal cord, endorphins are released which prevent nerve cells from releasing more pain signals. Endorphins are released during long, continuous workouts, when the level of intensity is between moderate and high, and breathing is difficult. This also corresponds with the time that muscles use up their stored glycogen. Workouts that are most likely to produce endorphins include running, swimming, cross country skiing, long distance rowing, bicycling, weight lifting, aerobics, or playing a sport such as soccer, basketball, rugby, lacrosse, or American football. Endorphins may be released during low levels of pain and physical stimulation when it lasts over 30 minutes.

4.7.2.1 Functions

[1] Controls and regulates the perception of pain (somatosensory cortex of parietal lobes, somatic nervous system).

[2] Can generate euphoria (hypothalamus). Overall, these chemicals allow the body to continue functioning despite being at or beyond the normal thresholds of endurance or pain. Opiate drugs are very similar chemically and mimic these effects.

4.7.3 Epinephrine(Adrenaline)

Epinephrine, also known as adrenaline, is an excitatory neurotransmitter. It is derived from norepinephrine and is secreted along with norepinephrine in response to fear or anger. This reaction, referred to as the “fight or flight” response, prepares the body for strenuous activity. Epinephrine regulates attentiveness, arousal, cognition, sexual arousal, and mental focus. It is also responsible for regulating the metabolism. Epinephrine is used medicinally as a stimulant in cardiac arrest, as a vasoconstrictor in shock, as a bronchodilator and antispasmodic in bronchial asthma, and anaphylaxis.

4.7.3.1 Functions

[1] Arousal, excitation, anxiety, fear, and rage (hypothalamus, autonomic nervous system).

[2] Readiness for stress, combat, or flight (autonomic nervous system - sympathetic branch).

4.7.3.2 High levels

Epinephrine levels that are too high can result in restlessness, anxiety, sleep problems, acute stress, and ADHD. Excess amounts of epinephrine can also raise the blood pressure, increase the heart rate, cause irritability and insomnia.

4.7.3.3 Low levels

Low levels of epinephrine can also contribute to weight gain, fatigue, lack of focus, decreased sexual arousal, and poor concentration. Stress tends to deplete our store of adrenalin (epinephrine), while exercise tends to increase it.

4.8 Monoamines

This is a class of neurotransmitters, which includes serotonin, norepinephrine, GABA, glutamate, and dopamine. The monoamine hypothesis holds that mood disorders are caused by depletion in the levels of one or more of these neurotransmitters.

4.8.1 Norepinephrine (Noradrenaline)

When the noradrenaline is activated, the system plays major roles in the brain. Noradrenaline is released from the neurons, and acts on adrenergic receptors. It is an excitatory neurotransmitter that is important for attention and focus. Norepinephrine is synthesized from dopamine and is strongly associated with bringing our nervous systems into the "fight or flight" state. Norepinephrine triggers the release of hormones from the limbic section of the brain that signal other stress hormones to act in a crisis. It can raise blood pressure and increase heart rate. It can elevate the metabolic rate, body temperature and stimulate the smooth bronchial muscles to assist breathing. It is also important for forming memories.

4.8.1.1 Functions

[1] Calming effects, relaxation, routine bodily functioning (autonomic nervous system - parasympathetic branch).

[2] Excesses in the brain are implicated in mania.

[3] Lack of sufficient usable norepinephrine in the brain implicated in depression. (Dopamine is oxidized by an enzyme to produce norepinephrine.) Most major tranquilizers (reserpine, chlorpromazine) decrease usable amounts of norepinephrine and dopamine. Antidepressants (MOA inhibitors, tricyclics such as imipramine) increase usable amounts of norepinephrine and dopamine.

4.8.1.2 High levels

Elevated norepinephrine activity seems to be a contributor to anxiety. In addition, brain norepinephrine turnover is increased in conditions of stress. Increased levels of norepinephrine will lead to alertness and mood elevation and increased sexual interest. However, high amounts raise blood pressure; increase heart rate, and cause anxiety, fear, panic, stress, hyperactivity, an overwhelming sense of dread, irritability, and insomnia.

4.8.1.3 Low levels

Low levels of norepinephrine are linked to lack of energy, focus, and motivation. Insufficient norepinephrine levels also contribute to depression, loss of alertness, and poor memory.

4.8.2 Dopamine

Dopamine can act as both an excitatory or inhibitory neurotransmitter and functions as the brain’s “feel good” neurotransmitter. It is part of the brain’s reward system and creates feelings of satisfaction or pleasure when we do things we enjoy, such as eating or having sex. Drugs like cocaine, nicotine, opiates, heroin, and alcohol increase the levels of dopamine. Eating foods that taste good and having sex also stimulate an increase in dopamine levels. For this reason, many surmise that a deficient level of dopamine in the brain may be behind peoples’ tendencies to use drugs, drink alcohol, smoke cigarettes, be promiscuous, gamble or overeat.

Dopamine’s functions are diverse, affecting memory, motor control, and pleasure. It allows us to be alert and motivated and to feel satisfied. Dopamine is associated with positive stress states such as being in love, exercising, listening to music, and sex. Once produced, dopamine can, in turn, convert into the brain chemicals norepinephrine and epinephrine. Dopamine can play a lot of different roles in the brain, depending on the location. In the frontal cortex, dopamine acts as a traffic officer by controlling the flow of information to other areas of the brain. It also plays a role in attention, problem-solving, and memory.

4.8.2.1 Functions

[1] Initiation of muscle movement (substantia nigra, caudate nucleus, cerebellum)

[2] Muscle control related to posture, gait, regulation of opposing muscle groups (cerebellum) Excess of usable dopamine affects this function in the form of rigidity such as the catatonia sometimes found in schizophrenia.

[3] Reflexive responses (cerebellum) Lack of usable dopamine affects these first three functions by causing an inability to control starting and stopping of movements, tremors, and motor/speech tics such as those found in Parkinson's patients and cases of tardive dyskinesia.

[4] Ability to sort/filter sensory inputs and information (frontal and temporal lobes)

[5] Ability to focus attention/concentrate (frontal lobes) Excess of usable dopamine affects the fourth and fifth functions in the form of hallucinations (especially auditory) and delusions found in schizophrenia.

[6] Regulation of impulsivity (frontal lobes, hypothalamus, amygdala)

[7] Ability to experience pleasure (reward/punishment centers in hypothalamus)

Excess of usable dopamine affects the sixth and seventh functions by producing behavioral or emotional outbursts and inappropriate affect as found in schizophrenia. Lack or excess may be due to actual amounts or improper regulation by way of other substances such as serotonin. Nicotine, amphetamine, cocaine, and related drugs mimic dopamine at receptors and produce enhancement of functions 5, 6, and 7. Prolonged abuse of these drugs results in fourth and fifth functions being affected in much the same way as in Schizophrenia. Prolonged use also increases number of dopamine receptors, and by way of this the amount of dopamine or drug needed to activate these functions/systems is elevated (tolerance). Discontinuing use of drugs results in anhedonia as body cannot supply enough dopamine to activate the additional receptors in brain pleasure centers of hypothalamus, so relapse common. The amino acid tyrosine is oxidized to produce L-Dopa, which is then transformed by an enzyme to produce dopamine.

4.8.2.2 High levels

However, too much of a good thing can be bad. An increased level of dopamine in the frontal lobe of the brain contributes to the incoherent and disrupted thought processes that are characteristic of schizophrenia. Excessive levels of dopamine cause our thinking to become excited, energized, then suspicious and paranoid, as we are hyper stimulated by our environment. With low levels of dopamine, we lose the ability to focus. When dopamine levels are too high, our focus becomes narrowed and intense. High dopamine levels have been observed in patients with poor gastrointestinal function, autism, mood swings, aggression, psychosis, anxiety, hyperactivity, and children with attention disorders.

4.8.2.3 Low levels

Too little dopamine in the motor areas of the brain are responsible for Parkinson's disease, which involves uncontrollable muscle tremors. A decline in dopamine levels in the thinking areas of the brain is linked to cognitive problems (learning and memory deficits), poor concentration, difficulty initiating or completing tasks, impaired ability to “lock onto” tasks, activities, or conversations, lack of energy, lack of motivation, inability to “feel alive”, addictions, cravings, compulsions, a loss of satisfaction in activities which previously pleased you, and slowed motor movements.

Dopamine can be supplied as a medication that acts on the sympathetic nervous system, producing effects such as increased heart rate and blood pressure. However, because dopamine cannot cross the blood-brain barrier, dopamine given as a drug does not directly affect the central nervous system. To increase the amount of dopamine in the brains of patients with diseases such as Parkinson's disease and dopa responsive dystonia, L-DOPA (levodopa), which is the precursor of dopamine, can be given because it can cross the blood-brain barrier.

4.8.3 Serotonin

Serotonin is an inhibitory neurotransmitter involved in the regulation of mood, anxiety, libido, compulsivity, headaches, aggression, body temperature, eating disorders, social anxiety, phobias, sleep, appetite, memory and learning, cardiovascular function, muscle contraction, and endocrine regulation. Other brain neurotransmitters, such as dopamine and norepinephrine, also influence mood and arousal. However, serotonin generally has different effects. Serotonin plays a major role in sleep and mood regulation. Proper amounts of circulating serotonin promote relaxation. Stress reduces our serotonin levels as our body uses up serotonin in an attempt to calm itself. Serotonin is chemically related to the amino acid tryptophan, as well as the neurotransmitters norepinephrine and dopamine. All known hallucinogens believed to simulate the structural characteristics of either serotonin, norepinephrine, and/or dopamine.

Serotonin (5-hydroxytryptamine, or 5-HT) is a monoamine neurotransmitter synthesized in serotonergic neurons in the central nervous system (CNS) and enterochromaffin cells in the gastrointestinal tract of animals including humans. In the central nervous system, serotonin plays an important role as a neurotransmitter in the modulation of anger, aggression, body temperature, mood, sleep, sexuality, appetite, and metabolism, as well as stimulating vomiting. Serotonin has broad activities in the brain, and genetic variation in serotonin receptors and the serotonin transporter, which facilitates reuptake of serotonin into presynapses, have been implicated in neurological diseases.

In addition, serotonin is also a peripheral signal mediator. It is found extensively in the human gastrointestinal tract. In the blood, the major storage site is platelets, which collect serotonin for use in mediating post-injury vasoconstriction. Recent research suggests that serotonin plays an important role in liver regeneration and acts as a mitogen (induces cell division) throughout the body. Defective signaling of serotonin in the brain may be the root cause of sudden infant death syndrome (SIDS).

4.8.3.1 Functions

[1] Regulates sleep/wake cycle (reticular formation)

[2] Regulates overall mood (frontal and temporal lobes)

[3] Responsible for sleep disorders such as insomnia or excess sleep.

[4] Implicated in mood disorders such as chronic depression and bipolar disorder, as well as a number of other conditions. This is most likely due to an overall function designed to modulate the effects of the other neuro-chemicals across a wide range of locations and systems.

Serotonergic action is terminated primarily via uptake of 5-HT from the synapse. This is through the specific monoamine transporter for 5-HT, 5-HT reuptake transporter, on the presynaptic neuron. Various agents can inhibit 5-HT reuptake including MDMA (ecstasy), amphetamine, cocaine, dextromethorphan (an antitussive), tricyclic antidepressants (TCAs) and selective serotonin reuptake inhibitors (SSRIs).Several classes of drugs target the 5-HT system including some antidepressants, antipsychotics, anxiolytics, antiemetics, and antimigraine drugs as well as the psychedelic drugs and empathogens. If neurons that make serotonin — serotonergic neurons — are abnormal in infants, there is a risk of sudden infant death syndrome (SIDS).

4.8.3.2 Low levels

Low levels of serotonin can result in depressed mood, anxiety, panic attacks , low energy, migraines, sleeping problems, obsessions or compulsions, feeling tense and irritable, craving sweets or loss of appetite, impaired memory and concentration, angry or aggressive behavior, slowed muscle movement, slowed speech, altered sleep patterns, and having a reduced interest in sex.

4.8.3.3 High levels

Excess amounts of serotonin cause sedation, a decrease in sexual drive, a sense of well-being, bliss, and of being one with the universe. However, if serotonin levels become too high they can result in Serotonin Syndrome, which can be fatal. Serotonin Syndrome produces violent trembling, profuse sweating, insomnia, nausea, teeth chattering, chilling, shivering, aggressiveness, over-confidence, agitation, and malignant hyperthermia. Emergency medical treatment is required, utilizing medications that neutralize or block the action of serotonin.

4.8.3.4 Factors affecting serotonin production

Hormones and estrogen levels can affect serotonin levels and this may explain why some women have pre-menstrual and menopausal mood problems. Moreover, daily stress can greatly reduce serotonin supplies. While exercise and exposure to light may increase or stimulate serotonin levels, antidepressants can aid the brain to replenish its own supply.

4.8.4 Glutamate

Glutamate is the most important excitatory neurotransmitter in the brain. It is also the major excitatory neurotransmitter in the spinal cord. With the exception of neurons that detect painful stimuli, all sensory organs transmit information to the brain through axons whose terminals release glutamate. One type of glutamate receptor (the NMDA receptor) plays a critical role in the effects of environmental stimulation on the developing brain and is also responsible for many of the changes in synaptic connections that are responsible for learning. This receptor is partially deactivated by alcohol, which accounts for the fact that binge drinkers often have no memory for what happened while they were drunk.

In addition, researchers believe that the effect of alcohol on this receptor is responsible for the dangerous convulsions that can be caused by sudden withdrawal from heavy, long-term alcohol abuse. When this receptor is suppressed for a long time, a compensatory mechanism makes it become more sensitive to glutamate. If the person suddenly stops taking alcohol, a rebound effect causes glutamate to have such a strong effect that the normal balance of excitation and inhibition in the brain is disrupted.

4.8.4.1 High levels

Excessive levels of glutamate are toxic to neurons and have been implicated in the development of neurological disorders such as amyotrophic lateral sclerosis and Huntington's chorea, peripheral neuropathies, chronic pain, schizophrenia, stroke, and Parkinson's disease.

4.8.4.2 Low levels

Insufficient levels of glutamate may play a role in impaired memory and learning.

4.8.5 GABA

GABA is the abbreviation for Gamma-aminobutyric acid. GABA is the major inhibitory neurotransmitter in the central nervous system and plays a major role in regulating anxiety and reducing stress. GABA has a calming effect on the brain and helps the brain filter out “background noise”. It improves mental focus while calming the nerves. GABA acts like a brake to the excitatory neurotransmitters, which can cause anxiety if the system is overstimulated. Many sedative/ tranquilizing drugs act by enhancing the effects of GABA. Correspondingly glycine is the inhibitory transmitter in the spinal cord.

Some drugs depress behavior, causing relaxation, sedation, or even loss of consciousness. Most of these drugs act on a particular type of GABA receptor (the GABAA receptor), increasing its sensitivity to the neurotransmitter. Barbiturates act this way. In low doses, barbiturates have a calming effect. In progressively higher doses, they produce difficulty in walking and talking, unconsciousness, coma, and death. Barbiturates are abused by people who want to achieve the relaxing, calming effect of the drugs, especially to counteract the anxiety and irritability that can be produced by stimulants. A dose of a barbiturate sufficient to cause relaxation is not much lower than a fatal dose; thus, these drugs do not have much of a safety factor. Physicians rarely prescribe barbiturates. By far the most commonly used depressant drug is ethyl alcohol, the active ingredient in alcoholic beverages. This drug also acts on the GABAA receptor. The effects of alcohol and barbiturates are additive: A moderate dose of alcohol plus a moderate dose of barbiturates can be fatal.

Many antianxiety drugs are members of a family known as the benzodiazepines, which include the well-known tranquilizer Valium (diazepam). These drugs, too, act on GABA receptors on neurons in various parts of the brain, including a region that is involved in fear and anxiety. Benzodiazepines are much safer than barbiturates—a lethal dose is more than a hundred times higher than a therapeutic dose. They are sometimes used to treat people who are afflicted by periodic attacks of severe anxiety. In addition, some benzodiazepines serve as sleep medications. These drugs also are used to treat the convulsions caused by sudden withdrawal from heavy, long-term alcohol abuse.

4.8.5.1 Functions

The primary function of GABA is to prevent over stimulation. GABA is used at the great majority of fast inhibitory synapses in virtually every part of the brain.

It regulates norepinephrine, adrenaline, dopamine, and serotonin and is a significant mood modulator.

4.8.5.2 High levels

Excessive GABA levels result in excessive relaxation and sedation, to the point that normal reactions are impaired.

4.8.5.3 Low levels

Insufficient GABA results in the brain being over stimulated. People with too little GABA tend to suffer from anxiety disorders and may have a predisposition to alcoholism. Low levels of GABA are associated with bipolar disorder, mania, poor impulse control, epilepsy, and seizure disorders. Since proper GABA functioning is required to induce relaxation, analgesia, and sleep, dysfunction of the GABA system is implicated in the patho physiology of several neuropsychiatric disorders, including anxiety and depression.

4.8.5.4 Taurine

Taurine is an inhibitory neurotransmitter involved in neuromodulatory and neuro protective actions. Supplementing with taurine can increase GABA function. By helping GABA function, taurine is an important neuro modulator for prevention of anxiety. The relevance of GABA support is to prevent overstimulation due to high levels of excitatory amino acids, such as norepinephrine and epinephrine. Therefore, taurine and GABA constitute an important protective mechanism against excessive excitatory neurotransmitters.

4.9 Histamine

Histamine is a biogenic amine involved in local immune responses as well as regulating physiological function in the gut and acting as a neurotransmitter. Histamine plays an important role in chemotaxis of white blood cells. Most histamine in the body is generated in granules in mast cells or in white blood cells called basophils. Mast cells are especially numerous at sites of potential injury - the nose, mouth, and feet; internal body surfaces; and blood vessels. Non-mast cell histamine is found in several tissues, including the brain, where it functions as a neurotransmitter. Another important site of histamine storage and release is the enterochromaffin-like (ECL) cell of the stomach.. Histamine helps control the sleep-wake cycle and promotes the release of epinephrine and norepinephrine.

4.9.1 High levels

High histamine levels have been linked to obsessive-compulsive tendencies, depression, and headaches.

4.9.2 Low levels

Low histamine levels can contribute to paranoia, low libido, fatigue, and medication sensitivities.

4.10 Drugs

The major neurotransmitter systems are the noradrenaline (norepinephrine) system, the dopamine system, the serotonin system and the cholinergic system. Most other neurotransmitters, on the other hand, e.g. glutamate, GABA and glycine, are used very generally throughout the central nervous system. Drugs targeting the neurotransmitter of such systems affects the whole system; this fact explains the mode of action of many drugs.

Drugs differ from hormones in that they are not produced inside the body but are introduced from outside. However, like hormones, drugs are carried by the blood and taken up in target tissues of the body including the nervous system. Once in the bloodstream drugs can have widespread effects and like hormones can affect synaptic transmission. Drugs often have molecular structures sufficiently close enough to those of neurotransmitters to allow them to bind with the post-synaptic receptors. Some drugs mimic the neurotransmitter and a false input is registered. Others simply block the receptor so the real neurotransmitter cannot bind, thereby rendering it inert. Also some drugs prevent the reuptake of neurotransmitter molecules causing them to repeatedly activate the receptors.

Cocaine, for example, blocks the reentering of dopamine back into the presynaptic neuron, leaving these neurotransmitters in the synaptic gap longer. Since the dopamine is in the synapse longer, the neurotransmitter rapidly hit the receptors on the postsynaptic neuron cell, and therefore causing happiness. Excess intake of cocaine can lead to physical addiction. The physical addiction of cocaine is when the neurotransmitters stay in the synapse so long , the body removes some receptors from the postsynaptic neuron. After the effects of the drug wear off, the person usually feels unhappy, because now the neurotransmitters are less likely to hit the receptor since the body removed many of them during the drug intake.

Prozac is a selective serotonin reuptake inhibitor (SSRI), hence potentiating the effect of naturally released serotonin. In neuroscience, neuromodulation is the process in which several classes of neurotransmitters in the nervous system regulate diverse populations of neurons (one neuron uses different neurotransmitters to connect to several neurons), as opposed to direct synaptic transmission in which one presynaptic neuron directly influences a postsynaptic partner (one neuron reaching one other neuron), neuromodulatory transmitters secreted by a small group of neurons diffuse through large areas of the nervous system, having an effect on multiple neurons. Examples of neuromodulators include dopamine, serotonin, acetylcholine, histamine and others. A neuromodulator is a relatively new concept in the field and it can be conceptualized as a neurotransmitter that is not reabsorbed by the pre-synaptic neuron or broken down into a metabolite. Such neuromodulators end up spending a significant amount of time in the CSF (cerebrospinal fluid) and influencing (or modulating) the overall activity level of the brain. For this reason, some neurotransmitters are also considered as neuromodulators. Examples of neuromodulators in this category are serotonin and acetylcholine.

4.11 Effect of neurotransmitter dysfunction

4.11.1 Depression

There are many known causes of depression, with one of them being the amount of serotonin in the brain. Decreases in the production of serotonin in the brain can lead to feelings of depression. In some cases, low serotonin levels can actually lead to “suicidal thoughts”. Some studies link lower levels of norepinephrine to depression. These studies suggest that the low levels of serotonin are actually triggering the norepinephrine levels to be low, causing a depressed mood.

4.11.2 Parkinson's Disease

Parkinson's Disease (PD) is a neurodegenerative disorder that affects the neurons responsible for movement in the body. Since dopamine is responsible for transmitting information about movement, the death of these neurons can cause symptoms such as tremor, stiffness, or balance issues. The body tries to compensate for the lack of dopamine by releasing more glutamate, which is a neurotransmitter that has a role in learning and memory. However, glutamate is an excitatory neurotransmitter, and having too much glutamate can lead to the overexcitement and eventual death of neurons. Treatments for PD include L-Dopa, which is a precursor to dopamine that can cross the blood-brain barrier and relieve movement problems.

4.11.3 Schizophrenia

Schizophrenia is a disabling disorder that impacts how a person thinks, feels, and acts. Research shows that some imbalances in dopamine might play a role. The "dopamine hypothesis" states that having too much dopamine in the brain can cause schizophrenia. This idea led to antipsychotic medications that aim to lower the amount of dopamine released in the brain and reduce the symptoms of schizophrenia. But there are other small changes in the brain that may contribute to schizophrenia. For example, the ventricles, or areas of the brain filled with cerebrospinal fluid (CSF), are larger in patients with schizophrenia. However, these differences are not significant enough to generalize for all people with schizophrenia.

4.12 Conclusion

Neurotransmitters have many roles within the body that extend beyond the central nervous system. Understanding how the neurotransmission systems of the body operate, leads to greater understanding regarding the effects of drugs and medications upon the body and the manifestations of impaired neuro regulation.

4.13 SUMMARY

Neurotransmitters are chemicals that are released from nerve cells to other target cells to communicate information. Neurons can communicate using both electrical and chemical methods. Tiny packages called vesicles are hidden within the synaptic terminal of each neuron. These vesicles contain the neurotransmitters that are released when stimulated by an electrical impulse, called an action potential. Once these packages are given a signal to open, they travel to the cell’s membrane and release the neurotransmitters into the synapse. The synapse is a gap between the dendrites of one neuron and the axon terminal of another neuron.

Neurotransmitters interact with receptors on the dendrites of the other neuron, much like how a lock and key work. The neurotransmitters have specific shapes that fit into a receptor that can accommodate that shape. Once the neurotransmitter and the receptor are connected, the neurotransmitter sends information to the next neuron to either fire an action potential, or to inhibit firing. If the neuron gets the signal to fire, then the whole process starts over again.

When the neurotransmitters are balanced, it helps us to lead healthy and balanced lives. But sometimes the environment or our genes can trigger imbalances in these essential chemicals, causing illnesses such as depression, Parkinson’s disease, and schizophrenia to arise.

4.14 KEY WORDS

:: Amino acids

Organic compounds containing amine (-NH2) and carboxyl (-COOH) functional groups, along with a side chain (R group) specific to each amino acid

:: Endorphins

Endogenous opioid polypeptide compounds.

:: Excitatory neurotransmitters

The nervous system's "on switches", increasing the likelihood that an excitatory signal is sent.

:: Exocytosis

Rapid process of cellular secretion.

:: Inhibitory neurotransmitters

The nervous system's "off switches", decreasing the likelihood that an excitatory signal is sent.

:: Monoamines

A compound having a single amine group in its molecule

:: Nerve impulse

An electrical signal

:: Neurotransmitters

Types of hormones in the brain that transmit information from one neuron to another.

:: Peptides

A compound consisting of two or more amino acids linked in a chain, the carboxyl group of each acid being joined to the amino group of the next by a bond of the type -OC-NH-.

:: Receptor binding

A technique in which a labeled compound, a ligand, which binds to a receptor is used to detect that receptor.

4.15 CHECK YOUR PROGRESS

1. Which neurotransmitter has 5 different receptors for it?
   (a) Acetylcholine
   (b) Dopamine
   (c) Serotonin
   (d) Glutamate

2. Which neurotransmitter is also called 5-hydroxytryptamine, or 5-HT for short?
   (a) Dopamine
   (b) GABA
   (c) Epinephrine
   (d) Serotonin

3. Which of the following neurotransmitters are inhibitory?
   (a) GABA
   (b) Acetylcholine

(c) Epinephrine

(d) Norepinephrine

4. The area in which neurotransmitters are released from one cell to communicate with the other is called the _____

(a) Dendrites

(b) Axon

(c) Synapse

(d) Myelin sheath

5. When there is a neurochemical imbalance causing an issue or illness, scientists can develop drugs that help to balance it. What is a major consideration when developing drugs that influence brain chemistry?

(a) Blood brain barrier

(b) Nature of neurotransmitter (inhibitory, excitatory)

(c) Type of neurotransmitter

(d) Location of the neurotransmitter in the brain

4.16 ANSWERS TO CHECK YOUR PROGRESS

1. (b)
2. (d)
3. (a)
4. (c)
5. (a)

4.17 MODEL QUESTIONS

1. Identify the common neurotransmitters.
2. Explain the effects of neurotransmitters in the body.
3. What are the effect of altered concentrations of specific neurotransmitters upon the system.

LESSON 5

THE SPINAL CORD, BRAIN AND THEIR FUNCTIONS

INTRODUCTION

The previous lesson was focusing on the types of neurotransmitters and how they transmit information. And also it was covering the effects of excess/lack of a particular neurotransmitter. The whole neurotransmission is the function of central nervous system and it is necessary to understand the structure and functions of CNS. This lesson teaches about the structure and functions of the central nervous system.

OBJECTIVES OF THE LESSON

At the end of this lesson you will be able to understand

- the anatomical and functional divisions of the central nervous system
- the basic structure of the spinal cord
- the basic structure of brain
- the basic functions of the central nervous system

PLAN OF THE LESSON

5.1 THE CENTRAL NERVOUS SYSTEM

The complete network of all nerve cells in the human body is divided into two systems: the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is composed of the brain and spinal cord and provides the command and integrating centre of the nervous system. Not only does the CNS contain all the major command centres vital for the maintenance of life, but its higher regions are crucially involved in decision making (that is, detecting sensory events, analyzing this information and deciding how to respond).

The central nervous system (CNS), consisting of brain and spinal cord, is the integrative control centre of the body. In particular, the brain exerts executive control over the peripheral nervous system and endocrine glands, and is the organ of movement, emotion, thought and consciousness. An important prerequisite for understanding how the brain produces behaviour is having a good understanding of its anatomy. This includes knowing where the main brain regions are sited and the ways in which they are connected.

The problem of understanding the structure of brain lies in trying to visualize the shape of brain structures and their pathways. The brain is simply too complex. One simple way to remember the main anatomical terms used to convey direction in the brain is to imagine a fish. Its front end, or head, is anterior (sometimes called rostral), and its tail-fin is posterior (sometimes called caudal). The fish also has a dorsal fin on its upper surface – and one on its underside called the ventral fin. In addition, the fish has lateral fins on its sides – while the term medial would be used to describe parts of the body towards the midline. Two other terms that are useful to know, particularly in regards to neural pathways, are ipsilateral (referring to structures on the same side of the body), and contralateral (referring to structures on the opposite side of the body).