B.Sc PSYCHOLOGY

4th SEM COMPLIMENTARY COURSE

UNIVERSITY OF CALICUT

PSG4C01- HUMAN PHYSIOLOGY

2019 ADMISSION

Prepared by

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COURSE CODE	**PSG4C01**
TITLE OF THE COURSE	**HUMAN PHYSIOLOGY IV**
SEMESTER IN WHICH THE COURSE TO BE TAUGHT	**4th**
NO. OF CREDITS	**3**
NO. OF CONTACT HOURS	**90 (5hrs/week)**

Objectives of the course:

- **This course familiarizes the student of Psychology with the most essential and fundamental aspects of physiological processes underlying psychological events like hunger, thirst, sexual behavior and emotion.**
- **It also dwells on brain damage and Neuroplasticity**.
- **Course Details**

MODULE NO.	NAME OF MODULE	MODULE HOURS
1	Physiological basis of hunger	18
2	Physiological basis of thirst	16
3	Physiological basis of sexual behavior	16
4	Neural basis of emotion	20
5	Brain damage and Neuroplasticity	20

Module 1 Physiological basis of hunger

- Role of hypothalamus: neuronal centres of the hypothalamus participate in the control of food intake. The lateral nuclei of hypothalamus serve as a feeding centre, and stimulation of this area causes an animal to eat voraciously (hyperphagia).
- The lateral hypothalamic feeding centre operates by exciting the motor drives to search for food.
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- The ventro-medial nuclei of the hypothalamus serve as the satiety centre. This centre gives a sense of nutritional satisfaction that inhibits the feeding centre. Electrical stimulation causes complete satiety and the animal refuses to eat (aphagia). Destruction causes voracious eating (larger than 4 times normal).
- The paraventricular, dorsomedial and arcuate nuclei of hypothalamus play a major role in regulating food intake.
- The arcuate nuclei are the sites in the hypothalamus where multiple hormones released from the gastrointestinal tract and adipose tissue converge to regulate food intake as well as energy.
- These nuclei of the hypothalamus also influence the secretion of several hormones that are important in regulating energy balance and metabolism.
- The hypothalamus receives neural signals from the gastrointestinal tract that provide sensory information about stomach filling, chemical signals from nutrients in the blood that signify satiety, signals from gastrointestinal hormones, signals from hormones

released by adipose tissue and signals from the cerebral cortex that influence feeding behaviour.

- Hypothalamic feeding and satiety centres have a high density of receptors for neurotransmitters and hormones that influence feeding behaviour.
- Neural centers that influence mechanical process of feeding: the actual mechanics of feeding are controlled by centres in the brain stem.
- The neural centres like amygdala and prefrontal cortex, which are closely coupled with the hypothalamus.
- Amygdala major part of olfactory nervous system. Stimulation of some areas of amygdala elicits the mechanical act of feeding. Destruction of amygdala on both sides of the brain is a "psychic blindness" in the choice of foods.
- Factors that regulate quantity of food intake: hormones play significant roles in the regulation of food intake. Gastrointestinal hormonal factors suppress feeding. There are 2 groups of hormones where one group increases food intake (oxexigenic) and other decreases food intake.
- 1. Chole-cystokinin: released in response to fat entering the duodenum and reduce subsequent eating
- 2. Peptide YY(PYY): secreted from the gastroi
- role of hormones (effect of Cholecystokinin, Peptide YY, GLP, Ghrelin).
- Short-term regulation of food intake: several types of rapid feedback signals that are important for these purpose.
    1. Gastrointestinal filling inhibits feeding
    2. Gastrointestinal hormonal factors suppress feeding

3. Gastrointestinal hormone ghrelin increases feeding.
4. Oral receptors meter food intake

- intermediate and long-term effect of food intake: an animal that has been starved for a long time and is then presented with unlimited food eats a far greater quantity than does an animal that has been on a regular diet. An animal that has forced-fed for several weeks eats very little when allowed to eat according to its own desires.
- Effect of blood concentrations of glucose, aminoacids, lipids on hunger and feeding: decrease in blood glucose concentration causes hunger, which led to the glucostatic theory of hunger and feeding regulation. The same effect found for amino acid concentration and blood concentration of breakdown products of lipids such as keto acids and fatty acids, leading to amino-static and lipo-static theories of regulation.
    - Feedback signals from adipose tissue regulate food intake: when the amount of adipose tissue increases the adipocytes produce increased amount of leptin, which is released into the blood.
    - Importance of having both long and short term regulatory systems for feeding: long term- regulatory system for feeding, which includes all the nutritional energy feedback mechanisms, helps maintain constant stores of nutrients in the tissues, preventing them from becoming too low or too high. Short term- have 2 purposes, they are firstly, they tend to make the person eat smaller quantities at each eating session. Secondly, they help prevent the person from eating amounts at each meal that would be too much for the metabolic storage systems once all the food has been absorbed.

- temperature regulation of food intake: when animal is exposed to cold, it tends to increase feeding; when it exposed to heat, it tends to decrease its caloric intake.
- Obesity - causes and treatment: obesity can be defined as an excess of body fat. A surrogate maker for body fat content is the body mass index (BMI), which is calculated as: BMI=WEIGHT in Kg/HEIGHT m^2
- A BMI between 25 and 29.9Kg/m^2 is called overweight, and a BMI greater than 30 Kg/m^2 is called obese.
- Obesity is usually defined as 25per cent or greater total body fat in men and 35 per cent or greater in women. Various method used to estimate body fat such as measuring skin fold thickness, bioelectrical impedance or underwater weighing.
- For each 9.3 calories of excess energy that enter the body, approximately 1 gram of fat is stored. Fat is stored mainly in adipocytes in subcutaneous tissue and in the intraperitoneal cavity.
- Causes are complex. Although genes play an important role in determining food intake and energy metabolism, lifestyle and environmental factors may play the dominant role in many obese people. Some important causes are sedentary lifestyle, abnormal feeding behaviour, childhood over-nutrition, neurogenic abnormalities and genetic factors.
- Treatment: depends on decreasing energy input below energy expenditure and sustained negative energy balance until the desired weight loss is achieved. Decrease in caloric intake of 500kilo-calories per day for overweight and moderately obese persons to achieve a weight loss of approximately 500 grams each week.
- Drugs for decreasing the degree of hunger used in the treatment of obesity. Some are amphetamines: directly inhibits the feeding centres in brain

Sibutramine: reduces the food intake and increases the energy expenditure.

Both drugs overexcite the CNS making the person nervous and elevating the blood pressure.

- Other eating disorders: besides obesity several other disorders
  - Bulimia : commonly called bulimia, is a serious, potentially life-threatening eating disorder. People with bulimia may secretly binge , eating large amounts of food with a loss of control over the eating and then purge, trying to get rid of the extra calories in an unhealthy way.
  - Bulimia signs and symptoms may include:
  - Being preoccupied with your body shape and weight
  - Living in fear of gaining weight
  - Repeated episodes of eating abnormally large amounts of food in one sitting
  - Feeling a loss of control during bingeing — like you can't stop eating or can't control what you eat
  - Forcing yourself to vomit or exercising too much to keep from gaining weight after bingeing
  - Using laxatives, diuretics or enemas after eating when they're not needed
  - Fasting, restricting calories or avoiding certain foods between binges
  - Using dietary supplements or herbal products excessively for weight loss
  - The severity of bulimia is determined by the number of times a week that you purge, usually at least once a week for at least three months

- Causes: The exact cause of bulimia is unknown. Many factors could play a role in the development of eating disorders, including genetics, biology, emotional health, societal expectations and other issues
- Risk factor: Girls and women are more likely to have bulimia than boys and men are. Bulimia often begins in the late teens or early adulthood.
- Factors that increase your risk of bulimia may include:
- **Biology.** People with first-degree relatives (siblings, parents or children) with an eating disorder may be more likely to develop an eating disorder, suggesting a possible genetic link. Being overweight as a child or teen may increase the risk.
- **Psychological and emotional issues.** Psychological and emotional problems, such as depression, anxiety disorders or substance use disorders are closely linked with eating disorders. People with bulimia may feel negatively about themselves. In some cases, traumatic events and environmental stress may be contributing factors.
- **Dieting.** People who diet are at higher risk of developing eating disorders. Many people with bulimia severely restrict calories between binge episodes, which may trigger an urge to again binge eat and then purge. Other triggers for bingeing can include stress, poor body self-image, food and boredom
- Treatment: diagnosis is based on person's medical history. CBT is the primary treatment. Antidepressants of the selective serotonin reuptake inhibitor (SSRI) or tricyclic antidepressant classes may have a modest benefit.

- Anorexia: Anorexia nervosa, often simply called anorexia is an eating disorder characterized by an abnormally low body weight, an intense fear of gaining weight and a distorted perception of weight. People with anorexia place a high value on controlling

their weight and shape, using extreme efforts that tend to significantly interfere with their lives.

- To prevent weight gain or to continue losing weight, people with anorexia usually severely restrict the amount of food they eat. They may control calorie intake by vomiting after eating or by misusing laxatives, diet aids, diuretics or enemas. They may also try to lose weight by exercising excessively. No matter how much weight is lost, the person continues to fear weight gain.

- Anorexia isn't really about food. It's an extremely unhealthy and sometimes life-threatening way to try to cope with emotional problems. When you have anorexia, you often equate thinness with self-worth.

- Anorexia, like other eating disorders, can take over your life and can be very difficult to overcome. But with treatment, you can gain a better sense of who you are, return to healthier eating habits and reverse some of anorexia's serious complications.

- The physical signs and symptoms of anorexia nervosa are related to starvation. Anorexia also includes emotional and behavioral issues involving an unrealistic perception of body weight and an extremely strong fear of gaining weight or becoming fat.

- It may be difficult to notice signs and symptoms because what is considered a low body weight is different for each person, and some individuals may not appear extremely thin. Also, people with anorexia often disguise their thinness, eating habits or physical problems.

- Causes: The exact cause of anorexia is unknown. As with many diseases, it's probably a combination of biological, psychological and environmental factors.

- **Biological.** Although it's not yet clear which genes are involved, there may be genetic changes that make some people at higher risk of developing anorexia. Some people may have a genetic tendency toward perfectionism, sensitivity and perseverance — all traits associated with anorexia.
- **Psychological.** Some people with anorexia may have obsessive-compulsive personality traits that make it easier to stick to strict diets and forgo food despite being hungry. They may have an extreme drive for perfectionism, which causes them to think they're never thin enough. And they may have high levels of anxiety and engage in restrictive eating to reduce it.
- **Environmental.** Modern Western culture emphasizes thinness. Success and worth are often equated with being thin. Peer pressure may help fuel the desire to be thin, particularly among young girls.
- Risk factors: **Genetics.** Changes in specific genes may put certain people at higher risk of anorexia. Those with a first-degree relative — a parent, sibling or child — who had the disorder have a much higher risk of anorexia.
- **Dieting and starvation.** Dieting is a risk factor for developing an eating disorder. There is strong evidence that many of the symptoms of anorexia are actually symptoms of starvation. Starvation affects the brain and influences mood changes, rigidity in thinking, anxiety and reduction in appetite. Starvation and weight loss may change the way the brain works in vulnerable individuals, which may perpetuate restrictive eating behaviors and make it difficult to return to normal eating habits.

- **Transitions.** Whether it's a new school, home or job; a relationship breakup; or the death or illness of a loved one, change can bring emotional stress and increase the risk of anorexia.

- Treatment: Treatment for anorexia is generally done using a team approach, which includes doctors, mental health professionals and dietitians, all with experience in eating disorders. Ongoing therapy and nutrition education are highly important to continued recovery.
- Psychotherapies like family-based therapy and individual therapy including CBT. Along with medication
- Inanition: Inanition is the opposite of obesity and is characterizedby extreme weight loss. It can be caused by inadequate availability of food or by pathophysiologic conditions that greatly decrease the desire for food, including psy-chogenic disturbances, hypothalamic abnormalities, and factors released from peripheral tissues.
- Cachexia: is a metabolic disorder of increased energy expenditure leading to weight loss greater than that caused by reduced food intake alone.
- Picca: is most commonly seen in pregnant women, small children, and persons with developmental disabilities such as autism.

Module 2 Physiological basis of thirst

- Peripheral factors in water regulation: thirst is the craving for potable fluids, resulting in our basic instincts of to drink. It is an essential mechanism involved in fluid balance of the body.
- Excessive thirst: polydipsia
- Excessive urination: polyuria
- Isotonic: the goal to keep the interstitial fluid, the fluid outside the cell, at the same concentration as the intracelluar fluid or fluid inside cell, this condition is called isotonic
- Hypertonic: if the interstitial fluid has a higher concentration of solutes than the intracelluar fluid it will pull water out the cell, this condition is called hypertonic
- Types of thirst: hypovolemic thirst- it is defined as thirst caused by loss of blood volume without depleting the intercellular fluid, cellular dehydration thirst- or osmometric thirst occur when the solute concentration of the interstitial fluid increases.
- Water regulations: classified as peripheral factors and central factors
- Peripheral factors such as Renin-angiotensin system

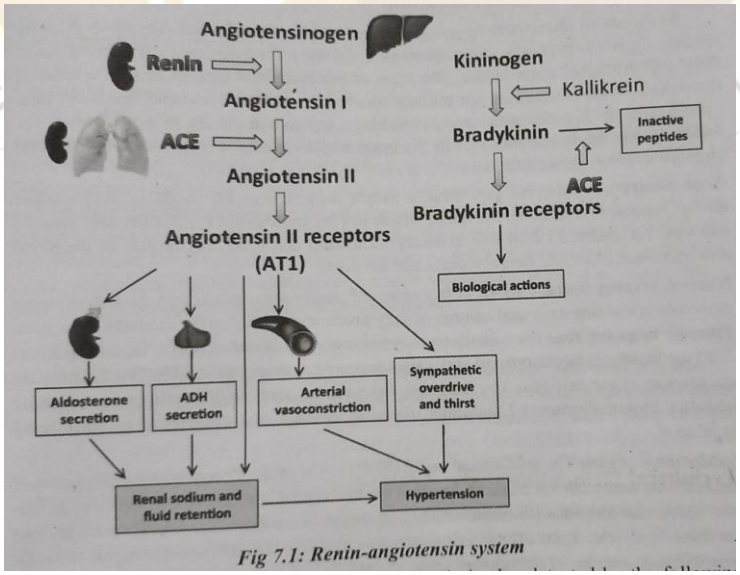

Fig 7.1: Renin-angiotensin system

- Central factors in water regulation: different areas in the brain are concerned with generation of thirst and promotes water intake
- Following areas are important in the brain which detects loss of blood volume and increase in solute concentration, they are- area postrema, nucleus tractus solitarii(SN), subfornical organ (SFO), lateral Parabrachial Nucleus, Median preoptic Nucleus and Organum vasculosum of the Lamina Terminalis.
- Production and release of vasopressin or Anti diurectic hormone(ADH)
- Threshold for osmolar stimulus of drinking: when the sodium concentration increses only about 2mEq/L above normal, the thirst mechanism is activated, causing a desire to drink water. This is called the threshold for drinking.
- Thirst quenching: thirst-quenching In the absence of a matching sensory input, the dominant thirst-quenching intention facilitates items in longterm memory with which it has acquired associations.

Module 3 Physiological basis of sexual behavior

- Hormones and sexual development – in humans biological sex is determined by five factors present at birth: the presence or absence of a Y chromosome, the type of Gonads, the sex Hormones, the internal genitalia and the external genitalia.
- Fetal hormones and the development of reproductive organs: sex organs consist of 3 structure they are- Gonads, internal genitalia and external genitalia. Gonads in males are testes and females are ovaries which produce gametes like sperm and egg which eventually fuse to form zygote, which later divides into embryo (zero to 8^{th} week), then as fetus (upto birth).

- Accessory ducts: mesonephric ducts(male); paramesonephric ducts (female)
- SRY gene: in the presence the bipotential gonads develop into testes
- After the gestation period male testes secrete 3 hormones like (AMH) anti-mullerian hormone, tetosterone, and dihydrotesterone(DTH). In females the AMH, Testosterone disappear and paramesonephric ducts develop into uterus, fallopian tubes and upper vagina.

- Sex differences in the brain:

- From ancient greek philosophers 850BC the difference between male and female brain exists
- Frontal lobe is 1% larger than females studies reported during that time, but it was found not significant result.
- Difference in memory found to be more in female than males.
- Anatomical differences found to be more in males than females in some aspects

- Lateraliztaion: men are likely to be left-handed than females. But these result were also not significant
- Hypothalamus structure and functions between males and females are found clear
- Amygdala size differs in males and females showing 10% larger in males, but this finding mislead and later found no size difference in amygdala. But emotional expression, understanding and behaviour appears vary in males and females
- Hippocampus id responsible for disorders. The volume size is greater in males which was a false result.
- Grey matter levels seen more in males in following area like amygdalae, hippocampi and anterior parahippocampal gyri. And in females in right forntal pole, inferior and middle frontal gyrus, anterior cingulate gyrus and lateral occipital cortex.

- Perinatal hormones and behavioral development: evidence support that perinatal hormones play a role in shaping the sex-related behaviour of people in later life.
- Puberty: hormones and development of secondary sexual characteristics: puberty is the process of physical changes through which a child's body matures into an adult body capable of sexual reproduction. The term puberty derived from Latin 'Puberatum' which means age of maturity. Puberty at ages 10-11 and complete puberty at ages 15-17. Boys generally begin puberty at ages 11-12 and complete puberty at ages 16-17. The major land mark of puberty for females is menarche and boys heir first ejaculation which occurs at age 13.

- Precocious puberty: puberty which starts earlier than usual time period
- Delayed puberty: puberty which starts later than usual time period

- Hormones in puberty: the endocrine reproductive system consists of the hypothalamus, the pituitary, the gonads, and the adrenal glands, with input and regulation from many other body systems.
- Description of hormonal puberty is a follow:
    1. GnRH- brain hypothalamus begins to release pulses of Gonadotropin-releasing hormone.
    2. Cells in the anterior pituitary respond by secreting LH (luteinizing hormone) and FSH (follicle stimulating hormone) into circulation
    3. The ovaries or testes respond to the rising amounts of LH and FSH by growing and beginning to produce estradiol and testosterone.
    4. Rising levels of estradiol and testosterone produce the body changes of female and male puberty.
- Components of the endocrine reproductive system:

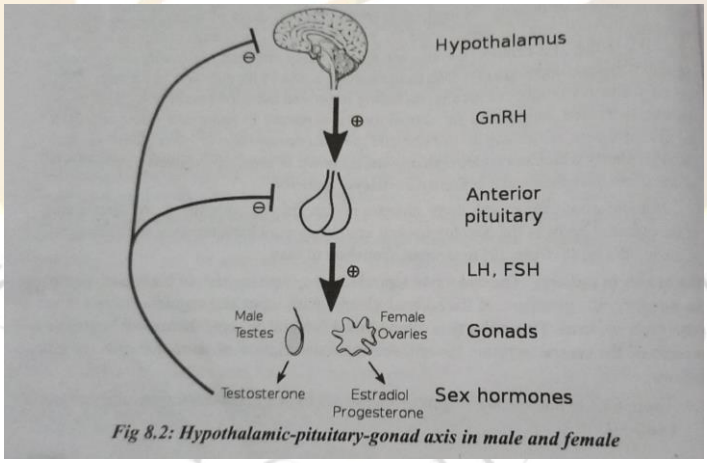

Fig 8.2: Hypothalamic-pituitary-gonad axis in male and female

- Major hormones and their roles in puberty:
- Neurokinin B and Kisspeptin: these are critical parts of control system
- GnRH: peptide hormone released from hypothalamus
- LH: protein hormone secreted by gonadotropic cells of the anterior pituitary glands

- FSH: main target on ovarian follicles and sertoli cells and spermatogenic tissue
- Estradiol: aromatization of testosterone
- Adrenal androgens: zona reticulosa of the adrenal cortex in both sexes
- IGF1: rising level of growth hormone
- Leptin: produced by adipose tissue. Target organ hypothalamus. Energy metabolism

• Development oof secondary sex characteristics

- Boys: enlargement of testicles and scrotum, penis increase in size, develops pubic hair, testicles begin making sperm, heavier bones , skeletal muscle increase, 150% lean body mass, voice box grows.
- Girls: first sign is thelarche, breast appearing mature size, pubic hair develops, changes in vagina, uterus and ovaries, first menstrual bleeding called menarche occurs.

• Effects of gonadal hormones on adults - Male reproduction related behavior and testosterone, Female reproduction related behavior and gonadal hormones.

• Neural mechanisms of sexual behavior – hypothalamus plays a key role in sexual behaviour. Located below the thalamus and a part of limbic system. Hypothalamus divided into 3 regions and 3 areas.

• Structural differences between the male hypothalamus and female hypothalamus: SDN sexually dimorphic nucleus, the volume of it is 2.2 times larger in males as in females contain 2.1 times as many cells. VMN- ventromedial nucleus of the hypothalamus is important region for regulating the sexual responses in female rodents. Estrogen plays important role in modulating the sexually dimorphic synaptic connectivity of VMN.

• the hypothalamus and male sexual behavior: divided into 2 phases

- the appetitive phase

- the consummatory phase

- the hypothalamus and female sexual behavior: not as in males. Anterior hypothalamic nucleus (Ahdc) nucleus comparison volumes between 2 groups show no significant difference in volume.

Module 4 Neural basis of emotion

- emotions are biological states associated with nervous system brought on by neurophysiological changes variously associated with thoughts, feelings , behavioural responses and a degree of pleasure or displeasure.
- Categorized as positive and negative emotions
- CPM- Scherer's Component Process Model of emotions- 5 crucial elements

- Cognitive appraisal
- Bodily symptoms
- Action tendencies
- Expression
- Feelings

- Role of frontal lobes: left prefrontal cortex is activated by stimuli that cause positive approach.

- Valence model: predicted that anger , a negative emotion, would activate the right prefrontal cortex
- Direction model: predicted that anger, an approach emotion, would activate the left prefrontal cortex.
- Prefrontal cortex is responsible for the various autonomic changes during emotional conditions, because of its connections with hypothalamus and brainstem.

- Behavioural functions of the hypothalamus and associated limbic structures, Reward centers- lateral and ventro-medial nuclei reward areas, punishment centres are in the central gray area surrounding the acqeduct of Sylvius in the mesencephalon and extending upward into the periventricular zones of hypothalamus and thalamus.

- Rage - its association with punishment centers: refers to violent and aggressive emotional expression with extreme anger. Mostly seen in animal behaviour strong stimulation cause animal to

- Develop a defence posture
- Extend its claws
- Lifts its tail
- Hiss
- Spit
- Growl and develop piloerection, wide-open eyes and dilated pupils.

- placidity and tameness: reward centres, exactly opposite emotional behaviour patterns occur when the reward centres are stimulated
- Functions of Amygdala: one of two almond-shaped clusters of nuclei located deep and medially within the temporal lobes of the brain. Stimulation causes intense emotions such as aggression or fear.

- Destructive lesions cause an effect opposite to the irritative lesions of the temporal lobe epilepsy.
- It combines many different sensory inputs
- It is involved in pleasureful emotional learning and as well as fearful emotions learning

Module 5 Brain Damage and Neuroplasticity

- The brain is a soft, spongy mass of nerve cells and supportive tissue and hence very vulnerable to damages.

  Neuroplasticity: is the ability of the brain to undergo structural or physiological changes. The aim is to optimize the neural networks during phylogenesis, ontogeny and physiological learning, as well as after a brain injury.

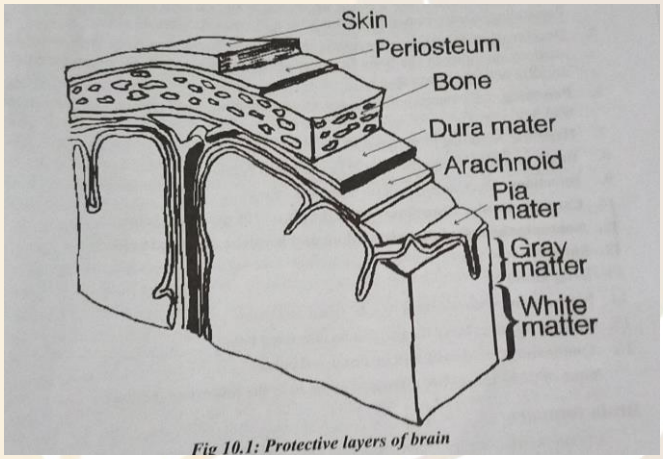

Fig 10.1: Protective layers of brain

- Causes of brain damage – trauma, open head injury, closed head injury, penetrating, deceleration injuries, poisoning, hypoxia, brain tumours, infeections, cerebrovascular disorders, neuropsychological disorders, surgery, drug abuse, neurotoxins, genetic factors and apoptosis.
- Brain tumors: abnormal cells are formed within the brain. Diagnosis is usually by medial examination along with CT and MRI. Tumours in forntal lobe, temporal lobe, occipital lobe, brain stem can be usually seen. There will be behavioural and poor functioning of particular lobes can be seen due to tumours in respective lobes.

- Cerebrovascular disorders (Cerebral hemorrhage, Cerebral ischemia): includes a variety of medical conditions that affect the blood vessels of the brain and the cerebral circulation.

- Ischemia is an inadequate blood supply to an organ or part of the body
- Hypertension (high blood pressure) is the most important contributing risk factor for stroke and cerebrovascular diseases as it can change the structure of blood vessels and result in atheerosclerosis.
- Types of stroke Ischemic and hemorrhagic
- Ischemic stroke the most common caused by a blockage of a blood vessel in the brain.
- Hemorrhagic stroke occurs when blood leaks out of damaged vessels into the cerebrospinal fluid in the subarachnoid space around the brain.

- Infections of the brain (Bacterial infections, Viral infections):

- Infections of the brain can be caused by viruses, bacteria, fungi or occasionally, protozoa or parasites. It can often involve other parts of the central nervous system including the spinal cord.
- Bacterial infection: fatal disease, have several bacteria. Bacterial meningitis, pneumococcal meningitis, meningococcal meningitis etc.
- Viral infections: it cause both meningitis and encephalitis. Enteroviruses are present in mucus, saliva and feces and can be transmitted through direct contact with an infected person or an infected object or surface.
- Equine encephalitis: 2 types- eastern equine encephalitis and western equine encephalitis. Both are transmitted by mosquitoes.

- Neurotoxins: are toxins that are destructive to nerve tissues causing neurotoxicity.

- Neurotoxins inhibits neuron control over ion concentrations across the cell membrane or communication between neurons across a synapse.
- Macroscopic manifestations of neurotoxin exposure can include widespread central nervous system damage such as intellectual disability, persistent memory impairments, epilepsy and dementia.
- Some examples are : botulinum Toxin(BTX); Tetanus TOXIN (TeNT); Mercury (methylmercury MeHg+)
- Alcohol: as a neurotoxin ethanol has been shown to induce nervous system damage and affect the body in a variety of ways.

• Genetic factors: genetic brain disorder caused by variation or a mutation in a gene. It affect the development and function of the brain.

- Some examples; Leukodystrophies (degeneration of the white matter in the brain)
- Phenylketonuria(PKU) – inborn error of metabolism that result in decreased metabolism of the amino acid phenylalanine.
- Tay-Sachs Disease- genetic disorder that results in the destruction of nerve cells in the brain and spinal cord.
- Wilson Disease- genetic disorder in which excess copper builds up in the body. It is on chromosome 13 and is expressed in liver, kidney and placenta.

• Apoptosis: means programmed cell death. It is normal process in the body.

• Neuropsychological disorders- various kinds of disorders, some are following

• Epilepsy (Grand Mal Epilepsy, Petit Mal Epilepsy and Focal Epilepsy): also called seizures, characterized by uncontrolled excessive activity of either part or all of the

central nervous system. 3 major types are Grand Mal Epilepsy, Petit Mal Epilepsy and Focal Epilepsy.

- Parkinson's disease: known as paralysis agitans, result from widespread destruction of that portion of the substantia nigra that spends dopamine secreting nerve fibers to caudate nucleus and putamen. It is characterized by
  1. Rigidity of much of the musculature of the body
  2. Involuntary tremor of the involved area even when the person is resting at a fixed rate of 3 to 6 cycles per second
  3. Serious difficulty in initiating movement called akinesia.

- Treatment for Parkinson's disease are with L-dopa and L-deprenyl

- Huntington's disease: is an inherited disorder that results in the death of brain cells. The disease is caused by an autosomal dominant mutation in either of an individual's two copies of gene called huntingtin. Diagnosis is by genetic testing, which can be carried out at any time, regardless of whether or not symptoms are prresent.
- Multiple sclerosis: is a demyelinating disease in which the insulating covers of nerve cells in the brain and spinal cord are damaged. This damage disrupts the ability of parts of the NS to transmit signals, resulting in a range of signs and symptoms, including physical, mental and sometimes psychiatric problems. There is no cure for multiple sclerosis.
- Alzheimer's disease: is defined as premature aging of the brain. Clinical features are
  1. Amnesic type of memory impairment
  2. Deterioration of language
  3. Visuospatial deficits.

- Is a progressive and fatal neurodegenerative disorder that result in impairment of the person's ability to perform activities of daily living as well as a variety of neuropsychiatric symptoms and behavioral disturbances in the later stages of the disease.
- It appears to be metabolic degenerative disease.