4.1: Modern Review:

Reproduction is the process by which new individuals of a species are produced and genetic material is passed from generation to generation. This maintains the constitution of the species. For the production of better progeny not only sperm have the important role but all the anatomy of reproductive organ should have these proper functions. E.g. if accessory glands are unable to secrete properly it may affect the motility of the sperm and may affect the total count. So a proper knowledge of anatomical and physiological aspects of reproductive organs should be known. The male reproductive system consists of the following structures

- Testis and their coverings, Scrotum
- Epididymis
- Ductus Deferens or Vas Deferens
- Ejaculatory ducts
- Urethra
- Accessory sex glands: Seminal Vesicles, Prostate Gland, Bulbourethral Glands.
- Penis

**Testis and their coverings, Scrotum**: Testis is considered as male gonads which have important functions in the formation of sperm and to secrete sex hormones. The testis or testicals are paired oval glands measuring about 5cm long and 2.5 cm in diameter. Each testis has a mass of 10 to 15 g. Each of the two testes (singular, testis) consists of the following structures:

- The tunica vaginalis is a two-layer outer serous membrane surrounding each testis.
The tunica albuginea lies inside the tunica vaginalis and protrudes inward, dividing each testis into compartments called lobules.

One to four tightly coiled tubes, the seminiferous tubules, lie inside each lobule. The seminiferous tubules are the sites of sperm production (spermatogenesis). The tubule is lined with spermatogenic cells, which form sperm, and sustentacular cells (Sertoli cells), which support the developing sperm. The coiled seminiferous tubules inside each lobule unite to form a straight tube, the tubulus rectus.

The rete testis is a network of tubes formed by the merging of the tubules rectifrom each lobule.

The efferent ducts transport sperm out of the testis (from the rete testis) to the epididymis.

Interstitial cells surrounding the seminiferous tubules secrete testosterone and other androgen hormones.
The scrotum is a sac consisting of skin and superficial fascia that hangs from the base of the penis. A vertical septum divides the scrotum into left and right compartments, each of which encloses a testis. The external scrotum positions the testes outside the body in an environment about 3°C below that of the body cavity, a condition necessary for the development and storage of sperm. The following two muscles help maintain this temperature if the external conditions get too cold:

- The dartos muscle is located in the superficial fascia of the scrotum and septum. Contraction of this smooth muscle creates wrinkles in the scrotum skin. The wrinkling thickens the skin, reducing heat loss when external temperatures are too cold.
- The cremaster muscles extend from the internal oblique muscle to the scrotum. Contraction of these skeletal muscles lifts the scrotum closer to the body when external temperatures are too cold.

Epididymis: The epididymis is a comma-shaped organ that lies adjacent to each testis. Each of the two epididymides contains a tightly coiled tube, the ductus epididymis. Here, sperm complete their maturation and are stored until ejaculation. During ejaculation, smooth muscles encircling the epididymis contract, forcing mature sperm into the next tube, the ductus deferens. The walls of the ductus epididymis contain microvilli called stereocilia that nourish sperm.
Ductus Deferens or Vas Deferens: The ductus deferens (vas deferens) is the tube through which sperm travel when they leave the epididymis. Each of the two tubes enters the abdominal cavity, passes around the urinary bladder (refer to Fig. 4.1.1), and together with the duct from the seminal vesicle, joins the ejaculatory duct. Before entering the ejaculatory duct, the ductus deferens enlarges, forming a region called the ampulla. Sperm are stored in the ductus deferens until peristaltic contractions of the smooth muscles surrounding the ductus force sperm forward during ejaculation.

Ejaculatory ducts: The ejaculatory ducts are short tubes that connect each ductus deferens to the urethra.

Urethra: The urethra is the passageway for urine and semen (sperm and associated secretions). Three regions of the urethra are distinguished:

- The prostatic urethra passes through the prostate gland.
- The membranous urethra passes through the urogenital diaphragm (muscles associated with the pelvic region).
- The spongy (penile) urethra passes through the penis.

The urethra ends at the external urethral orifice.

Accessory sex glands: The accessory sex glands secrete substances into the passageways that transport sperm. These substances contribute to the liquid portion of the semen:

- The seminal vesicles secrete into the vas deferens an alkaline fluid (which neutralizes the acid in the vagina), fructose (which provides energy for the sperm), and prostaglandins (which increase sperm viability and stimulate female uterine contractions that help sperm move into the uterus).
- The prostate gland secretes a milky, slightly acidic fluid into the urethra. Various substances in the fluid increase sperm mobility and viability.
- The bulbourethral glands secrete an alkaline fluid into the spongy urethra. The fluid neutralizes acidic urine in the urethra before ejaculation occurs.

Penis: The penis is a cylindrical organ that passes urine and delivers sperm. It consists of a root that attaches the penis to the perineum, a body (shaft) that
makes up the bulk of the penis, and the glans penis, the enlarged end of the body. The glans penis is covered by a prepuce (foreskin), which may be surgically removed in a procedure called circumcision. Internally, the penis consists of three cylindrical masses of tissue, each of which is surrounded by a thin layer of fibrous tissue, the tunica albuginea. The three cylindrical masses, which function as erectile bodies, are as follows:

- Two corpora cavernosa fill most of the volume of the penis. Their bases, called the crura (singular, crus) of the penis, attach to the urogenital diaphragm.
- A single corpus spongiosum encloses the urethra and expands at the end to form the glans penis. The bulb of the penis, an enlargement at the base of the corpus spongiosum, attaches to the urogenital diaphragm.

**Spermatogenesis**

The cells that line the walls of the seminiferous tubules are collectively called spermatogenic cells. Those cells nearest the basement membrane are called spermatogonia. These cells are stem cells—that is, they are capable of continuous division and remain undifferentiated, never maturing into specialized cells. Extending from the spermatogonia toward the lumen of the tubule is cells at various level of maturity, with the most mature cells—the sperm—facing the lumen.

**Spermatogenesis** begins at puberty within the seminiferous tubules of the testes. The spermatogonia, each of which contains 46 chromosomes, divide by mitosis repeatedly and differentiate to produce primary spermatocytes (still diploid cells with 46 chromosomes each). The primary spermatocytes begin meiosis. During the first meiotic division (meiosis I, or the reduction division), each primary spermatocyte divides into two secondary spermatocytes, each with 23 chromosomes (haploid cells). During the second meiotic division (meiosis II, or the equatorial division), each secondary spermatocyte divides again, producing a total of four spermatids. Each spermatid still contains 23 chromosomes, but these chromosomes consist of only one chromatid (rather than the normal two chromatids).
Spermiogenesis describes the development of spermatids into mature sperm (sperm cells, or spermatozoa). At the end of this process, each sperm cell bears the following structures:

- The head of the sperm contains the haploid nucleus with 23 chromosomes. At the tip of the sperm head is the acrosome, a lysosome containing enzymes that are used to penetrate the egg. The acrosome originates from Golgi body vesicles that fuse to form a single lysosome.
- The midpiece is the first part of the tail. Mitochondria spiral around the midpiece and produce energy (ATP) used to generate the whiplike movements of the tail that propel the sperm.
- The tail is a flagellum consisting of the typical 9 + 2 microtubule array.

**Hormonal regulation of spermatogenesis**

The production of sperm is regulated by hormones (Fig. 4.1.3):

- The hypothalamus begins secreting gonadotropin releasing hormone (GnRH) at puberty.
- GnRH stimulates the anterior pituitary to secrete follicle stimulating hormone (FSH) and luteinizing hormone (LH).
- LH stimulates the interstitial cells in the testes to produce testosterone and other male sex hormones (androgens). (In males, LH is also called interstitial cell stimulating hormone, or ICSH.)
- Testosterone produces the following effects:
  - Testosterone stimulates the final stages of sperm development in the nearby seminiferous tubules. It accumulates in these tissues because testosterone and FSH act together to stimulate sustentacular cells to release androgen-binding protein (ABP). ABP holds testosterone in these cells.
  - Testosterone entering the blood circulates throughout the body, where it stimulates activity in the prostate gland, seminal vesicles, and various other target tissues.
  - Testosterone and other androgens stimulate the development of secondary sex characteristics, those characteristics not directly involved in reproduction. These include the distribution of muscle
and fat typical in adult males, various body hair (facial and pubic hair, for example), and deepening of the voice.

![Diagram of hormone regulation in the male reproductive system](image)

**Fig 4.1.3: Processes of hormone regulation in the male reproductive systems**

Testosterone levels are regulated by a negative-feedback mechanism with the hypothalamus. When the hypothalamus detects excessive amounts of testosterone in the blood, it reduces its secretion of GnRH. In response, the anterior pituitary reduces its production of LH and FSH, which results in a decrease in the production of testosterone by interstitial cells. GnRH secretion is also inhibited by inhibin, a hormone secreted by sustentacular cells in response to excessive levels of sperm production.

**Physiology of Male Sexual Act**

The most important source of sensory nerve signals for initiating the male sexual act is the glans penis. The glans contain an especially sensitive sensory end organ system that transmits into the central nervous system that special modality of sensation called sexual sensation. The slippery massaging
action of intercourse on the glens stimulates the sensory end organs, and the sexual signals in turn pass through the pudendal nerve, then through the sacral plexus into the sacral portion of the spinal cord, and finally up the cord to undefined areas of the brain. Impulses may also enter the spinal cord from areas adjacent to the penis to aid in stimulating the sexual act. For instance, stimulation of the anal epithelium, the scrotum, and perineal structures in general can send signals into the cord that add to the sexual sensation. Sexual sensations can even originate in internal structures, such as in areas of the urethra, bladder, prostate, seminal vesicles, testes, and vas deferens. Indeed, one of the causes of sexual drive is filling of the sexual organs with secretions. Mild infection and inflammation of these sexual organs sometimes cause almost continual sexual desire.

Appropriate psychic stimuli can greatly enhance the ability of a person to perform the sexual act. Simply thinking sexual thoughts or even dreaming that the act of intercourse is being performed can initiate the male act, culminating in ejaculation.

Although psychic factors usually play an important part in the male sexual act and can initiate or inhibit it, brain function is probably not necessary for its performance because appropriate genital stimulation can cause ejaculation in some animals and occasionally in humans after their spinal cords have been cut above the lumbar region. Therefore, the male sexual act results from inherent reflex mechanisms integrated in the sacral and lumbar spinal cord, and these mechanisms can be initiated by either psychic stimulation from the brain or actual sexual stimulation from the sex organs, but usually it is a combination of both.

**Stages of the Male Sexual Act**

**Penile Erection:** Penile erection is the first effect of male sexual stimulation, and the degree of erection is proportional to the degree of stimulation, whether psychic or physical.

Erection is caused by parasympathetic impulses that pass from the sacral portion of the spinal cord through the pelvic nerves to the penis. These parasympathetic nerve fibers, in contrast to most other parasympathetic
fibers, are believed to secrete nitric oxide (NO) and/or vasoactive intestinal peptide (VIP) in addition to acetylcholine. The nitric oxide is the principal vasodilator of the penis. NO activates “guanylyl cyclase”, present in the cell membrane, which results in an increase in the level of “cyclic guanosine mono phosphate (cGMP) leading to the relaxation of arteries of the penis, as well as relaxes the trabecular meshwork of smooth muscle fibers in the erectile tissue of the corpora cavernosa and corpus spongiosum in the shaft of the penis. The erectile tissue is nothing more than large cavernous sinusoids, which are normally relatively empty of blood but become dilated tremendously when arterial blood flows rapidly into them under pressure while the venous outflow is partially occluded. The erectile bodies, especially the two corpora cavernosa, are surrounded by strong fibrous coats, therefore, high pressure within the sinusoids causes ballooning of the erectile tissue to such an extent that the penis becomes hard and elongated. This is the phenomenon of erection. (Fig. 4.1.4)

**Fig.4.1.4: Physiology of Erection**

Oxygen rich blood is critical for erectile health. Oxygen itself affects two substances that are important in achieving erection: it suppresses transforming growth factor beta 1 (TGF-B1) and enhances prostaglandin E1. The smooth muscles produce TGF-B1, which is a component of the immune system, and one of its roles is to produce collagen. Collagen contributes not only to structural tissue in the body but is also the material that comprises scar tissue. Prostaglandin E1 is produced during erection by the muscle cells in the penis, it activates an enzyme that results in calcium release by the
smooth muscle cells, which, in turn, relaxes them and allow blood flow. Prostaglandin E1 also suppresses collagen production. (Fig. 4.1.5) Oxygen levels vary widely from reduced levels in the flaccid state to very high in the erect state. During sleep, for instance, oxygen levels are high and a man can normally have three to five erections per night, each one lasting from 20 to 40 minutes.

Fig.4.1.5. Physiology of Erection due to Oxygen Rich Blood

The sex hormone, testosterone, is also essential to generate sexual desire at the brain centre as well as to help expand the spongy tissue of the penis, though it is not clear what their role is in potency. Certain chemical reactions involving neurochemicals like dopamine, oxytocin, endorphins, adrenaline, norepinephrine etc. in brain. The arousal or pleasure is the interpretation of these reactions in brain. The area’s most involved are related to the core and the limbic part of the brain. (Fig. 4.1.6)
Lubrication: During sexual stimulation, the parasympathetic impulses, in addition to promoting erection, cause the urethral glands and the bulbourethral glands to secrete mucus. This mucus flows through the urethra during intercourse to aid in the lubrication of coitus. However, most of the lubrication of coitus is provided by the female sexual organs rather than by the male. Without satisfactory lubrication, the male sexual act is seldom successful because unlubricated intercourse causes grating, painful sensations that inhibit rather than excite sexual sensations.

Emission and Ejaculation: Emission and ejaculation are the culmination of the male sexual act. When the sexual stimulus becomes extremely intense, the reflex centers of the spinal cord begin to emit sympathetic impulses that leave the cord at T–12 to L-2 and pass to the genital organs through the hypogastric and pelvic sympathetic nerve plexuses to initiate emission, the forerunner of ejaculation.

Emission begins with contraction of the vas deferens and the ampulla to cause expulsion of sperm into the internal urethra. Then, contractions of the muscular coat of the prostate gland followed finally by contraction of the seminal vesicles expel prostatic and seminal fluid also into the urethra, forcing the sperm forward. All these fluids mix in the internal urethra with mucus.
already secreted by the bulbourethral glands to form the semen. The process to this point is emission.

The filling of the internal urethra with semen elicits sensory signals that are transmitted through the pudendal nerves to the sacral regions of the cord, giving the filling of sudden fullness in the internal genital organs. Also, these sensory signals further excite rhythmical contraction of the internal genital organs and cause contraction of the ischiocavernosus and bulbocavernosus muscles that compress the bases of the penile erectile tissue. These effects together cause rhythmical, wave like increase in pressure in both the erectile tissue of the penis and the genital ducts and urethra, which “ejaculate” the semen from the urethra to the exterior. This final process is called ejaculation.

(Fig.4.1.7)

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**Fig.4.1.7. Emission and Ejaculation**

**4.2: Ayurvedic Review:**

**Etymology of word ‘Śukra’:** Etymological origin of word ‘Śukra’ in Sanskrit is from root ‘Śuk Soce’ which means cleanliness (Sabda Kalpadrum).

**Definition of ‘Śukra’:** Various lexicographers have elucidated definition of word ‘ŚUKRA’ according to different contexts (Nalanda Vishal Sabda Sagar): Śukrais
Substance which is white and potential
Pure and taintless substance
Fire
Name of a Famous Planet
Preceptor of Daityas
Seventh Dhatu of Body
Diseases of the Eye
Tree of Ricinus communis (Eranda)
Gold

Out of these, only two namely- ‘Seventh Dhatu of Body’ and ‘Diseases of the Eye’ are relevant to Ayurveda. In present context, the acceptable definition of Šukra is the ‘Seventh Dhatu of Body’.

**Synonyms of Šukra:**

1) Paurusam (C.S/Chi:30/133) means virility.
3) Ananda Samudbhavam means which is excreted at the time of intense pleasure or orgasm.
4) Majja Samudbhavam means which born out from majja dhatu.
5) Viryam(S.S/Su:35/29): By virtue of which an action is manifested.
6) Dhatu Saram
7) Retas (S.S/Sa:2/3) means which is ejaculated at the time of sexual intercourse.
8) Kitta Varjita
9) Tejas (resplendent) means which is shiny.
10) Bijam (S.S/Su:2/33) means which has capacity to produce new offspring.
11) Indriyam (C.S/Si:1/34)
12) Rupadravyam (C.S/Chi:2-4/49) means which gives form of ‘chetana’.
13) Charama Dhatu means last dhatu.
14) Balam means strength.

**Anatomical Consideration of Šukra:**
Mahabhautic configuration of śukra:
Śukra is Saumya (S.S/Su:3/4); which has originated from Jala Mahabhuta, but Caraka has differed in opinion and says śukra is Pancamahabhautic exceptakasa mahabhuta.

Dosic configuration of śukra:
Śukra is considered under Kapha Vargiya Dravya (Ha.Pu.1-4/52) and also śukra is one of Asrayasthana (dhatu) of Kapha dosa.

Rasa of śukra:
Śukra dhatu possesses Sadrasa (C.S/Su:2/4).

Śukra as one of vital spot of life:
Śukra dhātu is one of Prayatanas of Sarira (C.S/Su:30/3).

Śukra is one and ultimate dhātu of body:
Śukra is seventh in order of sapthadhātu and essence of all dhātus. It is produced as a result of successive evaluative metamorphosis of āhāraraśa (C.S/Chi:15/16).

Quantity of śukra:
Quantity of śukra in human body is half anjali (C.S/Sa:7/5), but as per Bhela Samhita it is about one anjali (Bhe.Sa:7/16).

Śukravaha Śrotas:
Concept of Śrotas is unique contribution of Ayurveda to medical system. Śrotas are minute hollow pathways or passages through which parinamita dhatus are transported across body (C.S/Vi:5/3). Any vikriti in śrotas leads to diseases (C.S/Vi:5/7). All the Brihatrayis have mentioned śukravaha/śrotas (C.S/Vi:5/8, S.S/Sa:9/8, A.S/Sa:6/43). Caraka has considered Sepha and Vrisana as mula of śukravaha śrotas, which can be interpreted as origin of śukravahaśrotas (C.S/Vi:5/8) but Susruta has opined that there are two śukravahaśrotas and Vrisana and Stanare mula of the same. Vagbhata has differed both above by saying that there are three mulas of śukravahaśrotas namely Muska (vriasana), Majja and Stana. After going through above mentioned opinions, Vrisana and Sepha seem to mula of śukravahaśrotas anatomically.

Vrisana:
It is one of mula of śukravahaśrotas and these are two in number. The word 'Vrisana' has originated from its root 'Varsati anena iti vrisanaha', that means which is showering (i.e. Sukra). Embryogenic origin of Vrisana is from sāra of Māmsa, Rakta, Kapha and Medas (S.S/Sa: 4/31). Anda (Dal. on S.S/Sa:4/31) (which are oval shaped) and Phala (which yield fruits i.e. off springs) are synonyms of Vrisana.
Vrisanagata Šukradhara Kalâ: This kalâ pervades all over body (S.S/Sa), brings about the formation of Rupadravyâ, which is admixture of factors responsible for progeny and some liquid medium. Here this factor can be correlated to sperms, since they are produced only at Vrisana; following quoting of Sarangadhara and Susruta, any injury to Vrisana leads to infertility or impotence, also supports the same (S.S/Chi:7/36, Sa.S/Pu.5/46).

Sepha: Sepha is the copulatory organ in males. It performs dual functions of excretion and ejaculation of Mutra and Šukra respectively (C.S/Chi:25/10) by the action of Apanavayu. Length of Sepha is six angula (C.S/Vi:8/117), but Dalhanasays that Sepha measures four angula in flaccid state and six angula in erect state (Dal. on S.S/Su:35/11-13). Upastha, Sisna, Medhra, Mehana, Dhwaja are some of synonyms used in classic. Sepha is bonded in the middle by sepha sevani (S.S/Sa:5/14).

Šukradhara Kala: Sukradhara Kala pervades all over body in all living beings, it is seventh kala. Its main function is to store pervading Sukra dhatu (S.S/Sa:4/20). Sukra pervades all over body in Sukradhara Kala in such a way ghrita is present in milk and iksu rasa present in iksu. Sukradhara Kala is not an anatomical entity present in body, but is a physiological phenomenon taking place in males.

Šukravaha Dhamani: There are two pairs of Sukravaha Dhamanis, out of which one pair does Sukra pradurbhava; others do Sukravisarga (S.S/Sa:9/7).

Šukravaha Siras: There is one pair of Sukravaha Siras, filling of which with blood facilitates erection of penis, enables to have sexual intercourse (S.S/Sa:2/45).

Physiological consideration of Šukra

Formation of Šukra:

A. Šukra Formation from Soma: As described earlier Bhautic origin of šukra is considered to be Soma or Jalamahâbhuta (S.S/Sa:3/2). As Soma or Jala mahabhuta is the predominant basic element from which Kapha is derived. So it can be said that šukra has originated from Jala or Somamahâbhuta.
B. Šukra Formation from Āhāra Rasa: Beginning from Rasa dhātu upto šukra, all the dhātu are produced in a fashion of progressive evaluative metamorphosis. This means that Rasa dhātu is basically produced from Āhāra rasa which is ingested by the action of Jatharāgni.Rasa dhātu gets converted into Rakta dhātu and so on. Previous dhātu is precursor to next and higher by the action of respective dhatvāgni in it. So from Majjā dhātu, Šukra dhātu is produced (C.S/Chi: 15/16; S.S/Su: 14/10; A.H/Sa:3/62-63). The mode of conversion of Āhāra rasa into Šukra is explained by three hypothesis namely - Ksiradadhi Nyāya, Khālekapota Nyāya, Kedārakulya Nyāya (Dal.on C.S/Chi:15/16).

C. Šukra Formation from Majjā Dhātu: Šukra is seventh in order of Sapta Dhātu and is quoted to be produced from evaluative metamorphosis of Majjā dhātu (C.S/Chi:15/16) by the action of Šukradhātvāgni on Majjā dhātu. Šukra is produced from prasāda bhāga of Majjādhātu (C.S/Chi:15/15). Vāyu and Ākāsa mahābhuta produce porosity in Asthidhātu. From this pores, Šukra oozes out like water from a new earthen pot (C.S/Chi:15/32-35) and spreads all over body.

Time required for production of Šukra Dhātu: Susrutāchārya says that nearly one month is required for metamorphosis of āhārarasa into Šukra. But Parāsara opines that eight days are enough for formation of Šukra. Finally Vāgbhata quoted all the view of different authors, either it may take twenty four hours or six days or one month (A.H/Sa:3/62). Cakrapani Dutta has correlated all the above opinions and brought the concept according to status of Dhātvāgni. According to Cakrapani, if dhātvāgni is at optimum level, then process of Šukra production occurs at speed of ‘Archi’ and produced within eight days. If dhātvāgni is at moderate level, Šukra takes place at the speed of ‘Sabda’ and it is produced within two to three weeks. If dhātvāgni is at mild level, the process of Šukra production takes place at the speed of ‘Jala’ and it takes one month (Chakrapani on C.S/Chi:15/20).

Upadhātu of Šukra Dhātu: Sārangadhara has mentioned Ojas as Upadhātu of Šukra (Sa.S/Sa/Pu:5/16).
Śukra Mala: Ojas, Smasru (A.H/Sa:3/39, Gayadas and Dal. on S.S/Sa:46/52); VaktraSnigdhata (sebum of face), Pidika (acne) (Sa.S/Sa/Pu:5/14-18) are malas according to various Authors.

**Machanism of Śukra Visarga (Ejaculation):** Ejaculation is very comprehensive and includes both physiological and psychological factors. It is a frequent accompaniment of erection and sexual act. The whole process of ejaculation starts from the initiation of sex and completed at ejaculation. Charaka has described the process of ejaculation of sukra into four stages. These are – Sankalpa, Chesta, Nishpeedana and Sukra chyuti.

1. **Sankalpa:** - The mental preparation for the sexual act with a willing partner is called sankalpa. It is the cognitive aspect of sex and includes the enjoyment of all senses just before the actual act of sex. This is the psychic element that causes erection. Psyche is directly related with vata (vyana). Vyana vata controls, regulates, initiates and maintains the ‘manas’. Sexual expression and ejaculation are under the control of vata.

   The basic initiation of sexual instinct is under the influence of psychological integrity. The sexual excitement (harsha) is depending on physical strength (dehabala) and psychological integrity (sattvabala) and also the sexual capacity (vrishattva) depends upon this excitement. The clarity of the senses and happy disposition of mind is necessary for good arousal. Charaka gives attention on sankalpa as agrya dravya of vrishya. The senses play a vital role in the mental desire. The role of environment acting as sankalpa enhancer. Water body with scented lotus flowers, cool perfumed room, blue sky filled with light blue clouds, a beautiful full Moon in the night are things which promote man’s virility, makes the mind free from anxiety and elevates the mood. Various melodious songs, pleasing sounds of birds, sound of ornaments of woman, touch by the beautiful, young woman, intake of intoxicating drinks etc. are enhanced the sexual excitement and urge.

2. **Chesta:** - It is a ‘kriya’, according to Charaka and according to Dalhan, chesta is “kaya parispadana” i.e. the response of the body or vibrations of the body. It means the physical actions follow sankalpa. The main object and means of sexual arousal is tactile stimulation. The sense of touch
pervades all the senses and sukra which is present all over the body is sensitive to tactile stimulation.

3. **Nishpeedana**: - Specific stimulation of the genital parts especially in the upastha (penis) causes ejaculation. This process of physical pressure is called nishpeedana.

4. **Sukra chyuti**: - Sukra is present in the entire body and responds to stimulation of skin. The process is similar to that of water coming out of a wet cloth on squeezing. The final process, ejaculation is because of chesta, sankalpa and nishpeedana.

    Susruta also says that ejaculation is the result of involvement of all the sense organs and compares into lactation in females as both are deeply associated with psychological factors. He explains the process of erection and ejaculation as “when a man has desire (ichcha) to have sex, his response to touch increases. Vayu located in skin causing sensation of touch. This causes arousal or “harsha”. Harsha intensifies actions of vayu and at this moment highly active vayu liberates the “teja” or heat of pitta. Thus tejas and vayu increases body temperature, heart beat and blood flow causing erection.

    Charaka has also explained eight factors contributing to the ejaculation of semen. They are:

1. **Harsha**: - It is the stimulating pleasure to initiate the sexual act by psychological means. Harsha can also be explained as the desire produced from sankalpa leading to erection and ejaculation. Though the word harsha has been used to denote different meaning like amoda, preeti, kama, in the present contex, harsha means the psychological feelings developed from the enjoyment of different senses leading to arousal.

2. **Tarsha**: - Tarsha is the passionate (intensive) desire on the female partner. It is also a psychological entity.

3. **Saratva**: - Saratva is “Asthairya” i.e. unstable according to Ckrapani. Due to its fluidity, sukra is unstable. So due to the natural quality of sukra it tends to flow down without any retention.
4. **Paichilya:** As an account of this factor, the śukra flows out without any friction.

5. **Gaurava (Heaviness):** It is the quality which causes patana karma (downward movement).

6. **Anubhava (Subtleness):** The śukra is able to come out from the minute channels due to its subtleness.

7. **Pravanabhava (Flowing nature):** Śukra possesses the tendency to flow out.

8. **Drutatva of maruta (Quick action of vata):** Apana vayu is responsible for śukra expulsion. Vata has varied fast action. Apana vayu controls and stimulates the sex organs especially the site of śukra, exerts force during the sexual act as a result of which, semen comes out of its place and ejaculates through the genital organ.

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Considerations of Šukra: On the basis of the available description from the classics regarding šukra, it may be said that the word šukra has been used extensively, either to denote semen or androgen or both. The details and the possible explanation of which are as follows:

A. Šukra as Semen: Šukra has been defined as the factor, which is implanted in the garbhāśaya for the formation of embrayo (C.S/Śa:2/4). The thing which comes out due to exhilaration during coitus and enters into vagina is called bija or šukra or pauruṣa (C.S/Chi:30/133). This definition indicates that šukra is semen, containing spermatozoa. Further it is said that šukra constitutes essence of all the dhātus and also bija (C.S/Śa:4/7). It is interesting to note that the seminal plasma contains innumerable types of proteins, enzymes, hormones, element including trace element such as copper, zinc, gold etc. In addition it is described that the šukra which is located at bastidvāra (opening of urinary bladder), gets ejaculated through mutrabaha srotas (S.S/Śa:4/22) during sexual act and it is also supporting šukra as semen.

The physical properties of šukra i.e. dravatā (liquidity), bahalam (thick), madhura (sweet), snigdha (unctuous), avisra (without any putrid smell), guru (heavy), picchila (viscous) and spatikābha (white like rock crystal) [C.S/Chi:2-4/50; C.S/Chi:30/145; S.S/Śa:2/11, 12] are pointed šukra towards semen which is a grayish white viscous fluid containing fructose and having seminin which gives musky odor and also subtle bodies of sperm.

B. Šukra as Androgens: Embryologically šukra is a paternal derivative (C.S/Śa:3/7); in the process of sex determination in foetus, first sexual differentiation by chromosomal sex occurs i.e. heterogamic sex (XY) as male and homogamic sex (XX) as female. In the male Y chromosome initiates testicular development which is turn secretes three hormones viz. two mullerian inhibiting substances which suppress the mullerian ducts; and testosterone which stimulate virilization of the Wolffian duct from which the internal urogenital organs are derived (Insler and Lunenfeld, 1993). So, it is the testosterone, which is responsible for the development
of male urogenital system, secreted by foetal testes which are differentiated by Y chromosome, a paternal contribution.

The functions of śukra are said to be dhairya (sexually potent), cyavanam (ejaculation at proper time), priti (love towards partner), dehabalam (physical strength), harāna (sexual desire) and biśjartha (to serve the function of biśja i.e. procreation) [Dal on S.S/Su:15/1]. All these functions are indicating śukra as androgen especially testosterone, which during puberty develops, musculature thereby masculine characters and is responsible for ignition of sex act. In addition it exerts stimulatory glands there by ejaculation of semen (Thaddeus and Mann, 1981) and also its high concentration is essential for initiation and to maintain the spermatogenesis (Insler and Lunenfeld, 1993). Further it is said that śukra pervades in the entire body (C.S/Chi:2-4/46; S.S/Sa:4/32) which is also supports śukra as being circulating androgen. While describing the ejaculation of śukra, it is mention that the śukra which is present in the entire body gets activated (pravarta) due to harā (sexual desire), saumanasyam (pleasant mind), seeing the lover, thinking about her, hearing her voice, touching her (the human skin has two components with exceptionally high sensitivity to androgens namely hair follicles and the sebaceous glands. Hay and Hodgins 1978; Kutten and Mauvasis- Jarvis 1975), or having sex acts with her (S.S/Sa:4/4, 23; S.S/Ni:10/19, 21) and comes to testes and is then ejaculated.

It is clear from below draw figure, the higher brain functions such as smell, touch, sight etc. stimulate the hypothalamus which in turn stimulate pituitary through GnrH. The pituitary releases FSH and LH. In turn FSH stimulates seminiferous tubules resulting into sperm formation, whereas LH acts on Leyding cells and causes secretion of testosterone (Fig-4.2.2). Hence both spermatogenesis as well as secretion of testosterone is occurring simultaneously. The description pertaining to śukra i.e. the sārvadaihika śukra coming to testes and then being ejaculated may be explained as the action of testosterone on male sexual glands during ejaculation.
Fig. 4.2.2: Endocrine regulation in adult male (Master & Johnson 1993)
C. Šukra as Semen and Androgens: Šukra is produced by vrisana (C.S/Vi:5/8). Considering the testicular functions here, the testes fulfill two tasks: steroidogenesis, a process that takes place in Leyding cells, situated between seminiferous tubules; and spermatogenesis which takes place in the germinal epithelium of these tubules. Further, the statement saumyam šukram (S.S/Sa:3/3) can be explained as the necessity of the temperature less than the body temperature for spermatogenesis. In general testicular temperature is kept 2°C below the body temperature, because spermatogenesis extremely sensitive to very small elevations of temperature. Though Leyding cells are less sensitive to temperature, decreased cell number and decreased synthesis of testosterone was noticed in cryptorchidism (Insler and Lunenfeld, 1993). Apart from these, it is mentioned that, though šukra is present in the body since childhood, it does not exhibit any of its functions till the attainment of puberty (C.S/Chi:2-4/39). It is evident from the recent studies that both secretion of testosterone (Guyton 1981), as well as spermatogenesis occur during 1st to 8th week of post natal life, but in a mature manner only at the time of puberty (Thaddeus and Mann, 1983).

Varied opinions about the duration of spermatogenesis are available: 64 to 75 days (Hafez 1979); 74 days (Guyton 1981; Insler and Lunenfeld 1993); however, widely accepted is 74 days. The volume of semen is reported as 1.5 to 4.5 ml per ejaculate (Gopalakrishnan 1995); whereas daily secretion of testosterone is 10mg (Thaddeus and Mann 1981).

The physical characters explained for śukraduṣṭi (eight type of śukraduṣṭi) are all pertinent to semen whereas the clinical features (Klaibya, daurbalya, pându etc.) are pertaining to androgens. So, on the whole it may be said that śukra means semen as well as androgens, in other words, the complete testicular secretions.