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choice"**

**"You need to win at any
cost"**



Seed Technology

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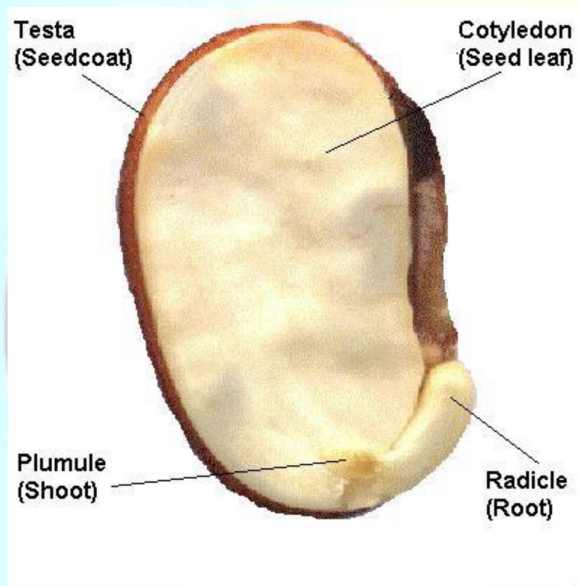
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SEED TECHNOLOGY

A seed is a fertilized ovule containing the plant embryo, enclosed in seed coat.

About seed-

A seed (in some plants, referred to as a kernel) is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food. It is the product of the ripened ovule of gymnosperm and angiosperm plants which occurs after fertilization and some growth within the mother plant. The formation of the seed completes the process of reproduction in seed plants (started with the development of flowers and pollination), with the embryo developed from the zygote and the seed coat from the integuments of the ovule.



A typical seed includes three basic parts: (1) an embryo, (2) a supply of nutrients for the embryo, and (3) a seed coat.

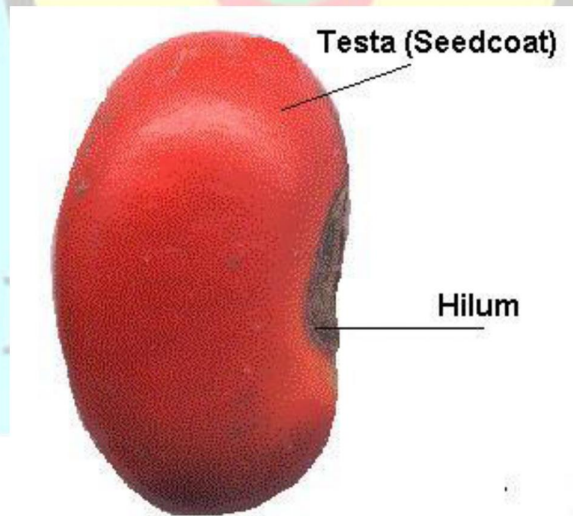
- The embryo is an immature plant from which a new plant will grow under proper conditions. The embryo has one cotyledon or seed leaf in monocotyledons, two cotyledons in almost all dicotyledons and two or more in gymnosperms.
- The radicle is the embryonic root.
- The plumule is the embryonic shoot. The embryonic stem above the point of attachment of the cotyledon(s) is the epicotyl. The embryonic stem below the point of attachment is the hypocotyl.
- Within the seed, there usually is a store of nutrients for the seedling that will grow from the embryo. The form of the stored nutrition varies depending on the kind of plant.

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- In angiosperms, the stored food begins as a tissue called the endosperm, which is derived from the parent plant via double fertilization. The usually triploid endosperm is rich in oil or starch and protein.
- In gymnosperms, such as conifers, the food storage tissue is part of the female gametophyte, a haploid tissue. In some species, the embryo is embedded in the endosperm or female gametophyte, which the seedling will use upon germination.
- In others, the endosperm is absorbed by the embryo as the latter grows within the developing seed, and the cotyledons of the embryo become filled with this stored food. At maturity, seeds of these species have no endosperm and are termed exalbuminous seeds.
- Some exalbuminous seeds are bean, pea, oak, walnut, squash, sunflower, and radish. Seeds with an endosperm at maturity are termed albuminous seeds. Most monocots (e.g. grasses and palms) and many dicots (e.g. brazil nut and castor bean) have albuminous seeds. All gymnosperm seeds are albuminous.

The seed coat (or testa) develops from the tissue, the integument, originally surrounding the ovule. The seed coat in the mature seed can be a paper-thin layer (e.g. peanut) or something more substantial (e.g. thick and hard in honey locust and coconut). The seed coat helps protect the embryo from mechanical injury and from drying out.



Type of seeds-

Monocot seeds- Cereals and grasses which contains single cotyledons.

Dicot seeds- Pulses which contain two cotyledons.

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Positive Photoblastic seeds- Good germination in presence of light. Eg. Tobacco

Negative Photoblastic- Good germination in absence of light. Eg. Onion

Non- Photoblastic- Good germination in any condition. Eg. Most of the crops.

Note- 662 nm wavelength (Red light) is best for seed germination. Above 730 nm germination stops.

How Seed is formed?

Seed is formed by transfer of pollen grains from anther (male part) to stigma (female part). This process is called as pollination.

There are two types of pollination:

- Self-Pollination (Autogamy)
- Cross-Pollination (Allogamy)

The process by which pollen grains are transferred from anthers to stigma is referred as pollination. Pollination is of two types: viz. 1) Autogamy or self-pollination and 2) Allogamy or cross pollination.

I. Autogamy

Transfer of pollen grains from the anther to the stigma of same flower is known as autogamy or self-pollination. Autogamy is the closest form of inbreeding. Autogamy leads to homozygosity. Such species develop homozygous balance and do not exhibit significant inbreeding depression.

Mechanism promoting self-pollination

1. *Bisexuality*-Presence of male and female organs in the same flower is known as bisexuality. The presence of bisexual flowers is a must for self-pollination. All the self-pollinated plants have hermaphrodite flowers.
2. *Homogamy*-Maturation of anthers and stigma of a flower at the same time is called homogamy. As a rule, homogamy is essential for self-pollination.
3. *Cleistogamy*-When pollination and fertilization occur in unopened flower bud, it is known as cleistogamy. It ensures self-pollination and prevents cross pollination. Cleistogamy has been reported in some varieties of wheat, barley, oats and several other grass species.
4. *Chasmogamy*-Opening of flowers only after the completion of pollination is known as chasmogamy. This also promotes self-pollination and is found in crops like wheat, barley, rice and oats.

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5. *Position of Anthers*-In some species, stigmas are surrounded by anthers in such a way that self-pollination is ensured. Such situation is found in tomato and brinjal. In some legumes, the stamens and stigma are enclosed by the petals in such a way that self-pollination is ensured. Examples are greengram, blackgram, soybean, chickpea and pea.

II. **Allogamy**

Transfer of pollen grains from the anther of one plant to the stigma of another plant is called allogamy or cross pollination. This is the common form of out-breeding. Allogamy leads to heterozygosity. Such species develop heterozygous balance and exhibit significant inbreeding depression on selfing.

Mechanism promoting cross-pollination

1. *Diocliny*- It refers to unisexual flowers. This is of two types: viz. i) monoecy and ii) dioecy. When male and female flowers are separate but present in the same plants, it is known as monoecy. In some crops, the male and female flowers are present in the same inflorescence such as in mango, castor and banana. In some cases, they are on separate inflorescence as in maize. Other examples are cucurbits, grapes, strawberry, cassava and rubber. When staminate and pistillate flowers are present on different plants, it is called dioecy. It includes papaya, date palm, spinach, hemp and asparagus.
2. *Dichogamy*-(from the Greek dikho-apart and gamous-marriage) It refers to maturation of anthers and stigma of the same flowers at different times. Dichogamy promotes cross pollination even in the hermaphrodite species. Dichogamy is of two types: viz. i) protogyny and ii) protandry. When pistil matures before anthers, it is called protogyny such as in pearl millet. When anthers mature before pistil, it is known as protandry. It is found in maize, sugarbeet and several other species.
3. *Heterostyly*- When styles and filaments in a flower are of different lengths, it is called heterostyly. It promotes cross pollination, such as linseed.
4. *Herkogamy*- Hinderance to self-pollination due to some physical barriers such as presence of hyaline membrane around the anther is known as herkogamy. Such membrane does not allow the dehiscence of pollen and prevents self-pollination such as in alfalfa.
5. *Self-Incompatibility*- The inability of fertile pollen to fertilise the same flower. It prevents self-pollination and promotes cross pollination. Self-incompatibility is found in several crop species like Brassica, Radish, Nicotiana, and many grass species. It is of two types sporophytic and gametophytic.
6. *Male Sterility*- In some species, the pollen grains are non-functional. Such condition is known as male sterility. It prevents self-pollination and promotes cross pollination. It is of three types: viz. genetic, cytoplasmic and cytoplasmic genetic. It is a useful tool in hybrid seed production.

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Mode of pollination and reproduction	Examples of crop plants
A. Autogamous Species	
1. Seed Propagated	Rice, Wheat, Barley, Oats, Chickpea, Pea, Cowpea, Lentil, Green gram, Black gram, Soybean, Common bean, Moth bean, Linseed, Sesame, Khesari, Sun hemp, Chillies, Brinjal, Tomato, Okra, Peanut, etc.
2. Vegetatively Propagated	Potato
B. Allogamous Species	
1. Seed Propagated	Maize, Pearl millet, Rye, Alfalfa, Radish, Cabbage, Sunflower, Sugar beet, Castor, Red clover, White clover, Safflower, Spinach, Onion, Garlic, Turnip, Squash, Muskmelon, Watermelon, Cucumber, Pumpkin, Kenaf, Oilpalm, Carrot, Coconut, Papaya, etc.
2. Vegetatively propagated	Sugarcane, Coffee, Cocoa, Tea, Apple, Pears, Peaches, Cherries, grapes, Almond Strawberries, Pine apple, Banana, Cashew, Irish, Cassava, Taro, Rubber, etc.
C. Often Allogamous Species	
	Sorghum, Cotton, Triticale, Pigeon pea, Tobacco.

Sometimes two more terms are used they are

Geitonogamy is the type of self-pollinations where the transfer of pollen grains from the anther to the stigma takes place between different flowers in the same plant. Though it seems like cross-pollination and takes place with the help of pollinator, both the gametes have the same plant as their origin.

Xenogamy is the cross-pollination where the pollen grain transfer occurs across flowers of two different plants. In other words, the transfer of pollen from the anther of one plant to the stigma of another plant.

Important Terms:

Genetic purity- Seed should be free from other variety seed or other crop seeds.

Physical purity- Seed should be free from gravels, stone and broken seeds.

Seed Germination- Emergence and development of seedlings from the seed-embryo which is able to produce a normal plant under favourable condition.

Types of germination-

Hypogeal- The cotyledons remain under the soil. Eg. Cereals, Gram.

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Epigeal- The cotyledons pushed above the soil surface. Eg, Tamarind, mustard, castor, sunflower, onion.

Essential factors for germination- Moisture, Temperature and Oxygen supply

Germination %= Number of seeds germinated X 100/Total number of seeds

Methods for testing Germination- Petridish method, Rolled towel method, Folder paper towel method, Sand method, Mechanical method, Gunny sacs method etc.

Seed Purity- Real percentage of desirable seed from a lot of seeds with various impurities. Purity %=
Weight of pure seeds / Total weight of the working sample X 100

Real Value of seeds- Purity % X Germination % / 100

Viability test of seeds- Viability is the capacity of seed to germinate.

Potassium permanganate method- Qualitative method of testing viability.

Electrical conductance method- Seeds are soaked in distilled water and EC is tested.

Embryo culture method- Embryo is removed from cotyledons and it is placed on peat mass or agar medium. It takes 7-10 days for result.

Tetrazolium chloride test- Also known as Biochemical test. Seeds are soaked in 0.5 to 2% solution of tetrazolium chloride. The viable or living seeds take bright red colouration which becomes more intense in the embryo while the dead seeds remain in their original colour.

Grodex test- Grodex test is a germination indicator test based on triphenyl tetrazolium bromide powdered from.

Classes of Seed

The four generally recognized classes of seeds are: Breeder's seed, Foundation seed, Registered seed and Certified seed. The Association of Official Seed Certifying Agencies (AOSCA) has defined these seed classes as follows:

A. Nucleus seed-

These are initial seed of an improved variety, developed by plant breeder at research institute. Genetic and Physical purity is 100%, there is no need of certification and no tag color is assigned.

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B. Breeder seed

It is the progeny of nucleus seed. The seed or vegetatively propagated material directly controlled by the originating or the sponsoring breeder or institution which is the basic seed for recurring increase of foundation seed. Genetic and Physical purity is 100%, Tag color is Golden yellow and tag size is 12x6 cm.



C. Foundation seed

It is the progeny of breeder seed. The seed stock handled to maintain specific identity and genetic purity, which may be designated or distributed and produced under careful supervision of an agricultural experiment station, National Seed Corporation or at Government farm and Agriculture universities. This seed is the source of all other certified seed classes either directly or through registered seed. Genetic purity is 99.5% and Physical purity should be 98%. It is used for production of registered and certified seeds. Tag colour is white and size is 15x7.5 cm.



D. Registered Seeds

The progeny of the foundation seed or registered seeds so handled as to maintain its genetic identity and purity and approved and certified by a certifying agency. Not used in India. It should be of quality suitable to produce certified seed. Tag colour is Purple and size is 15x7.5 cm.

E. Certified seed

It is the progeny of the foundation seed or certified seeds itself. Its production is so handled to maintain genetical identity and physical purity according to standards specified for the crop being certified. It should have the minimum genetical purity of 99% or more and physical purity of 98% is required. Certified seed may be the progeny of certified seed, provided this reproduction does not exceed two generations beyond foundation seed and provided that if certification agency determines the genetic and physical purity, if not be significantly altered. In case of highly self-pollinated crops certification of one further generation may be permitted. Tag colour is blue and size is 15 x 7.5 cm.



Other Types of seed

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Orthodox seeds are capable of being dried to internal seed moisture of less than 12% water, stored at freezing temperatures, and surviving. Eg. Cereals and Pulses.

Recalcitrant seeds cannot be stored in a conventional freezer as they cannot survive after drying and/or freezing at -20°C. Eg. Mango, Coconut and most of the fruit crops.

Intermediate seeds tend to age faster than orthodox seeds and may have only a 5-year lifespan when stored at -20°C. They have greatest longevity when dried between 45 and 65% RH.

Truthful Labelled Seeds- It is the category of seed produced by cultivators, private seed companies and is sold under truthful labels.

- This type of seeds **does not come under the purview of the Department of Seed Certification.**
- Rather, field standard and seed standard should be maintained as per seed act and certified seed stage.
- Under the seed act, the seed producer and seed seller are responsible for the seed.
- Truthful labelling is compulsory for notified kind of varieties and it is tested for physical purity and germination.
- Tag colour- Opal green.
- **Notified Variety:** After a variety has been released for a zone by the Central Sub-Committee, the Director, HYV, Ministry of Agriculture and Irrigation, GOI notifies the concerned authorities of the states within that zone for seed multiplication and distribution of variety. This is known as notification of variety.

Difference between certified seed and truthful labelled seed

Certified seed	Truthful labelled seed
Certification is voluntary. Quality guaranteed by certification agency.	Truthful labelling is compulsory for notified kind of varieties. Quality guaranteed by producing agency
Applicable to notified kinds only	Applicable to both notified and released varieties

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It should satisfy both minimum field and seed standards	Tested for physical purity and germination
Seed certification officer, seed inspectors can take samples for inspection	Seed inspectors alone can take samples for checking the seed quality.

Attributes of international seed analysis certificate

Orange certificate- Issued when the sample is drawn officially from the lot under the authority of a member station. The lot is sealed, labelled and tested for seed quality attributes from the same member station.

Green certificate- Issued when the sample is drawn officially from the lot under the authority of a member station and seed is tested for seed quality attributes from the member station of different country.

Blue certificate- Issued when testing is done by a member station in same country, sampling not done under the responsibility of member station.

Kind of certificate	Certificate relates to	Sampling	Testing	Issuance of certificate
1. Orange	Seed lot	done by a member station as per ISTA procedure	in the same country by the same station who has done sampling.	by the station which had done testing.
2. Green	Seed lot	- do -	in another country by a member station.	by the station which had done testing.
3. Blue	Seed sample	sample submitted and not done under the responsibility of a member station.	by a member station in the same country.	by the station which has done testing.

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Model of seed generation

Generation system of seed multiplication is nothing but the production of a particular class of seed from specific class of seed up to certified seed stage. The choice of a proper seed multiplication model is the key to further success of a seed programme.

This is basically depending upon,

- i. The rate of genetic deterioration
- ii. Seed multiplication ratio and
- iii. Total seed demand

Moisture content in seed for storage- long term (6-8%), short term (10-13%), cereals (10-12%), pulses (8-10%), oil seeds- (6-8%).

Storage substances-

Rice- Oryzein, Wheat-Glutenin, Barley- Hordein, Maize- Zein, Soybean- Nodulin, Sunflower- Inulin, Pea- Legumin, Grain legumes- Phaseolin

Various policies related to seeds

National Seed Corporation established in- 1963

National Seed Act passed in 1966

International Seed Testing Association- 1924

First Seed Testing Lab, IARI- 1961

Indian Seed Act- 1966, Came into force- 1969

Seed Rules- 1968

PPV&FR Act 2021

National Seed Policy- 2002

New Seed Act formulated- 2004, came into force- 2005

Isolation distance:

It is the minimum separation required between two or more varieties of the same species for the purpose of keeping seed pure.

TYPE	Distance

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	Foundation seed	Certified seed
SELF POLLINATED CROPS	3mtr	3mtr
Rice, Wheat, Ragi, Groundnut, Green gram, Cowpea, Oat, Barley, Soybean		
Black gram, Greengram, Field pea, Chickpea	20 m	10 m
Tomato	50 m	25 m
CROSS POLLINATED CROPS	Foundation seed	Certified seed
Maize and Mustard/Rapeseed	400 m	200 m
Pearl millet	1000 m	200 m
Sunflower,Safflower	400 m	200 m
Cabbage, Cauliflower	1600 m	1000 m
Onion	1000 m	400 m
OFTEN CROSS POLLINATED		
Pigeon pea	100 m	50 m
Cotton	50 m	30 m
Sorghum, Red gram, Brinjal	200 m	100 m
Okra, Chilli	400 m	200 m

Seed Replacement Rate:

Seed Replacement Rate is the rate at which the farmers replace the seeds instead of using their own seeds.

In terms of percentage:

Horticultural Crop SRR (%)

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• <u>Brinjal</u> 63.4	• <u>Melons</u> 89.2
• <u>Cabbage</u> 100	• <u>Okra</u> 92.4
• <u>Cauliflower</u> 86.4	• <u>Tomato</u> 99.3
• <u>Chilli</u> 83.7	• <u>Beans</u> 62.2
• <u>Gourds</u> 73.5	• <u>Onion</u> 87.3
• <u>Peas</u> 93.5	
Field Crop SRR (%)	
<u>Paddy</u>	17
<u>Bajra</u>	8
<u>Maize</u>	6
<u>Redgram</u>	6.1
<u>Blackgram</u>	17.7
<u>Greengram</u>	11.7
<u>Cowpea</u>	14.2
<u>Groundnut</u>	5
<u>Sunflower</u>	50
<u>Sesame</u>	15

Seed Multiplication Ratio

SMR is number of seeds to be produced from a single seed when it is sown and harvested, which can be altered by adoption of proper seed and crop management techniques.

Wheat 1:20	Lucerne 1:25
Paddy 1:80 (Varieties)	Oats 1:15
1:100 (Hybrids)	Bhendi 1:100

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Maize 1:80 (Varieties)	Tomato 1:400
1:100 (Hybrids)	Brinjal 1:450
Sorghum 1:100	Chillies 1:240
Bajra 1:200	Watermelon 1:100
Ragi 1:80	Pumpkin 1:160
Gram 1:10	Bittergourd 1:41
Blackgram 1:40	Bottlegourd 1:99
Greengram 1:40	Ridgegourd 1:83
Cowpea 1:40	Cucumber 1:200
Horsegram 1:40	French bean 1:9
Moth bean 1:40	Clusterbean 1:50
Red gram 1:100	Peas 1:19
Cole crops 1:433	Onion 1:171
Potato 1:4	Radish 1:100
Groundnut 1:8	Carrot 1:83
Linseed 1:50	Mustard and rapeseed 1:100
Cotton 1:50	Soybean 1:16
Jute 1:100	Sunflower 1:50
Mestha 1:40	Sesame 1:250
Sunhemp 1:30	Safflower and castor 1:60
Berseem 1:10	Lucerne 1:25

Germination and purity standard for foundation and certified seeds of different crops.

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Percent of total seed (on weight basis)				
S. No.	Crop	Pure seed (min.)	Moisture (max)	Germination (min)
1	Hybrid maize (other than single cross)	98	12	90
2	Maize composites and open-pollinated varieties	98	12	90
3	Hybrid Jowar and varieties	98	12	80
4	Hybrid bajra* and open-pollinated varieties	98	12	75
4	Rice*	98	13	80
5	Wheat*	98	12	85
6	Barley	98	12	85
7	Cotton varieties and hybrids	98	10	60
8	Gram	98	9	85
9	Arhar	98	10	75
10	Urid	98	9	65
11	Mung	98	9	75
12	Rapeseeds and mustard	97	8	85
13	Sesamum (til)	97	9	80
14	Groundnut	96	9	70
15	Sunflower	98	9	60

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16	Linseed	98	7	80
17	Soyabean	97	12	70
18	Peas	98	9	75
19	Cowpeas	98	9	75
20	Tomato	98	8	70
21	Cauliflower	98	7	65
22	Bhindi	99	10	65
23	Watermelon and other cucurbits	99	7	60
24	Onion	98	8	70
25	Carrot	95	8	60
26	Chillies	98	8	60
27	Radish	98	6	70
28	Brinjal	98	8	70

Dormancy of seeds-

- Temporary suspension of growth of any viable seeds with reduced metabolic activities. Dormancy is actually the resting stage, it delays germination.
- Due to unfavorable climatic conditions, presence of hard testa, immature embryo or due to presence of germination inhibitors dormancy may occur.

Types of dormancy-

Innate dormancy

It is the condition of seeds which is incapable of germination even if conditions suitable for seedling growth are supplied. This inability to germinate may be due in certain species to the embryo being immature at the time of dispersal.

Enforced dormancy

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It is the condition of seeds which is incapable of germination due to an environmental restraint which includes, an adequate amount of moisture, oxygen, light and a suitable temperature.

Induced dormancy

This type of seed dormancy occurs when the seed has imbibed water, but has been placed under extremely unfavourable conditions for germination. Finally, seed fails to germinate even under more favourable conditions.

Germination inhibitors in crops-

S.No	Species	Location of inhibitor	Name of inhibitor
1	<i>Gossypium</i> spp.	Pericarp, testa	Abscic acid (ABA)
2	<i>Coriandrum sativum</i>	Pericarp	Coumarin
3	<i>Helianthus annuus</i>	Pericarp, testa	Hydrocyanic acid
4	<i>Oryza sativa</i>	Hull	Probably ABA
5	<i>Triticum</i> spp.	Pericarp, testa	Catechin, catechin tannins, several unknowns
6	<i>Hordeum vulgare</i>	Hull	Coumarin, Phenolic acids. scopoletin
7	<i>Elaeagnus angustifolia</i>	Pericarp, testa	Possibly coumarin
8	<i>Beta vulgaris</i>	Pericarp	Phenolic acids, Possibly ABA, high concentration of inorganic ions
9	<i>Avena sativa</i>	Hull	Unknown

Classification of seed dormancy-

Types	Reasons	Treatment
Physical dormancy	Impermeability of seed coat	Scarification
Physiological dormancy	Inhibitory mechanism of germination inside embryo	Soaking seeds in GA ₃ , Ethrel, KNO ₃ (Strongest), Thiourea (Used for potato)

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Combination of Physical and Physiological dormancy	Physical + Physiological	Scarification & Chemical
Morphological dormancy	Embryo not fully developed properly	Cold stratification
Morphological-Physiological dormancy	Underdeveloped embryo and physiological factors responsible for dormancy	Stratification + Chemical soaking

Dormancy Breaking Treatments-

1. Scarification (Acid/Mechanical)
2. Hot water treatment
3. Stratification (Cold/Warm)
4. Leaching of inhibitors (Metabolites)
5. High/Low Temperature treatment

Scarification- These treatments make a hard seed coat permeable to water or gases either by softening or cracking. This process is called scarification. The treatment can be either chemical or physical in nature. It weakens or softens the seed coat. Generally used for seeds of crops of Malvaceae and Leguminales family.

- a) Acid scarification- Concentrated H_2SO_4 @ 100 ml/kg (2-3 minutes), Concentration may vary according to species as tree crops may take 2-4 hours.
- b) Mechanical scarification- Rubbing seeds in sandpapers or by puncturing seed coat with needle, increases moisture absorption. Eg. Sand scarification where ratio of sand:seed is 2:1
- c) Hot water treatment- Seed soaked in boiled water for 2-5 minutes. It is generally used for leguminous species. We need to be careful as in some crops like groundnut and Bengal gram, if soaked for more than 1 minutes, it may be injurious.

Stratification- It is used when caused of dormancy is internal (embryonic factor). *Cold stratification-* Seeds incubated at 0-5 degree Celsius over a moist substrate for 2-4 days to a few months. It is used for cole crops. *Warm stratification-* Some seeds required warm temperature to break dormancy. Eg. Rice and Oil palm.

Chemical methods- KNO_3 (Strongest dormancy breaker), Thiourea (1%) used in potato.

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Leaching of metabolites- To leach inhibitors, seeds are soaked in water for 3-4 days. In every 12 hours, water should be changed.

Temperature Treatment- *High temperature-* Early flowering winter annuals need high temperature to germinate. Eg. Blue bell (*Hyacinthoides nonscripta*). *Low temperature-* It is used for plants growing in cool temperature. They require a period of chilling. Eg. Apple seeds are store at 5 degree Celsius.

Seed Processing

The process of removal of dockage in a seed lot and preparation of seed for marketing is called seed processing. The price and quality of seed is inversely related to dockage, which should not exceed a maximum level permitted for different crops for seed certification.

Basic steps

Sequence of operations are based on characteristics of seed such as shape, size, weight, length, surface structure, colour and moisture content. Because each crop seed possesses individually seed structure. Therefore, sequence of operation will be applied proper equipments. However, It is also involved stages following as

- 
- Drying
 - Receiving
 - Pre-cleaning
 - Conditioning
 - Cleaning
 - Separating or Upgrading
 - Treating (Drying)
 - Weighting
 - Bagging
 - Storage or Shipping

Principle of seed processing:

The processing operation carried out based on the principle of physical differences found in a seed lot.

Process followed in Seed certification

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- **An Administrative check on the origin of the propagating material**
- **Field Inspection**
- **Sample inspection**
- **Control plot testing:** Here the samples drawn from the source and final seed produced are grown side by side along with the standard samples of the variety in question. By comparison it can be determined whether the varietal purity and health of the produced seed are equal to the results based on field inspection.
- **Grow-out test:** Evaluation of the seeds for their genuineness to species or varieties or seed borne infection. Here the samples drawn from the lots are grown in the field along with the standard checks. Growing plants are observed for the varietal purity. Grow-out test helps in the elimination of the sub-standard seed lots.

Seed Treatment-

Benefits of Seed Treatment:

- Prevents spread of plant diseases.
- Protects seed from seed rot and seedling blights.
- Improves germination.
- Provides protection from storage insects.
- Controls soil insects.

Types of Seed Treatment

1. Seed Disinfection:

Seed disinfection refers to the eradication of fungal spores that have become established within the seed coat, or in more deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus that is present.

2. Seed Disinfestations:

Seed disinfestations refer to the destruction of surface borne organisms that have contaminated the seed surface but not infected the seed surface. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successful.

3. Seed Protection:

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The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Seed treatment can be done in one of the following types.

1. **Seed dressing:** This is the most common method of seed treatment. The seed is dressed with either a dry formulation or wet treated with a slurry or liquid formulation. Dressings can be applied at both farm and industries. Low-cost earthen pots can be used for mixing pesticides with seed or seed can be spread on a polythene sheet and required quantity of chemical can be sprinkled on seed lot and mixed mechanically by the farmers.
2. **Seed coating:** A special binder is used with a formulation to enhance adherence to the seed. Coating requires advanced treatment technology, by the industry.
3. **Seed pelleting:** The most sophisticated Seed Treatment Technology, resulting in changing physical shape of a seed to enhance palatability and handling. Pelleting requires specialized application machinery and techniques and is the most expensive application.

Phases of Seed Certification

Seed Certification is carried out **in six** broad phases listed as under:

- Receipt and scrutiny of application.
- Verification of seed source, class and other requirements of the seed used for raising the seed crop.
- Inspection of the seed crop in the field to verify its conformity to the prescribed field standards.
- Supervision at post-harvest stages including processing and packing.
- Drawing of samples and arranging for analysis to verify conformity to the seed standards; and
- Grant of certificate, issue of certification tags, labelling, sealing etc.

Validity Period of the Certificate

The validity period shall be **nine months** from the date of test at the time of initial certification. The validity period could be further extended for **six months** provided on retesting seed conforms to the prescribed standards in respect of physical purity, germination and insect damage for all seeds except vegetatively propagating material for which lot shall be re-examined for seed standards specified for

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respective crop. A seed lot will be eligible for extension of the validity period as long as it conforms to the prescribed standards.

Seed Village

What is seed village?

- A village, wherein trained group of farmers are involved in production of seeds of various crops and cater to the needs of themselves, fellow farmers of the village and farmers of neighbouring villages in appropriate time and at affordable cost is called "a seed village".

Concept

- Organizing seed production in cluster (or) compact area.
- Replacing existing local varieties with new high yielding varieties.
- Increasing the seed production.
- To meet the local demand, timely supply and reasonable cost.
- Self sufficiency and self reliance of the village.
- Increasing the seed replacement rate.

Features

- Seed is available at the door steps of farms at an appropriate time
- Seed availability at affordable cost even lesser than market price
- Increased confidence among the farmers about the quality because of known source of production
- Producer and consumer are mutually benefited
- Facilitates fast spread of new cultivars of different kinds

Important Points

Biologically Seed is a matured Ovule.
Seed contains Embryo, Endosperm, Seed coat.
Embryo consists of Embryonic axis, Cotyledons. Embryonic root is called Radicle .
In monocots only one cotyledon which is reduced and modified to form Scutellum.
In maize the hypocotyls is modified to form Mesocotyl.
The base of hypocotyls sheathing the radical is termed as Coleorhizae.

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In castor, the embryo acts as a Storage structure.
Endosperm is developed from Primary endosperm nucleus (PEN).
The ploidy of endosperm of angiosperm is 3n.
The intermediate of nuclear and cellular endoplasm development is Helobial endosperm.
Helobial type of endosperm development is prevalent in Monocotyledons.
Seeds with well developed endosperm are called Aluminous seeds.
The seeds which are having small amount of endosperm are called Exalbuminous seeds.
Examples of endospermic seeds of Monocots: Rice, Wheat, Dicots : Castor, Legumes: Fenugreek, Opium.
Examples of non-endospermic seeds monocots: Orchids, water plantain, dicots; Grams, peas, beans.
In some of the plant species like coffee and pigweed Endosperm is absent and Perisperm acts as storage tissue.
All seeds bear scar like point is called Hilum .
The small hole at one end of the hilum is present in the seed coat of many species is called Micropyle.
In castor bean the axil is associated with micropyle is called Caruncle.
In dicots the ratio of embryo to endosperm is ore.
In monocots the ratio of embryo to endosperm is less.
Phytin is a rich source of Phosphorous.
During the seed development the moisture content drops to 10-15%.
Phtyin deposited as Myo- inosital hexa phosphoric acid.
The stage at which the seed reaches to its maximum dry weight, viability and vigour Physiological maturity.
Physiological maturity will occur 35-40 days after anthesis in sorghum.
At the time of physiological maturity the colour of the seed coat will be Pink.
The total soluble solids in sugarcane can be measured by Brix sugar hydrometer.
The value of brix reading for harvesting sugarcane crop is >17.
Harvest which coincide with the ripening process of the seed beyond physiological maturity Harvestable maturity.
Rice crop harvested at 15% seed moisture content instead of 21% moisture content results in a yield reduction by 20%.
The capacity of the seed to germinate and produce a normal seedling is called seed Viability.
The condition of active good health and robustness in seed is called Seed vigour.
During storage the vigour and viability of seed will be decreased.
Seed viability and vigour are maximum at the time of Physiological maturity.
If the seed moisture content increases storage life will be Decreases.
Tetrazolium test is used to measure Seed viability.
In tetrazolium test Dehydrogenase enzyme activity will be measured.
Tetrazolium test is conducted by using Tri phenyl tetrazolium chloride solution.
The colour of the formazan is Red.
In sulphuric acid test the living portion of the cut surface of the seed develops Deep rose colour.

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In exhaustion test the seedlings with roots and shoots extending more than 2 inches are said to be vigorous.
Sulphur containing amino acids are Cysteine and Methionine.
The normal concentration of gases like O ₂ , CO ₂ and N ₂ for good seed germination is 20% 30% ,80%.
Rice seeds can be germinated even under absence of Oxygen although the seeds are weak and abnormal.
The effect of temperature on germination can be expressed in terms of Cardinal temperature.
The optimum temperature for germination of seeds is in between 15-30°C.
The low temperature pre-treatment before germination is usually called Stratification.
The greater promotion of light on germination occurs in Red region.
Seed index- Weight of 100 seeds, Test weight- Weight of 1000 seeds
First seed testing laboratory was established at IARI in 1961

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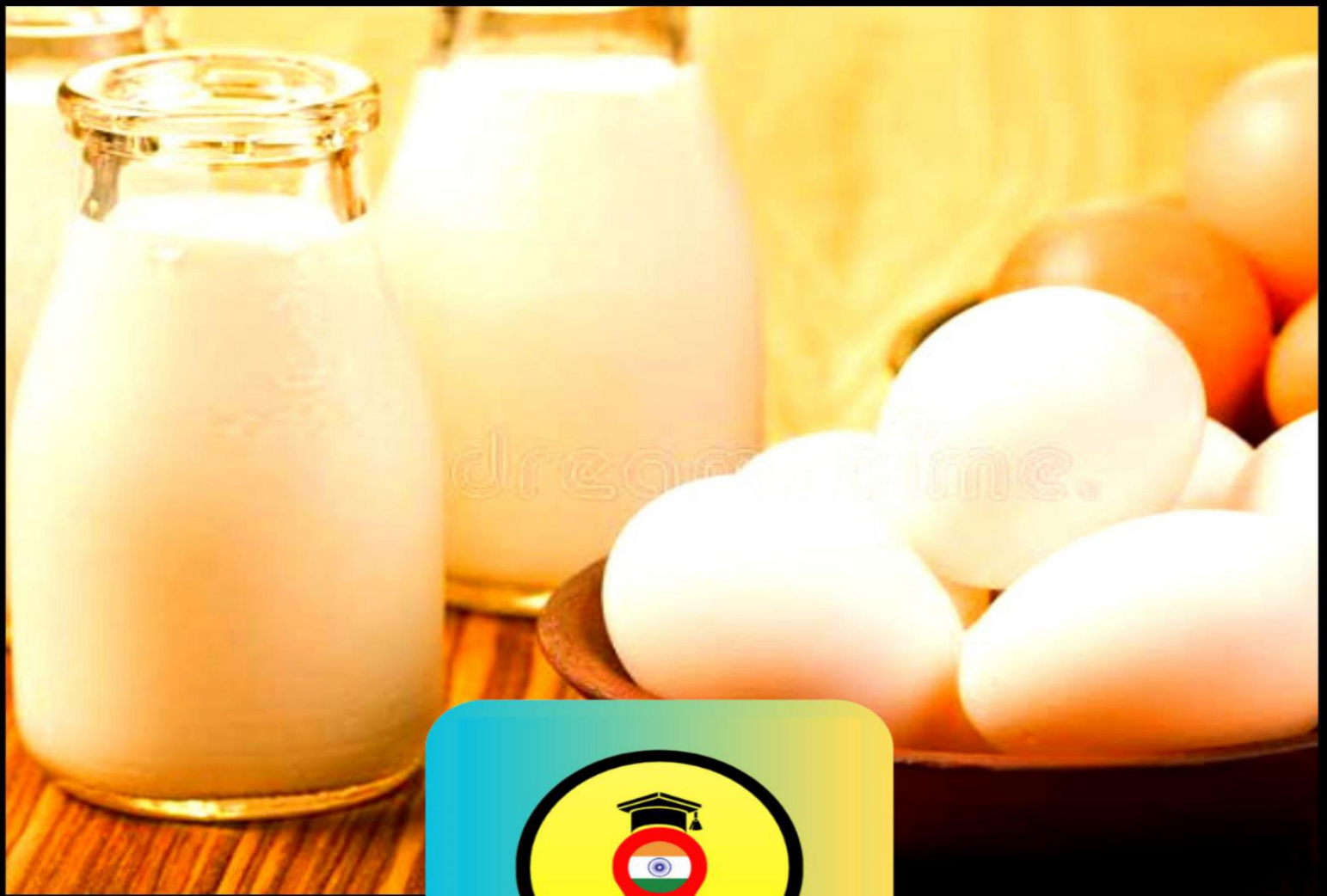
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DAIRY TECHNOLOGY

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Dairy Technology

Dairy is a place where handling of milk and milk products is done and technology refers to the application of scientific knowledge for practical purposes.

S.No	Constituents	Buffalo	Cow	Goat	Liquid skimmed milk
1	Moisture (g)	81.00	87.50	86.80	92.10
2	Protein (g)	4.30	3.20	3.30	2.50
3	Fat (g)	6.50	4.10	4.50	0.10
4	Minerals (g)	0.80	0.80	0.80	0.70
5	Carbohydrates (g)	5.00	4.40	4.60	4.60
6	Energy calories (kcal)	117.00	67.00	72.00	29.00
7	Calcium (mg)	210.00	120.00	170.00	120.00
8	Phosphorus (mg)	130.00	90.00	120.00	90.00
9	Iron (mg)	0.20	0.20	0.30	0.20

Average milk composition of different species

Species	Water	Fat	Protein	Lactose	Ash
Friesian cow ¹	87.92	3.40	3.13	4.86	0.69
Sindhi cow ²	86.07	4.90	3.42	4.91	0.70
Gir cow ²	86.44	4.73	3.32	4.85	0.66
Tharparkar cow ²	86.58	4.55	3.36	4.83	0.68
Sahiwal cow ²	86.42	4.55	3.33	5.04	0.66
Crossbred cow ²	86.54	4.50	3.37	4.92	0.67
Buffalo ³	82.76	7.38	3.60	5.48	0.78
Goat ⁴	87.10	4.25	3.52	4.27	0.86
Sheep ⁵	81.00	7.90	5.80	4.50	0.80
Camel ⁶	86.50	3.10	4.00	5.60	0.80

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PFA Standards for different class of milk in India

Class of milk	Designations	State and Union Territories	Minimum percentage	
			Milk fat	Milk solids-not-fat (SNF)
Buffalo milk	Raw, pasteurized, boiled, flavoured and sterilized	Assam; Bihar; Chandigarh; Delhi; Gujarat; Maharashtra; Haryana; Meghalaya; Punjab; Sikkim; Uttar Pradesh; West Bengal; Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Dadra & Nagar Haveli; Goa; Daman & Diu; Kerala; Himachal Pradesh; Jammu & Kashmir; Karnataka.	6.0	9.0
		Kerala; Lakshadweep; Madhya Pradesh; Manipur; Mizoram; Nagaland; Orissa; Pondicherry; Rajasthan; Tripura; Tamil Nadu.	5.0	9.0
Cow milk	-do-	Chandigarh; Haryana; Punjab.	4.0	8.5
	-do-	Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Dadra & Nagar Haveli; Delhi; Goa; Daman & Diu; Gujarat; Himachal Pradesh; Jammu & Kashmir; Karnataka; Kerala; Lakshadweep; Madhya Pradesh; Maharashtra; Manipur; Meghalaya; Nagaland; Pondicherry; Rajasthan; Sikkim; Tamil Nadu; Tripura; Uttar Pradesh; West Bengal.	3.5	8.5
	-do-	Mizoram; Orissa;	3.0	8.5
Goat or sheep milk	-do-	Chandigarh; Haryana; Kerala; Madhya Pradesh; Maharashtra; Punjab; Uttar Pradesh.	3.5	9.0
	-do-	Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Dadra & Nagar Haveli; Delhi; Goa; Daman & Diu; Gujarat; Himachal Pradesh; Jammu & Kashmir; Karnataka; Kerala; Lakshadweep; Manipur; Meghalaya; Mizoram; Nagaland; Orissa; Pondicherry; Rajasthan; Sikkim; Tamil Nadu; Tripura; West Bengal.	3.0	9.0
Mixed milk	-do-	All India	4.5	8.5

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Standardized milk	Pasteurized, flavoured and sterilized	All India	4.5	8.5
Recombined milk	-do-	All India	3.0	8.5
Toned milk	-do-	All India	3.0	8.5
Double toned milk	-do-	All India	1.5	9.0
Skimmed milk	-do-	All India	Not more than 0.5	8.7
Full cream milk	Pasteurized, and sterilized	All India	6.0	9.0

Note- Buffalo milk is because buffaloes are more effective at converting beta-carotene — an antioxidant with a distinctive yellow colour — into vitamin A.

Important Points-

- Total Solid, SNF, Fat and Protein is highest in sheep and buffalo milk and water is highest in mare milk, lactose is highest in human milk.
- Fresh milk contains **84–87% water** in which all other constituents of milk are dissolved and in which are dispersed two different systems, namely fat globules enclosed within their protective membrane as an oil-in-water emulsion, and protein, containing casein molecules and insoluble salts in a colloidal suspension.
- Rank of India is 1st in total milk production and 2nd in cow milk production.
- Per year growth rate in milk production is approximately 5%
- The all-India per capita availability of milk is **427 grams per day** in 2020-21.
- National Dairy Development Board was established in 1965 in **Anand, Gujarat**.
- National Milk Day- **26 November**
- World Milk Day- **1st June**
- **Operation Flood and White Revolution** is related to Milk production.
- Milk is good source of calcium, protein, fat soluble vitamins (A,D,E&K), 22 minerals, phosphorus, potassium, zinc, magnesium, phosphorus, iron, sodium, copper, manganese etc. Vitamin C is absent in milk.

Physical Properties of Milk-

Colour and optical properties

Milk appears turbid and opaque owing to light scattering by fat globules and casein micelles. Optical properties are influenced by the manner of scattering of light by the molecules. Light scattering occurs when the wavelength of light matches the magnitude of the particle. Thus, smaller particles scatter light of shorter wavelengths and vice versa. Beta-carotene, the carotenoid precursor of vitamin A, is responsible for the creamy colour of cow milk. The greenish tinge in whey is due to the presence of riboflavin. Refractive index of milk is an optical property and ranges from 1.3440 to 1.3485 at 20°C.

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Flavour of milk

The natural sweet flavour of milk is due to the combined effect of its components. Off-flavours are very quickly developed in milk owing to several factors. The feed consumed by animals may lead to some undesirable flavours. Bacterial growth in milk causes fruity, barny, malty or acid flavours. Enzyme activities also may lead to unnatural flavours, rancidity due to lipase action being a classic example. **Oxidative reactions** may cause a cardboard flavour in milk. Processing of milk may produce cooked flavours.

Specific gravity and density

Milk is heavier than water. The specific gravity of cow milk varies **from 1.018 to 1.036** and of buffalo milk from **1.018 to 1.038**. Though specific gravity varies with temperature, (lower at higher temperature and vice versa), the rate of this variation is not uniform.

Viscosity

Viscosity of milk depends on the temperature and the amount and state of dispersion of the solid constituents, mainly casein and fat. Viscosity of the whole milk at 25°C is about 2.0 cP. Cooler temperatures increase viscosity due to the increased voluminosity of casein micelles whereas temperatures above 65°C increase viscosity due to the denaturation of whey proteins. An increase or decrease in pH of milk also causes an increase in casein micelle voluminosity.

Surface tension

The surface activity of milk is related to proteins, fat, phospholipids and fresh fatty acids present in it. Homogenization and heat sterilization increase the surface tension of milk. **Milk has a surface tension of 50 dyne/cm at 20°C.**

Freezing and boiling points of milk

The freezing points of cow and buffalo milk vary **from -0.512 to -0.572°C** and from **-0.521 to -0.575°C** respectively. Freezing point of milk is mainly used to determine added water. The boiling point of milk is **100.17°C.**

Acidity and pH

Freshly drawn milk has a pH value in the range of **6.5 to 6.7** and contains **0.14 to 0.18% titratable acid** calculated as lactic acid. There is no developed acidity in freshly drawn milk, the slightly lower than the neutral pH being attributed to the presence of carbon dioxide, citrate, casein etc.

Heat stability of milk

Heat stability is defined as the length of time required to induce coagulation at a given temperature or the temperature required to induce coagulation in a given time. The stability of milk system at the high

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processing temperatures to which milk is exposed for the manufacture of certain products is very important.

Composition of Milk

Factors that influence the chemical composition of milk are individuality of the animal, breed variation, seasonal changes, weather, age and health of the animal, managerial practices including nature and quality of feed, stage of lactation, the quarter of the udder of the animal from which milk is drawn, different fractions of milking etc.

Detection of Common Preservatives, Neutralizers and Adulterants in Milk

Boric acid and borates

When a strip of turmeric paper is dipped into adulterated milk sample that has been acidified, it turns into characteristic **red colour indicating the presence of boric acid** and or its salt.

Formalin or formaldehyde

Formalin is added in milk as a preservative, as it checks the rise in acidity. Acidified milk containing formalin or formaldehyde forms characteristic violet colour with ferric salts and other oxidizing agents. *There are mainly two tests namely Hehner and Lech tests that are commonly followed.*

Hehner test

To 10 ml of the milk sample, 0.5 ml of 10% ferric chloride solution is added. Thereafter, 5 ml of concentrated sulphuric acid is added carefully down the side of test tube to form a separate layer without mixing with milk. **Presence of a violet coloured ring at the junction of two liquids indicates the presence of formaldehyde.**

Lech test

To 5 ml of milk in a test tube is added equal volume of concentrated hydrochloric acid containing 1 ml of 10% ferric chloride solution. The contents are heated over a flame for 5 min and the tube rotated or shaken to break the curd. **Development of violet colour indicates the presence of formaldehyde.**

Hydrogen Peroxide

Hydrogen peroxide acts as an antimicrobial agent thereby, checking the development of acidity. Addition of 2 drops of 2% freshly prepared aqueous solution of paraphenyl diamine hydrochloride to the **adulterated milk sample gives intense blue colour, thus indicating the presence of hydrogen peroxide.**

Neutralizers

Chemicals such as carbonates or bicarbonates are added to milk in order to disguise developed acidity. **Presence of rose red colour indicates addition of sodium hydroxide, potassium hydroxide and/or calcium hydroxide while pink colour points to the addition of sodium bicarbonate, potassium carbonate or calcium carbonate.**

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Detection of Common Adulterants

Sugar

Resorcinol produces **red colour** with sucrose in an acidic medium.

Starch

Iodine solution gives intense blue colour with starches. Three ml of well-mixed milk is boiled over a Bunsen burner. After cooling, one drop of 1% iodine solution is added and mixed well. The appearance of an intense blue or bluish violet colour indicates the presence of added starch.

Urea

There are two methods by which added urea can be detected in milk. To 5 ml of well mixed milk sample, 5 ml of para-dimethylamino benzaldehyde solution is added and mixed. **The development of an intense yellow colour indicates the presence of urea.**

In the second method, 5 ml of 24% TCA solution is added to 5 ml of well-mixed milk sample in a test tube. The contents are filtered through Whatman No. 42 filter paper, and 2% of NaOH solution and 0.5 ml of 2% sodium hypochlorite solution are added to one ml of the filtrate. After thorough mixing, 0.5 ml of 5% phenol solution is added. **The development of blue or bluish-green colour indicates the presence of urea.**

Pond water

Several unscrupulous milk vendors dilute the milk with unclean water waterways such as ponds. To detect its presence, a clean test tube is rinsed with 5 ml of milk sample and decanted. Along the side of test tube, **1-2 ml of 2% diphenylamine solution** is added. The appearance of **blue colour** indicates presence of pond water.

Synthetic Milk

In recent times raw milk has sometimes been adulterated with the so called 'synthetic milk' usually prepared out of vegetable oil emulsified with the help of commonly available commercial detergents and other compounds such as urea, glucose etc.

Fat Determination

Gerber method and Rose Gottlieb method.

Hansa Test

To detect presence of **buffalo milk in cow milk.**

Milk Adulteration and Lactometer

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- ✓ Adulteration is an unwanted and inferior mixing process in food. The food-added material or material is referred to as adulterants. Water is the most common milk adulterant. A lactometer can detect water adulteration in a milk. The density of the milk decreases when water is added to the milk and this is detected via a lactometer. The less than 1.026 reading of the lactometer shows milk adulterating by water. Adulteration simply signifies mixed impurities and pure means unadulterated.
- ✓ The instrument is composed of a TEST-TUBE and a METER BULB and is very simple to use. To verify the purity of cow's milk a lactometer is used. Milk is poured into and allowed to be able to stand until cream is formed, so milk content is determined by the depth of the cream deposit in degrees. If it's pure, the lactometer floats and the lactometer sink when it is adulterated or impure. Lactometer is a medium for monitoring the pureness of milk samples.

Methods of pasteurization

- **In bottle pasteurization**

In this case bottles filled with raw milk and tightly sealed with special caps are held at **63 to 66 degrees Celsius for 30min**. Then the bottles passed through water space of decreasing temperature, which cool both the product and the bottle. One of the advantages is that it prevents the possibility of post-pasteurization contamination.

- **Batch/Holding pasteurization/Low temperature long time method**

In this case the milk is heated to **63 degrees Celsius for 30 min and promptly cooled to 5 degrees Celsius** or below and thus heating is done indirectly. The heat moves through a metal wall into the product for heating, and out of the product for cooling.

- **High temperature short time (HTST) pasteurization**

In this case large volumes of milk are handled and it gives a continuous flow of milk which is heated to **72 degrees Celsius for 15 sec and promptly cooled to 5 degrees Celsius or below**.

- **Vacuum pasteurization**

This refers to pasteurization of milk and their reduced pressure by direct steam. The equipment used is termed as 'Vacreator' and the process hence is known as 'Vacreation'.

- **Ultra high temperature pasteurization**

This method consists of temperature-time combinations of **135 to 150 degree Celsius for no hold (a fraction of second)**. The success of this method depends on immediate aseptic packaging.

- **Uprization**

Uprization term means '**Ultra- pasteurization**' where in milk is heated with direct steam up to **150 degree Celsius** for a fraction of second and thus the process is continuous.

- **Flash pasteurization 'HTST'**.

The formulation of the standards of pasteurization includes following points.

1.	Bacterial destruction
2.	Cream line reduction
3.	Phosphatase inactivation

MILK

Milk is one of the most basic of all food. Milk constitutes a complete diet and even for adults, cow's milk includes many essential nutrients particularly calcium. SOURCE: Mankind from time immemorial has used the milk of animals. The milk of cow, buffalo and goat is generally used. In some countries milk of

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sheep, mare and camel is also used.

Milk represents a major ingredient in our diet- poured over cereals, drunk in glasses, in tea and coffee- but it also enters the composition of many dishes especially desserts such as ice cream, custard, pancakes, rice puddings etc. it is particularly high in calcium, but it is also fairly in fat.

COMPOSITION:

Whole milk – that is, milk comes from the cow- is composed of water (88%), milk fat (3.25 %), other milk solids (protein, lactose and minerals)- 8.25%.

There are many types of milk consumed though mostly it is cow's milk, goat's milk and sheep's milk.

PROCESSING TECHNIQUES:

Processing

From the time it is milked from the animal to the time of sale, milk has to undergo processing to improve the keeping quality and to make it fit for consumption. The various stages are:

1. Collection

Milk is brought to the dairy in clean sterilized vessels, preferably stainless steel.

2. Holding tanks

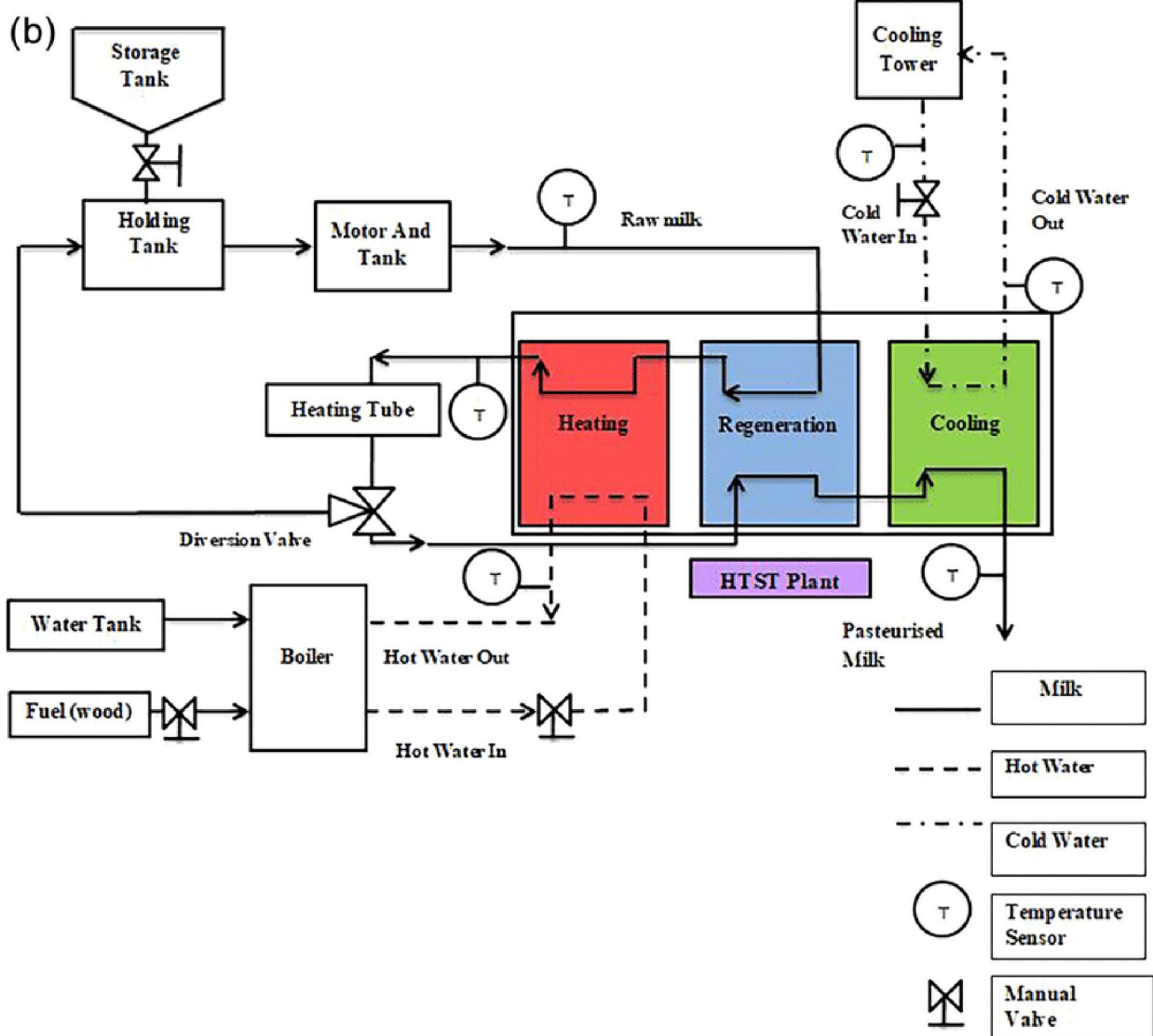
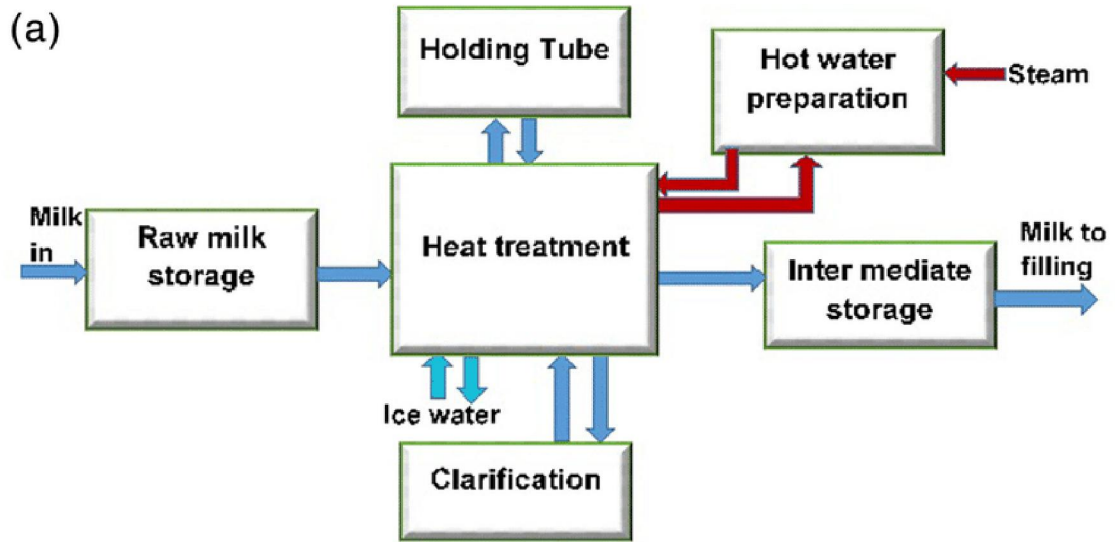
The milk is immediately transferred to holding tanks and is held at 10°C to keep it safe. Cooling is done either in a tank, jacketed with pipes in which runs a brine solution. Else the milk is run over very cold water pipes.

3. Filtration

The milk is passed through a series screens and filters to remove sediment and floating particles.

4. Pasteurization

It is the process of heating milk to 63.7°C and holding it at that temperature for 30 minutes. This is known as the "Holder Process of Pasteurization". Nowadays, the **Flash Pasteurization** is more commonly used. It is also called the HTST or High Temperature Short Time method, where the milk is heated to 71.6°C for only 15 seconds. Pasteurization makes milk safe for human consumption by destroying pathogenic germs (pathogens). It also helps to increase the shelf life. Flavors of the milk remains unaffected at pasteurization temperature.



5. Homogenization

At temperature of 60°C, milk is passed under high pressure through small opening of a machine called homogenizer. The main purpose is to **subdivide the fat globules in milk and disperse them evenly** in the entire mass. Fat has a low density and tends to rise to the surface during heating.

6. Bottling

The bottles of selected and uniform size have to be sterilized by steam and hot water and then they are filled with milk, which are capped automatically. Nowadays milk is filled in plastic pouches and these are more economical, easily transported and save storage space. Plastic pouches are easily disposed and are safe to handle.

7. Sterilization

The sealed bottles are now heated for **30 to 40 minutes at temperatures ranging from 104-110°C in steam chambers called autoclaves and then allowed to cool**. Milk can also be sterilized before bottling. It is subjected to temperatures of 135-150°C for just 1 second. This is called the UHT or Ultra Heat Treatment. This process kills off all microorganisms and the very short holding temperature reduces the changes in colour and lined with aluminum foil. Milk is then distributed through various outlets.

Various types of milk:

1. **Untreated milk:** It retains its entire natural flavor. It is advised to boil for 15 minutes before using. It remains good in refrigerator for 24 hrs.
2. **Pasteurized milk:** To kill bacteria by heating milk or other liquids to moderately high temperatures for a short period of time. Milk must be heated to at least 145°F for not less than 30 minutes or at least 161°F for 15 seconds, and then rapidly cooled to 40°F or lower.
3. **Sterilized milk:** is homogenized milk, heated to about 112°C under pressure for 15 mins in sealed bottle. The bottle is rapidly pulled to 80°C and then allows reaching lower temperature.
4. **Skimmed milk:** this is the milk without any fat. Basically it is a fat buster, low calorie produce
5. **Fortified milk:** extra nutrients are added to make the milk more nutritive. Usually, vitamin B is used.
6. **Flavored milk:** flavor and color added. Treated with high temperature of 100°C for about 15 mins, so that they may be kept later at room temperature.

TONNED MILK: toning is done to make buffalo milk resemble in appearance and flavor to cow's milk. It is done by dilution and addition of skimmed milk powder. 40 % of skimmed milk is added to 60 % of buffalo milk. The addition of skimmed milk powder makes up for the dilution of the nutrients, the fat content remains diluted and equal to that of cow's milk.

Concentrated milk:

Evaporated milk – unsweetened milk, evaporated under reduced pressure and reduced to 60% and canned.

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Sweetened milk- same as above but sugar is added before processing. Sugar acts as preservatives also. Milk powder-This is the whole milk from which the water is removed by either spray drying or by drying processes

CULTURED DAIRY PRODUCTS:

Cultured dairy products such as yoghurt, butter milk, and sour cream are produced by adding specific bacterial cultures to fluid dairy products. The bacteria convert the lactose to lactic acid, giving the products their body, and tangy and unique flavor.

WHOLE MILK: It comes as pasteurized & has fat content of 3.9 %.

Cream

Cream is the butter fat content of whole cow's milk, separated from the water.

Cream is commercially separated from milk in a creamery, by means of a mechanical separator. The milk is first heated to between 32-49°C (90-120°F) before being run into the separator which operates like centrifugal machine, rotating at very high speed and forcing the milk, which is heavier, to the outside; while the cream, which is lighter, remains at the centre. The cream and the skimmed milk are drained out through separate outlets and by means of a control valve, the fat content is adjusted. The skimmed milk is then heated to 79.5°C (175°F) to kill off any harmful bacteria before being further processed into dried milk etc.

The principal difference between the various types of cream -single cream, double cream, whipping cream, clotted cream and soured cream - is the balance between water and butterfat. This will make them liquid or of a very thick consistency.

Other differences are in the way they have been made and their time for maturing which results in different tastes. Cream has a slight yellow or ivory color and is more viscous than milk. Cream is used in kitchen to give flavor and body to sauce, soups and desserts.

Single Cream: contains **not less than 18% butterfat**. It cannot be whipped due to their being too little butterfat.

Double cream: contains **not less than 45% butterfat**. It can be whipped but not too much as it will turn to butter. It can be used to enrich sauces, but may curdle if boiled along with acid ingredients.

Whipping Cream: containing **not less than 38% butterfat**. It is perfect for whipping as its name indicates. After whipping you will find a difference in texture and a change in volume. Sweetened or unsweetened cream can be used in desserts or can be used as an accompaniment, and is incorporated in mousses to lighten them.

Clotted Cream: contains **not less than 55% butterfat**. It is already very thick so it can be used as it is and not whipped. **Soured Cream:** These are single creams which contain about 20% butterfat, but have a souring culture in them, and they are matured.

Half and Half: is a mixture of milk and cream in equal quantities and contains about **10-12% butterfat**.

Manufactured Cream

1. Reconstituted Cream

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2. It is made by emulsifying butter with skimmed milk or skimmed milk powder. This is not true cream, but a substance which resembles it in appearance.
3. Imitation or Synthetic Cream
4. It is made by the emulsification of vegetable fats with dried egg and gelatin, and then sugar and flavourings are added. It is a product which is frequently used in catering and baking trade, but which is very easily contaminated and liable to cause food-poisoning.

Cheese

Cheese is the curd of or the fresh or matured product obtained by enzyme activity and subsequent separation of whey by drainage, after coagulation of milk, cream, partly skimmed milk, butter milk or a combination of these bases.

The present word cheese is derived from the old English word "Cese" and "Chiese" from the Latin "Caseus". The equivalent words in German "Kase", and French "Fromage", in Spain it is called "Queso", and in Italy "Fromaggio".

The ingredients used for the manufacture of cheese making are Milk, starter, colour, added chemicals, coagulates, salt.

COMPONENTS OF CHEESE MAKING

Milk - The various cheese of the world first owe their character and taste to the type of milk used - double cream, toned, or skimmed milk. The character also greatly depends on the animal the milk came from - cow, goat, ewe, or water buffalo.

Starter - If left in a warm place, milk will sour by itself. This souring is due to the action of bacteria on the milk sugar, lactose, and its conversion to lactic acid or sour milk. To speed up the process of souring and to prevent the milk from becoming bitter and unpleasantly sour, a little warm sour milk from the previous day's milk is added to this batch. This speeds up or starts the process of coagulation, and is known as the starter or starter culture. In the case of pasteurized milk, all bacteria is killed, and hence the starter consists of a combination of cultures grown in the lab.

Rennet - Although the starter culture speeds up the process of souring milk, and would eventually cause it to curdle, it produces quite a sharp, acidic taste. The use of rennet, which is an enzyme from the inner lining of young hooved animals like lambs and calves, significantly improves the product. Rennet also helps break down the curd into a smooth, even consistency, contributing to the texture and flavor.

TYPES OF CHEESE

1. Fresh Cheeses

Fresh cheeses are usually made by setting the curd with **starter and rennet and are high in moisture**. The young curd is placed in sacks or perforated containers and drained slowly without pressure for a few hours so that the curd retains much of the whey. Once sufficient whey has been drained off, the curds are either mixed or sprinkled with salt. They are now ready to be eaten. For some cheese, like from age fares, the rennet is not added. Such cheese are called 'lactic cheese'. Some fresh cheeses are allowed to mature and grow either a white or bluish grey mould.

Fresh cheeses are always mild and high in moisture and therefore low in fat. They have a slightly acidic or lactic taste. Most are used for cooking but some may be wrapped in leaves or dusted with paprika or fresh herbs for serving as a table cheese.

2. Soft Cheeses

The curd is ladled gently into perforated moulds and left to drain in an atmosphere of high humidity so that the curd does not lose too much whey. After a few hours, the cheeses are turned out of their moulds and left to mature for a few weeks. Their high moisture content, coupled with high humidity, attracts and encourages the growth of classic white penicillium mould, which helps to break down the curd and contribute the flavour and texture of the cheese. The result is a creamy, smooth, interior that looks as though it is almost ready to run.

3. Semi-hard Cheeses

To obtain a firmer cheese, the curd is cut up to release some of the whey before the curd is placed in the moulds. It is then often lightly pressed to speed up the draining. After a day or so, the cheese is turned out of its mould and washed in brine. This seals the rind before the cheese is placed in cellars or ripening rooms where moulds are encouraged to grow.

The lower moisture content means the fermentation process is slower, producing cheeses with a round, full bodied, rather than strong flavour. Their taste often seems to be embodied with the oils and esters of the wild mountain flowers of Europe. When young, semi-soft cheeses have a firm yet springy, school eraser texture, becoming elastic and supple.

4. Hard Cheeses

To make a hard cheese, the curd must be cut more finely - from small cubes to rice-sized pieces. - The smaller the pieces the more whey will be lost from the curd. The curds are then gently heated in a vat to force out more moisture before the whey is drained out. Salt is then added to the curd, which now resembles rubbery, lumpy cottage cheese. They may be cut again before being placed in large, perforated moulds that are frequently engraved with the unique symbol, logo, pattern or name to identify the finished cheese or its maker. This is then sealed and left to mature for weeks or even years. Hard block cheeses are pressed into shape and then matured in special plastic wrap that allows the cheese to age without the development of either mould or rind. The moisture that would normally be lost during maturation is also retained.

5. Blue Cheeses

Blue cheeses are neither pressed nor cooked. Most frequently the curd is crumbled, eliminating much of the whey, then scooped into stainless steel cylindrical moulds, each with a wooden disc on top. The curd remains in the moulds for one to two weeks and is churned frequently to let the weight of the curds to press out more of the whey. Once the cheeses can stand up on their own, they are removed from the moulds, rubbed with salt, and returned to the cellars.

The process of making cheese can be divided into three fundamental steps. The first is the precipitation of casein into curd. Bacteria that produce lactic acid are infused in to the warm milk to obtain an adequate acidity for the action of rennet and to crowd out less desirable organisms. Then , rennet is added , which causes the caseins to aggregate ,trapping fat globules and whey in the protein network.

The second stage is the concentration of curds .Any free whey is drained off. The curds are cut, pressed, cooked and salted to remove much of the rest.

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The final stage is the ripening or ageing of the green curd. It transforms the initially produced bland and either crumbly or rubbery curds into a smooth substance with a pronounced and complex flavour. Ripening is mostly a matter of molecular breakdown caused by the enzymes of microbes, both the original starter bacteria and special ripening organisms.

Preparation of cheese

Preparation of milk

Milk is one of the prime ingredients for making cheese, it is a high protein dairy product made from the milk of animals like cows, sheep, goat, buffalo, yak etc.

Prior to manufacture process, milk needs to be prepared; this is done by pasteurizing the milk, homogenizing it and then clarifying it.

Addition of starter

This is done by two methods:

In *sour milk cheese* lactic acid bacteria thickens the milk

In *sweet milk cheeses* (most cheeses are of this kind), which are also called *rennet cheeses*, the cheese maker adds rennet- an enzyme taken from the stomach of suckling calves to separate solids in the milk from the fluid.

The rennet causes the milk protein to build up and the milk to curdle without the milk turning sour.

Formation of Coagulum

Addition of starter leads to coagulation of milk into a thick mass called 'young curd' and separation of whey.

Cutting

Firm curd is cut into smaller pieces by use of knives or chains.

Stirring/ Scalding

This process is also carried out for hard cheeses. It expels more whey and shrinks the curd. This process also speeds up the bacterial metabolism.

Salting

Salt is added into the cheese by wet or dry method as per the recipe. Brining in some cheeses also leads to longevity in shelf life

Moulding or Vatting and Pressing

After salting cheese is put in moulds for it to acquire a particular shape. This can be done in plastic or wooden moulds.

The cheese is pressed which gives it a definite shape. In case of blue chesses pressing is not done.

Finishing

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Cheese is de moulded and a rind or coating is given to the cheese. In some cases rind is dried by rubber ash, use of grape must and wrapping it in leaves. Such as Gorgonzola which is coated with plaster of Paris

Ripening/ Maturing

Mostly the harder cheeses are matured. They are matured in caves. A hard cheese can take anything from 8 weeks to a year to ripen and mature.

Famous Cheeses of the world English

Cheddar

Often called American cheese, but it is English and made in the Cheddar Gorge region in Somerset.

Stilton

Considered the “King of Cheeses” and is the best of all English blue cheeses and can take its place confidently alongside the world famous Roquefort in France and Gorgonzola from Italy.

Italian

Parmesan Another well-known flavourer of salad dressings and sauces. It is a hard ripe cheese with a piquant and sharp flavour.

Gorgonzola

Originally produced near Milan in a town called Gorgonzola, from full cream pasteurized cow milk. It has a sharp and spicy taste which is an excellent contrast to the creamy texture of the cheese.

Mascarpone

It is described as curd cheese. Serves as a very good alternative to double cream cheese in tiramisu.

Bel Paese

Another delicious cheese from Italy, which is soft and yellow, sweetish and very mild. Made from pasteurized milk.

Dolcelatte

It is a famous sweet cheese from Italy

Mozzarella

Mozzarella is one of the most famous Italian cheeses, it is used more to give finish to a dish rather than taste. It is a creamy cheese made from Buffalo milk.

Parmigiano - Reggiano

It is a hard cheese with orange rind. It has a strong and fruity aroma, but not overpowering. Used in sauces, salads and over pasta and risotto.

Ricotta

Is a soft, moist yet firm cheese.

French Brie and Camembert

Most French cheeses are soft and the luxury end of the scale is two dessert cheeses Brie and Camembert-both almost sauce soft. But an odour of ammonia will tell you when they are past their prime.

Roquefort

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Comes from the region of Rouergue of France.

It looks like marble, for its noble paleness is patterned with blue veins and patches. It is made from sheep's milk that is full cream and unpasteurized. Is used for blue cheese dressing for salads.

Reblochon

It has a creamy and supple texture. It has a yellow orange rind with a white mold. The elastic smooth creamy dough has a pleasantly mild taste somewhat reminiscent of hazelnut.

Boursin

Boursin is a soft fresh cheese it comes from Normandy region in France. This is a moist and creamy cheese, it melts in the mouth.

Neufchatel

Comes from Normandy region in France.

It is a soft white cheese with a grainy texture.

It has a slight taste of mushroom and is salty and sharp.

Greece Feta

This is a goat cheese from Greece made from goats or sheep's milk and is an integral part of Greek cuisine.

Swiss Emmenthal

Emmenthal cheese is equated with Swiss cheese all over the world. It is made of raw cow milk and with the addition of rennet. It is a mild cheese with a nutty aroma.

Gruyere

Another delicious cheese from Switzerland, which also has holes though, they are much smaller.

Edam

Named after the small port of Edam, north of Amsterdam, it is a pressed, semi soft cheese of Holland.

Gouda

It accounts for more than 60% cheese in Holland. Gouda is firm, smooth and supple cheese; it has a sweet and fruity flavour. Also had as a breakfast cheese.

CHEESES OF THE WORLD

CHEESE	TYPE	COUNTRY	MILK
Cottage	Fresh	Universal	Cow, goat, buffalo
Cream	Fresh	Universal	Full cream milk of cow, goat, buffalo
Mozzarella	Fresh	Italy	Cow, buffalo
Ricotta	Fresh	Italy	Cow
Feta	Fresh	Greece	Ewe, cow, goat
Quark	Fresh	Germany, Austria	Cow
Barbery	Soft	France	Cow
Bel Paese	Soft cream	Italy	Cow
Brie	Soft	France	Cow
Camembert	Soft	France	Cow
Bonchester	Soft	Scotland	Jersey Cow
Munster	Soft, with orange red rind	France	Cow

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Stracchino	Soft	Italy	Cow, buffalo
Appenzeller	Semi hard with pale yellow or burnt orange rind	Switzerland	Cow
Caerphilly	Semi-hard with buttermilk flavor	Britain	Cow
Cantal	Semi-hard	France	Cow
Cheddar	Semi-hard	Britain	Cow
Cheshire	Semi-hard	Britain	Cow
Chevre	Semi-hard	France	Goat
Danbo	Semi-hard, caraway flavored, square cheese	Denmark	Cow
CHEESE	TYPE	COUNTRY	MILK
Derby	Semi-hard	Britain	Cow
Edam	Semi-hard with yellow or red wax rind	Netherlands	Cow
Emmenthal	Semi-hard	Switzerland	Cow
Esrom	Semi-hard, with red rind	Denmark	Cow
Gloucester, Double Gloucester	Semi-hard, full cream	Britain	Gloucestershire cow
Gouda	Semi-hard, with yellow or red rind	Netherlands	Cow
Gruyere	Semi-hard, with pea size holes	Switzerland	Cow
Havarti	Semi-hard	Denmark	Cow
Jarlsberg	Semi-hard, with yellow coating	Norway	Cow
Lancashire	Semi-hard	Britain	Cow
Leicester	Semi-hard	Britain	Cow

BUTTER

Butter is fatty substance obtained from churned cream, containing 80% fat, 20% water and whey (milk solids left from separating process).

- Butter hardens at low temperature and melts when heated.
- **The smoking temperature of butter is 127°C.**
- Color varies from creamy white to golden yellow. It is the milk protein in the whey that makes butter spoil quickly.
- Most of the butter is made from cow's milk but other are some butter made from the milk of buffalo, yak, goat and sheep is also available.

Processing / manufacturing of butter-

1. **HOLDING:** Cream is pasteurized for 2-4 seconds at 95° C and then the temperature is lowered to 4-5° C and that is kept for several hours to ensure uniform hardening of fat particles.

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2. **RIPENING:** When the end product is going to be Lactic butter, only then this step is carried out, in which bacterial culture is added. In this case, the holding temperature will be 15-18°C for 3-4 hours before being cooled to 4-5°C. This gives butter a good flavor and the stage is omitted while making sweet cream butter.
3. **CHURNING:** It is carried out in big stainless-steel containers holding about 100 gallons of cream and the internal churners pass through the cream. This breaks the layer of fat solids which are released and are combined to form a large group of butter fat. After about 30 minutes of churning the butter gets separated from butter milk and floats to the surface.
4. **WASHING AND SALTING:** The butter grains are now washed with ice cold water to remove any butter milk left on the surface of each grain, in order to maximize the keeping quality.

Salting is carried in two ways:

- By adding fine grains of dairy salt.
- By dipping butter grains into brine solution (salt + vinegar) for 10-15 minutes and allowing the butter grains to absorb it.

Types of butter :

There are two types of butter-

1. Sweet cream butter
2. Lactic butter.

Butter can be made from any kind of milk. In India, butter is made from buffalo milk. Sweet cream butter : it is also known as fresh cream butter and is made from unripened cream. It can be salted or unsalted. It is soft, creamy texture and a creamy buttery taste.

Lactic butter : *This type of butter specially made in Denmark, Holland and France. The cream is mostly pasteurized, inoculated with a culture that ripens the butter, then pasteurized once more to arrest the ripening process.*

Note: Unsalted butter /sweet butter- it has mild aroma and slightly sweet flavor, used for making sweet pastries and cakes.

Salted butter –butter was originally salted to preserve it for the winter months when fresh butter was not made. Today salted is added to butter as ingredients. It is not ideally used in preparation of pastries.

Compound butter : these are made by adding a particular natural flavor or color to butter, depending on the type of food with which it is served. It is generally used as an accompaniment e.g. Lobster butter, parsley butter etc.

GHEE

Ghee is obtained by **clarifying butter**. Butter is heated to evaporate water. Pure ghee has a higher keeping quality and is a good cooking medium and shortening agent used in Indian cuisine.

Quality of ghee-

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Consumer judge the quality of ghee base on its inherence flavour, colour and appearance. Ghee should have characteristic pleasant, nutty, slightly cooked rich aroma. Ghee flavour is best described as lack of blandness, sweetly rather than acid. Golden yellow to light yellow colour of ghee is appreciated largely. Granular appearance of the product rather more score as it is important quality as well as purity preventer of ghee.

Apart from above sensory characteristics, its chemical and other physical preventers are evaluated to judge the quality of ghee and also to prevent adulteration of ghee.

(i) Refractive Index: It is the ratio of the velocity of light in vacuum to the velocity of light in the sample medium. In case of milk fat reading is normally made at 40 degree C using Abbe refractometer and its values range from 1.4157 to 1.4566. This value is low in comparison to the other fats and oils. The RI of ghee is influenced by both the molecular weight and the degree of saturation of the component fatty acids. RI could be used as indicator of adulteration.

(ii) Iodine Number: It is defined as number of grams of iodine absorbed by 100 g of fat under specified conditions. Thus constant is a measure of the unsaturated linkages present in a fat. The iodine number for milk fat falls within the range of 26 to 35 which is low in comparison to other fat and oils.

(iii) Reichert-Meissl Number (RM Number): This is defined as number of ml of N/10 Sodium hydroxide required to neutralize the steam volatile water soluble fatty acids distilled from 5 g of ghee under precise conditions specified in the method. It is primarily measure of butyric acid and caproic acid. The value for milk fat ranges between 17 to 35 and it is above that of all other fats and oils. Therefore, milk fat contains more of these acids than any of the fats.

(iv) Polenske Number: It is defined as number of ml of N/10 Sodium hydroxide required to neutralize the steam volatile water insoluble fatty acids distilled from 5 g of fat under precise conditions specified in the method. Caprylic acid, capric acids which are somewhat steam volatile but longely insoluble in water are indicated mainly in Polenske number and it ranges from 12 to 24 for milk fat.

(v) Saponification Number: It is defined as the number of milligrams of potassium required to saponify one gram of fat. The value ranges from 210 to 233 and more often falls in the range of 225 to 230. This constant is an indication of the average molecular weight of the fatty acid present. Saponification value is more useful in detecting the presence of mineral oils in ghee as they are not acted upon by alkali and such a sample does not form a homogeneous solution on saponification.

(vi) Melting Point: Melting point for milk fat ranges from 30 degree to 41 degree C as reported in literature.

Adulteration of ghee in India is more prevalent especially in unorganized sector. Being the most expensive fat people started to adulterate the product to make profits. Major adulterants of ghee are as follows:

- i). **Vanaspati (Hydrogenated vegetable oil).** Because of close resemblance in its texture most commonly used this as adulterant to ghee.
- ii). **Refined (de-odourized) vegetable oil.**
- iii). **Animal body fat.**

Government has made it compulsory that all Vanaspati must contain a maximum of 5% of Sesame oil which can be identified in ghee by a simple colour test (known as Baudouin test). By means of this Adulteration of ghee with Vanaspati to an extent of 3% can be detected.

CURD/DAHI

Dahi is a dairy product which is obtained when pasteurized milk or boiled milk is soured using previously cultured milk or by using lactic cultures. Pasteurised milk is cultured with *Streptococcus* or

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Leuconostoc bacterias and remain undisturbed after sealing for 15-20 hours at 22-26 degree Celsius to reach acidity of 0.9.

RABRI

It is prepared concentrated and sweetened product comprising of several layers of clotted cream. The layer of cream formed, as a skin is continuously removed. When the milk is reduced to 1/3 of the original volume, sugar is added and the layer of cream skin is mixed.

KHOA

Khoa is a partially dehydrated whole milk product.

PANEER

Paneer refers to the indigenous variety of rennet-coagulated, small-sized, soft cheese.

CHHENA

Chhena, also called paneer in certain parts of the country, constitutes one of the two chief bases (the other being khoa) for the preparation of indigenous sweetmeats. Chhana refers to the milk-solids obtained by the acid coagulation of boiled hot whole milk and subsequent drainage of whey. The acids commonly used are lactic or citric, in both natural and chemical forms. It should not contain more than 70% moisture, and the milk fat content should not be less than 50.0 per cent of the dry matter.

Please check the below table giving a complete overview of all the tests performed on the aforementioned dairy products:

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Material Test	Tests Performed	Test Method
Milk Powder,	Moisture/ Water	IS:1165-1992/ IS:13334-1998
	Total solids	
	Acidity	
	Fat	
	Protein	
Fresh Milk	Total solids	IS: 13688-1999
	Total fat	
	Solids not fat	
	Protein	
	Sugars	
Pure (Deshi) Ghee	Loss on Drying	IS: 13689-1992
	Acidity/F.F.A.	
	BR Value	
	RM Value	
	Polenske Value	
Butter Pasteurised	Loss on drying	IS: 13690-1992
	Fat	
	Acidity	
	Curd	
	Salt	
	Colouring matter	

Various Milk Tests

Milk Testing – Clot on Boiling Test (COB)

Objectives: *To determine the stability of milk for heat processing.*

If milk is kept as such at room temperature, there will be increased in the acidity which is called as developed acidity. If acidity is increased to more than 0.2 percent, there is coagulation due to heat treatment, which is the result of dissociation of calcium caseinate salt. Hence it is essential to know the heat stability of incoming raw milk for further processing.

Milk Testing – Sediment Test

Objective: *To know the extent of visible dirt present in the milk as a mark of clean milk production.*

Sediment test of raw milk will reveal the extent to which visible insoluble matter has gained entrance in the milk. It is a rapid test indication quantitative measure of carelessness in handling the milk and lack of sanitation. But in milk that appears as visible or insoluble sediment is always associated with relative number of microbes. The test is carried out by allowing a measured quantity of milk to pass through a fixed area of a filter disc and comparing the sediment with the prescribed standards.

Milk Testing – Alcohol Test

Objective: To detect abnormal milk such as colostrum or mastitis milk.

The alcohol test is used for rapid assessment of stability of milk for processing particularly for condensing and sterilization. The alcohol test is useful as an indication of the mineral balance of milk and not as an index of developed acidity. The test aids in detection abnormal milk such as colostrum, milk from animals in late lactation, milk from animals suffering from mastitis and milk in which mineral balance has been disturbed.

Milk Testing- Resazurin Test

Objective- To check quality and consistency of the milk. It also determines the bacteria that are present in the milk. Resazurin is a type of test that defines the quality and consistency of the milk. It also determines the bacteria that are present in the milk. This test is designed to assess the quality of raw milk. It is a rapid test of three hours that suggests the milk whether is all good or bad for us. The resazurin test gives the bluish characteristic colour to the milk that is all based on the quality of the milk. The milk quality is considered by only noting the colour change degree of the milk.

Through an earlier report, it is found that this test is particularly a chemical indicator that can determine the sanitary quality of the bulked milk. This test is also used to conclude more prominent information on milk quality. This test takes place in an isolated laboratory and there is no point of compromise at the time of the test in the laboratory at any cost. The blue colour of the milk suggests the perfect character of the milk after testing the milk.

Milk Testing – Platform Tests

Objectives: For examination of milk by adopting rapid test for acceptance / rejection of incoming milk.

Platform tests include the tests for judging the quality of the raw milk.

These are:

- (a) organoleptic evaluation (OE),
- (b) Clot on boiling test (COP),
- (c) Alcohol test (AT),
- (d) Sediment test (ST)
- (e) Resazurin test (RT).

The milk is collected from various sources and transported to milk scheme for processing, marketing and distribution. Large quantity of milk is supplied to the plant through different agencies, so that is subjected to check for its suitability. Hence it is essential to examine the milk by using different platform tests.

Milk Testing- Alkaline Test

Objectives: To verify if the heating process of pasteurization is done correctly.

The alkaline phosphatase (ALP) is an enzyme normally present in raw milk and it is inactivated in conditions of heat treatment. The temperature of inactivation of ALP is slightly higher than that required for the destruction of pathogenic bacteria. So, the ALP test in pasteurized milk is used to verify if the heating process of pasteurization is done correctly.

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SELECTION का दूसरा नाम

Indian IQ Institute

- 250+ Selections In IBPS AFO 2022 (AIR 1 and 10 Other Top Rankers with 70+ Marks From Indian IQ Institute)
- 140+ Selections In FCI AG3 (Technical) 2022
- 150+ Selection In IBPS AFO 2021
- 3 in IFFCO AGT, 2 in OPSC AAO



Why Indian IQ Institute?

- India's Topmost **Agricultural Exam** Related Institute, known for our crisp and exam-relevant content, actual exam-level mock tests, Topper's talk sessions, AFO Maha-Mock, Target-based disciplined practice, etc.
- The founder is a **gold medallist in Agriculture** and has cleared SSC Phase 7 (AIR 1), was Nominated for MoA&FW and IBPS RRB AO exam, and also qualified for different levels of IBPS clerical, SSC CGL, SSC 12th Level for analysis and review.
- Produced 500+ **Final selections in IBPS AFO, FCI AG3 (Technical), IFFCO AGT, ADO, and AAO** just in 2 years, Mentored **lakhs of students on channel** and thousands in different courses.
- Produced **best-selling e-books** in the Brahmashtira series for IBPS AFO, NABARD, MP RAO, RHEO, SADO and FCI Technical
- We focus on to-the-point, smart study, in-depth exam analysis, rigorous practice, competitive environment fortified with direct learning from toppers.
- All Subject Matter Experts & Content Development Team Members are well qualified from **NABARD, AFO, MSc, Gold medals & AO exams background.**
- **The Board of Advisors** includes Senior Edu-veterans from reputed universities and newly recruited young Officers for practical approaches and improvements.

Indian IQ-Secret Of Success



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In 2 Years Only



5000+ Paid
Students



12 L Youtube views
15K Subscribers



10+ Courses of
Agri-exams



Best Selling Books
Of Indian IQ



Target Based Test
In Courses



Exam Relevant &
Updated Contents



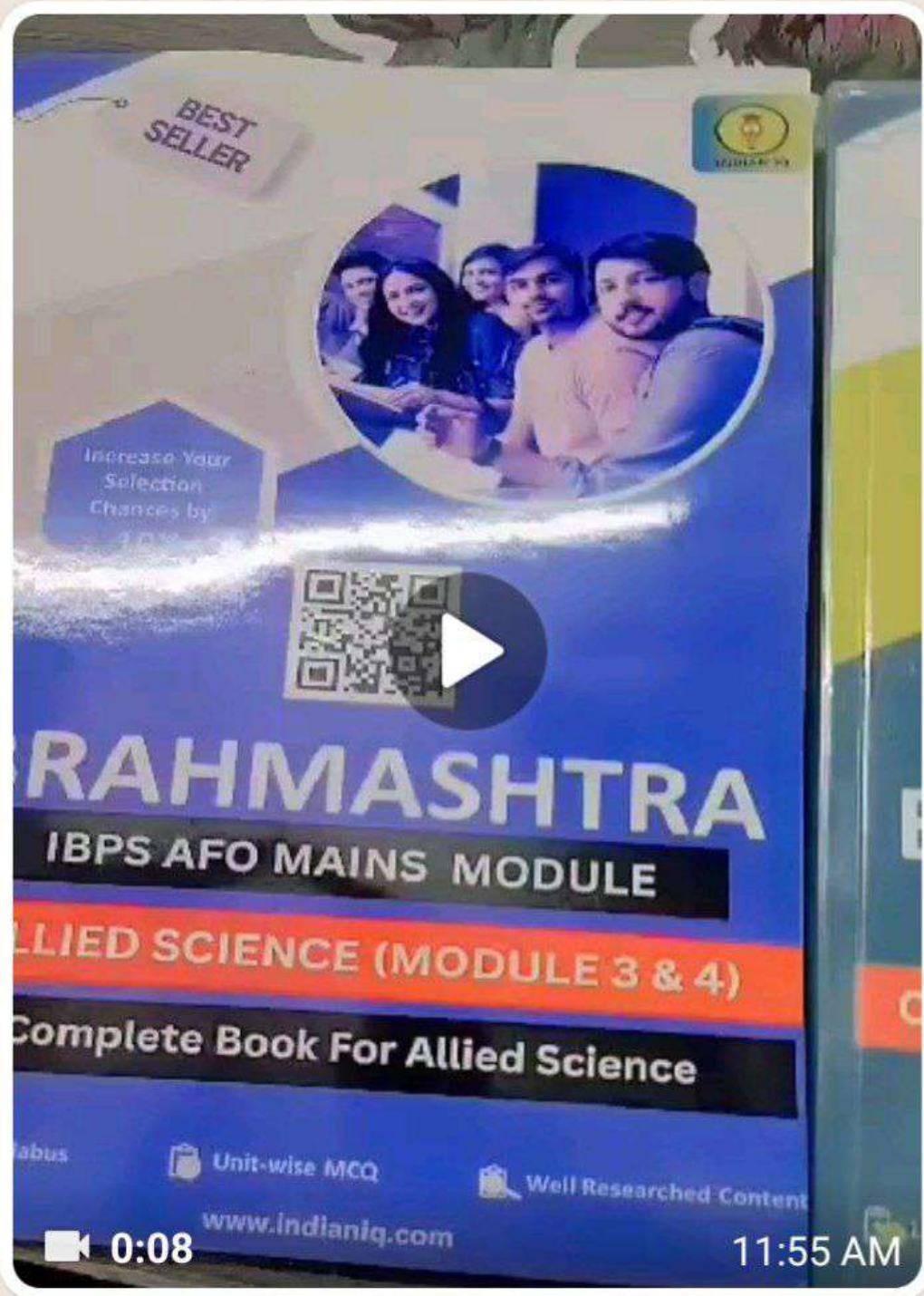
Personalized
Guidance



9958393505



011-45683444



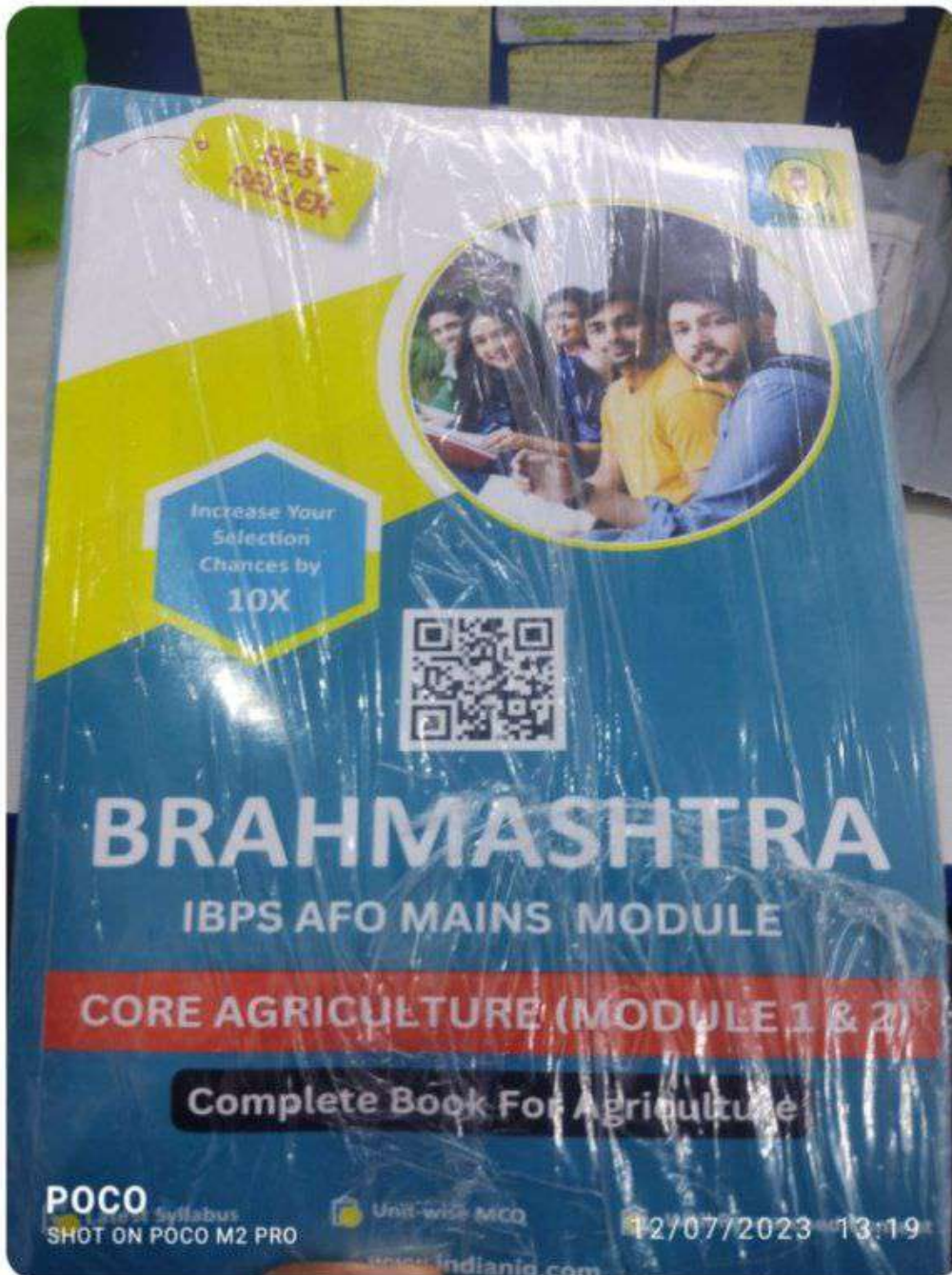
Finally..received the happiness sir.. 🙏

12:02 PM

In this running week 2:23 PM ✓✓

2 Unread Messages

Today



Thanku Sir... Received successfully

1:46 PM

Finally i can read them without my eyes getting stressed from my mobile screen

1:47 PM

EK EK student ka jaa chuka

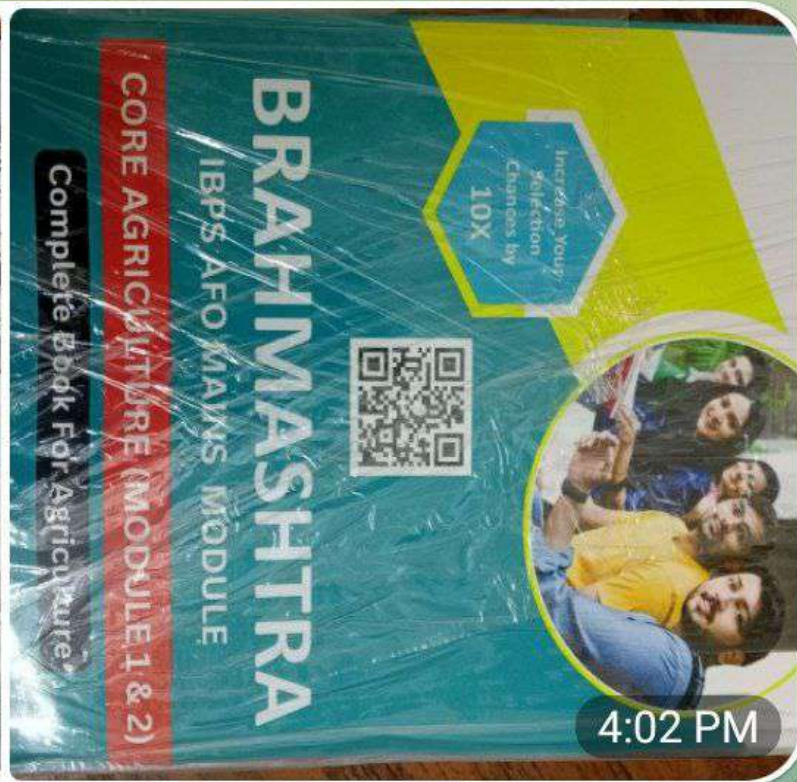
12:17 PM ✓

Unread Messages

Hamara b aajaye bss

12:22 PM

July 13



Sir kaafi happy hu atleast ab aankh me pressure nhi pdega aur bhut acha lgrha hai
Thank you sir ji 🙏🙏 books are awesome

4:02 PM

SELECTION की कला गीत

Indian IO Institute

2011 भारतीय IO इंस्टीट्यूट (आईओआई) के लिए प्रथम बार आयोजित हुए थे। इन परीक्षाओं में, 1000 उम्मीदवारों ने भाग लिया था।

2012 भारतीय IO इंस्टीट्यूट (आईओआई) के लिए प्रथम बार आयोजित हुए थे। इन परीक्षाओं में, 1000 उम्मीदवारों ने भाग लिया था।

2013 भारतीय IO इंस्टीट्यूट (आईओआई) के लिए प्रथम बार आयोजित हुए थे। इन परीक्षाओं में, 1000 उम्मीदवारों ने भाग लिया था।

2014 भारतीय IO इंस्टीट्यूट (आईओआई) के लिए प्रथम बार आयोजित हुए थे। इन परीक्षाओं में, 1000 उम्मीदवारों ने भाग लिया था।

Why Indian IO Institute?

Indian IO - Secret Of Success

S MODULE

MODULE 3 & 4

Allied Science

World Research Centre

9958393505

011-45683444

1:57 PM

BEST SELLER

BRAHMASHTRA

IBPS AFO MAINS MODULE

ALLIED SCIENCE (MODULE 3 & 4)

Complete Book For Allied Science

World Research Centre

9958393505

011-45683444

1:58 PM

Today I received the books 1:58 PM



Books received sir 🙏 1:14 PM



1:56 PM ✓

3:07 PM

Wow wow wow!! 😄😄❤️❤️😊

So so so happy sir.

Thankful & grateful to you sir 100 your immense efforts means alot 100 🙏 100

Sir I'm so so so thankful to you Sir.

These books are TRUE BLESSINGS of 2023 for me.

Thanks a ton sir 🙏🙏🙏🙏🙏🙏🙏🙏🙏🙏
🙏🙏🙏🙏🙏🙏

3:08 PM

Content... Wow.. So unique & authentic 100 🙏 😄

Clarity 100

Description 100

Error less 😍

These books arw bunch of "SUCCESS + HAPPINESS" for every AFO aspirant not just AFO for every agriculture Aspirant 100 🙏 😄 🌻

Blessed & grateful Sir. 🙏

3:10 PM

It means a lot ❤️❤️❤️❤️

Hardwork is paying off... Make me proud at any cost 🌸🌸

❤️ 3:19 PM ✓

Indian IQ

It means a lot ❤️❤️❤️❤️ Hardwork is paying off... M...

Yes sir 100

Sure. 100

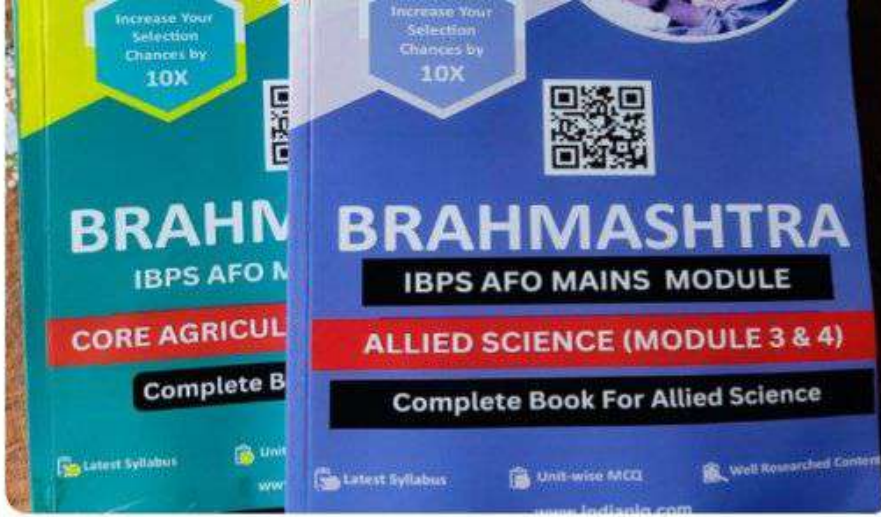
Trying my best sir ❤️❤️❤️❤️❤️

😊😊😊😊😊😊😊😊😊😊😊😊😊😊😊😊

3:25 PM

1

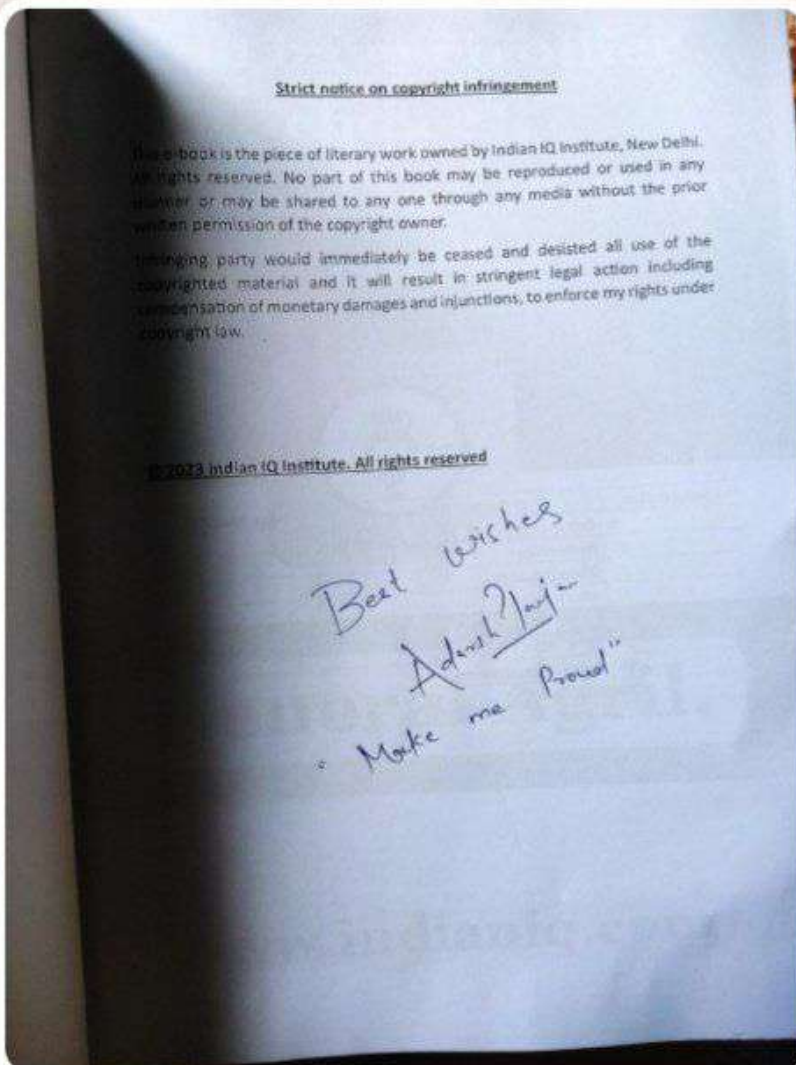




Sir, Finally got the "Brahmastra"s ❤️

Extremely happy to have these 😊

4:15 PM



Thank you so much for the beautiful message ❤️. Will make my family and YOU proud for sure 🙏

4:15 PM

All the best champion 🏆🏆

4:21 PM ✓✓

July 17



Sir...Books a gaya 🥰🥰🥰🥰🥰

8:42 PM



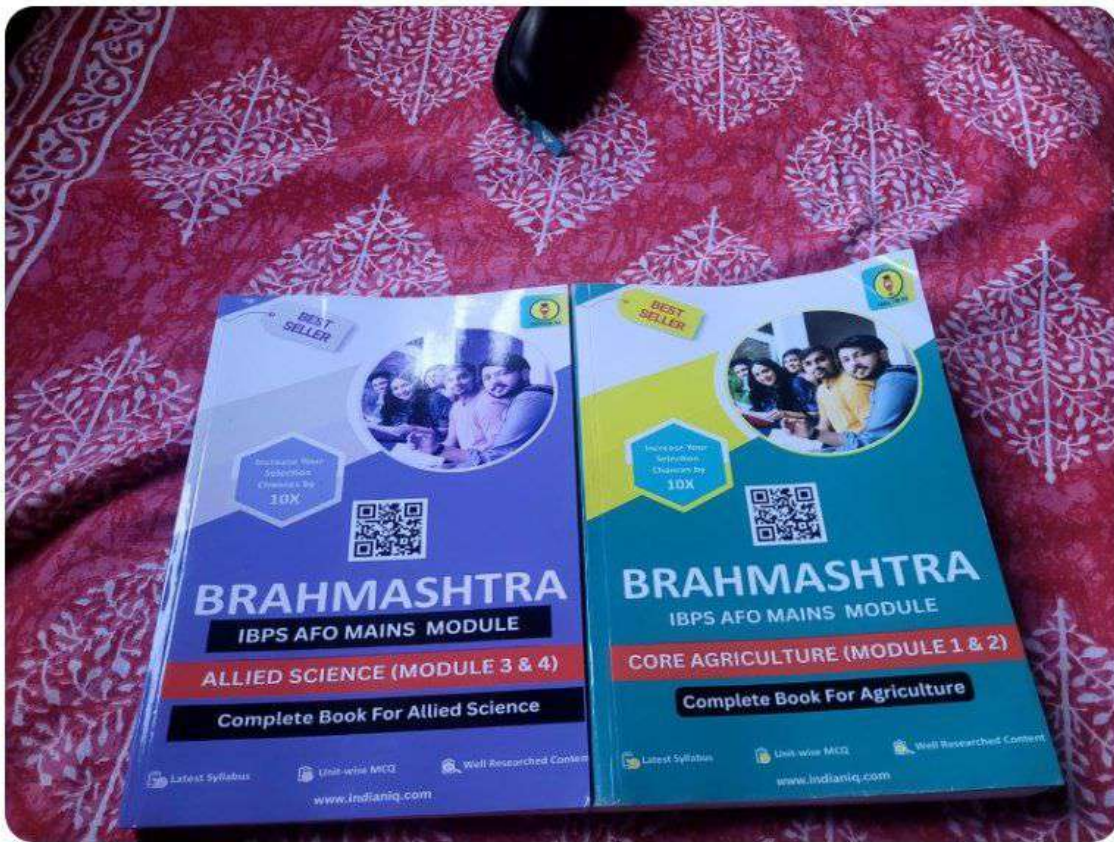
8:50 PM ✓

Keep tracking 👍👍

9:08 AM ✓✓

Ok sir 9:27 AM

Today



Sir finally got the **BRAHMASHTRA** books



6:08 PM



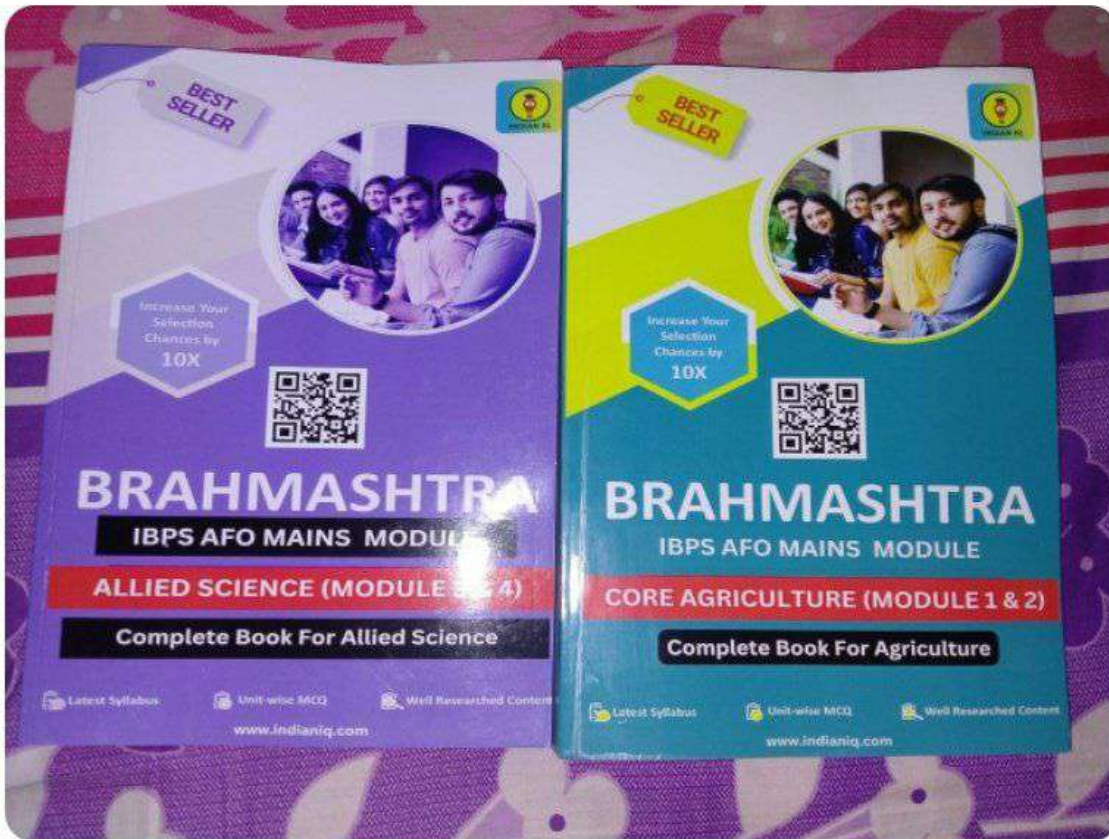
7:23 PM ✓✓

Make me extremely proud 👍👍

7:23 PM ✓✓

4:03 PM

Today



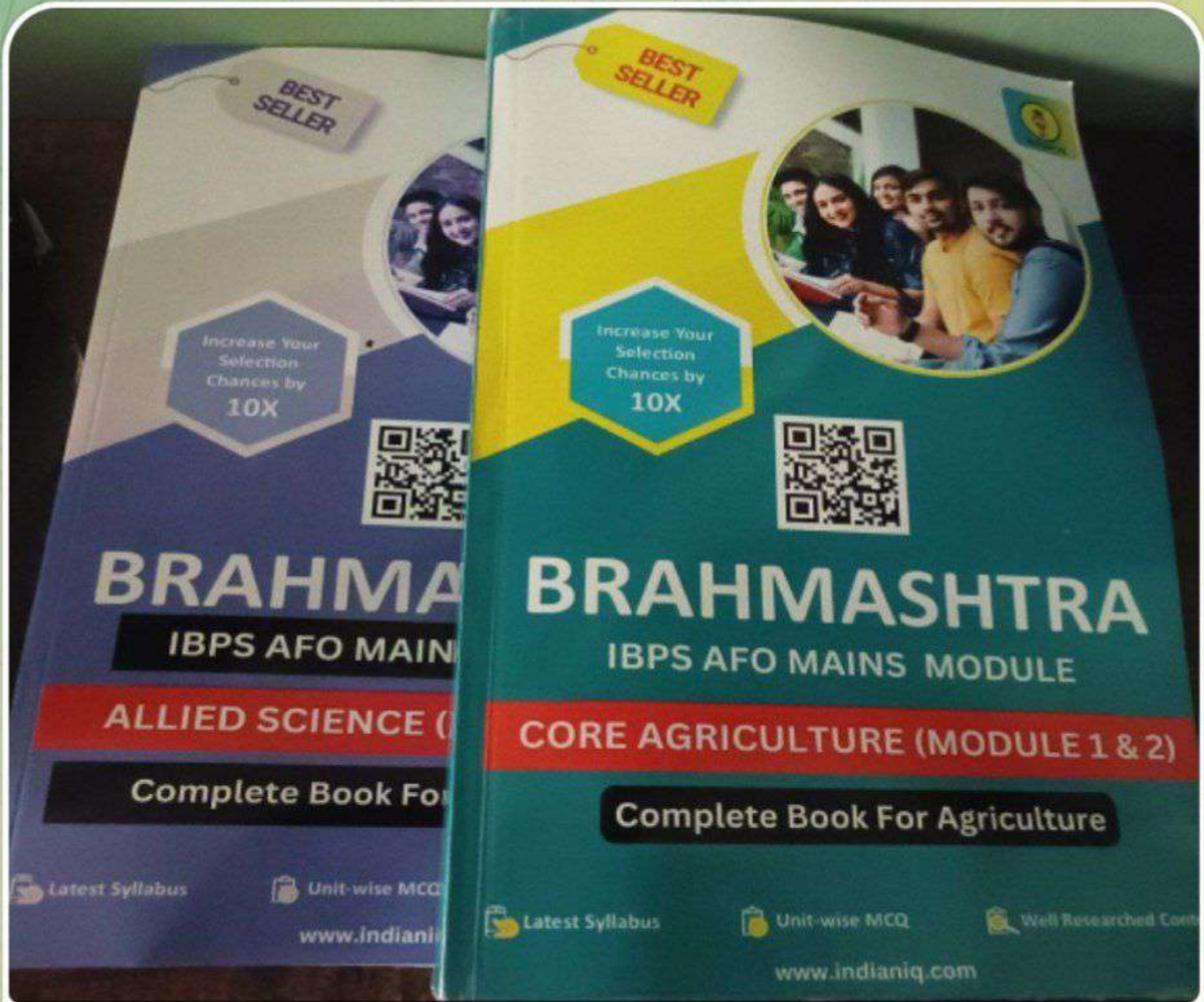
Finally received the happiness sir 😊😊

5:23 PM

Make me proud 🎉🎉🎉🎉

7:23 PM ✓✓

July 17



Received the books sir..
Thank you sir 🙏

3:15 PM



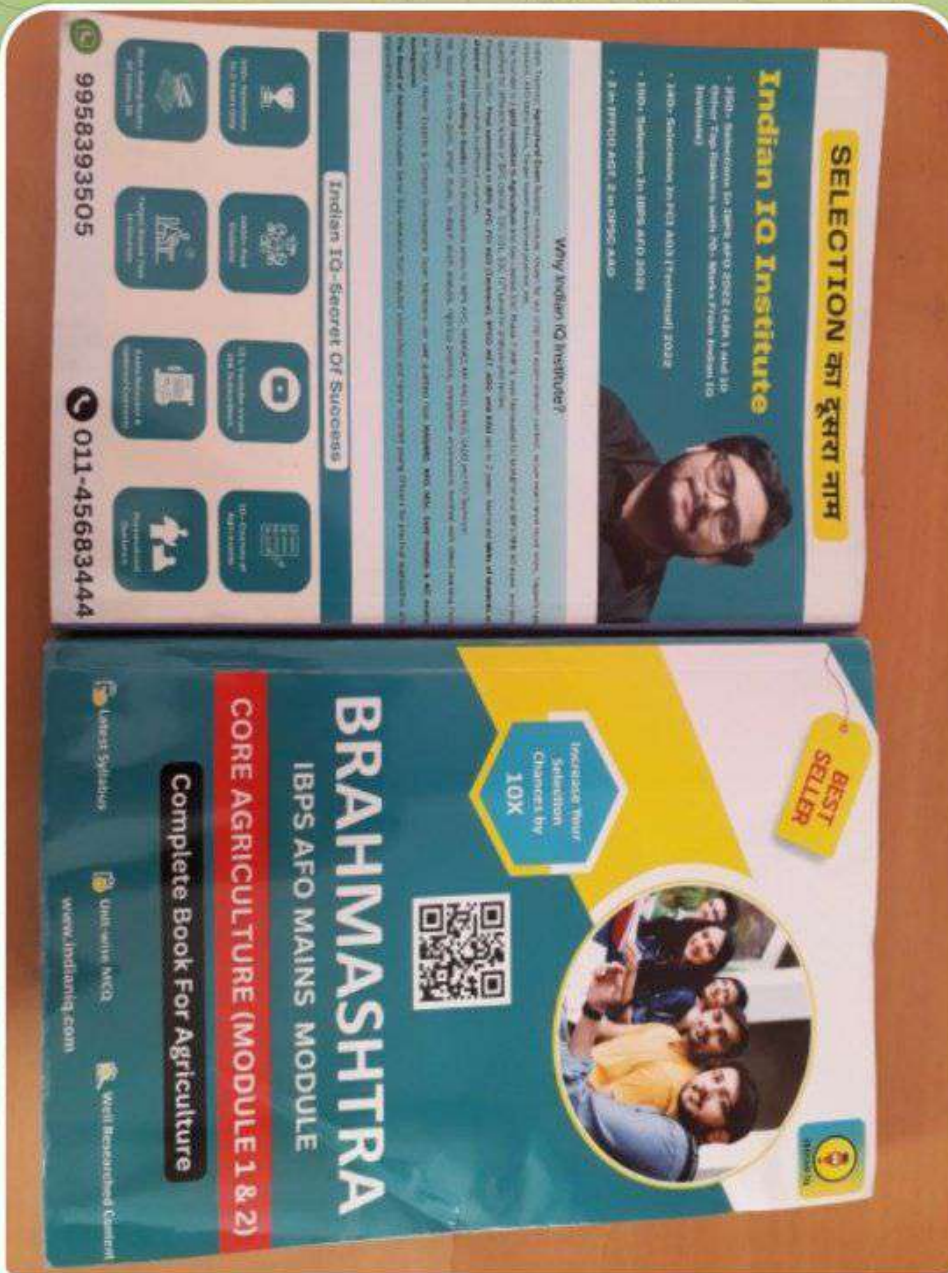
Dhuadhar padhai kijiye 🔥 🔥 🔥

3:24 PM ✓

Ok sir thank you... 😊

8:06 PM

July 17



Books aa gai sir... 😍😍
Thank you so much..

"Is bar AFO par"

1:29 PM



1:47 PM ✓

Lag jaiye ekdum.. make me proud at any cost.

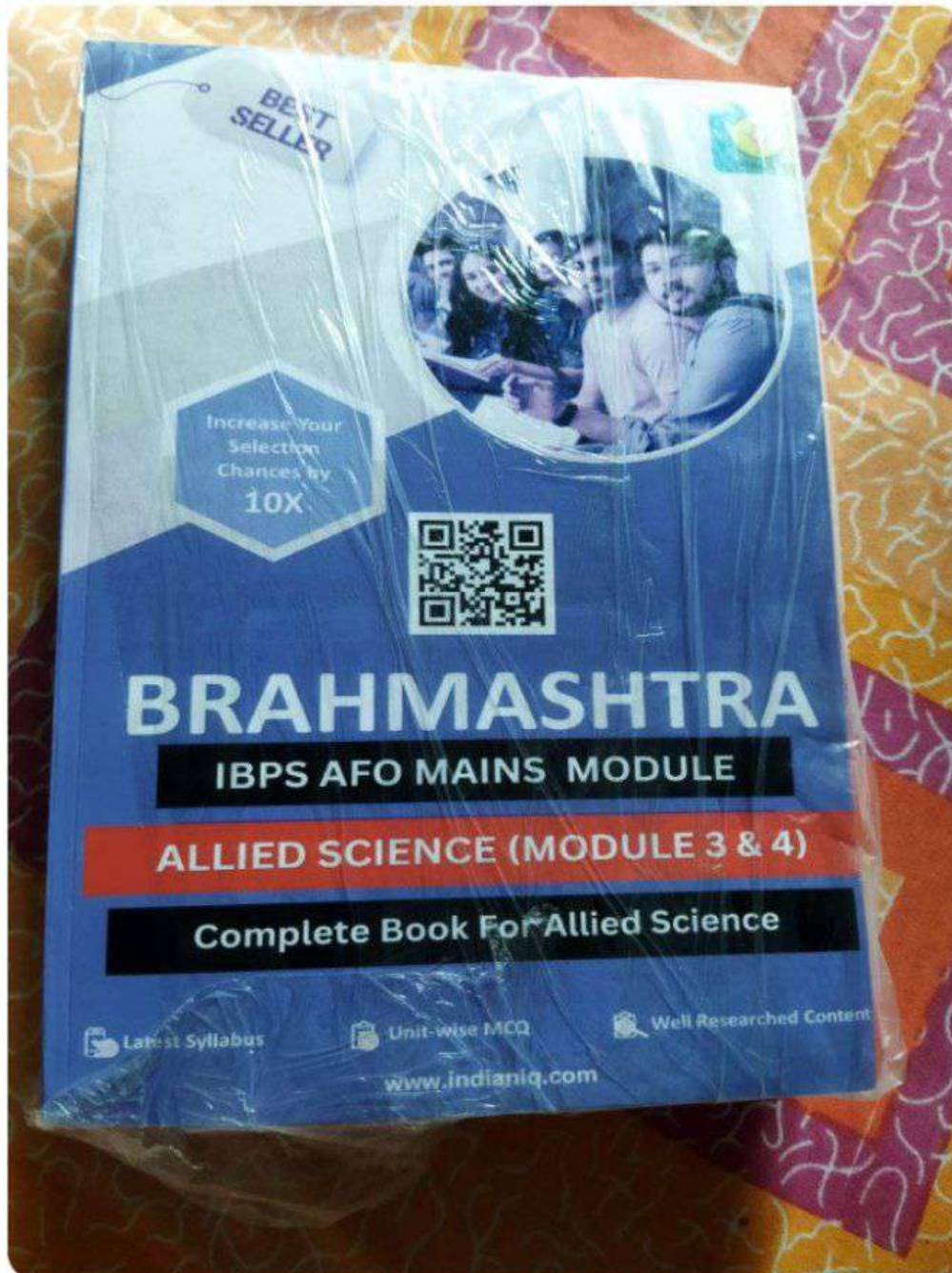
1:47 PM ✓

🕒 Expires On Apr 1, 2024

[GO TO DASHBOARD](#)

10:09 AM

Today



Thank you soo much sir, I have received this book . And i will try my best for upcoming exams.

2:20 PM

July 15

FCI me horti kaise eligible sir 4:42 PM

July 17



Books aagye ❤️ Best Content yaha se aur koi book padhne ki awashyakta hi nai haiMatlb not a single source 🙌



7:37 PM

Upsc bhi clear ho jaye isse 😄😄 7:39 PM



These words means a lot.. ❤️❤️

Make me proud soon 🙌🙌🙌

8:02 PM ✓

Ok Sir I am eagerly waiting for that one ...

11:30 AM

July 17

Today I Received the Brahmastra Of Agriculture



9:48 PM





9:53 PM

Bole to jhakaas sir 🙌 🙌

9:54 PM

Abki baar AFO paar 😎 😎

9:54 PM



9:54 PM ✓✓

Exam se pehle 5 baar khatam kijiye is book ko kam se kam

9:54 PM ✓

Make me proud 🎉 🎉 🎉

8:15 PM

July 18



Sir Finally Received...
Thank you so much Sir .. 🙏

10:40 AM

You are most welcome dear 👍👍👍 7:04 PM ✓

Isko ghooti ke tarah pi jaiye ab 👍👍 7:05 PM ✓

revision test

9:13 PM

That's good, could have been better.

9:58 PM ✓✓



9:58 PM ✓✓

Ok sir... edited 10:24 PM

July 18



Received the books sir... I'm very excited ❤️😍

4:39 PM

Make me proud soon... AT ANY COST



7:04 PM ✓

Already in the way 6:15 PM ✓✓

On* 6:15 PM ✓✓

Ok sir thank you 😊 6:16 PM



6:16 PM ✓✓

July 18



Finally Received Sir 😍👍 5:12 PM

Vijayi bhava 🙏🙏👍👍 7:04 PM ✓

Aap aaye the na?

1:12 PM ✓

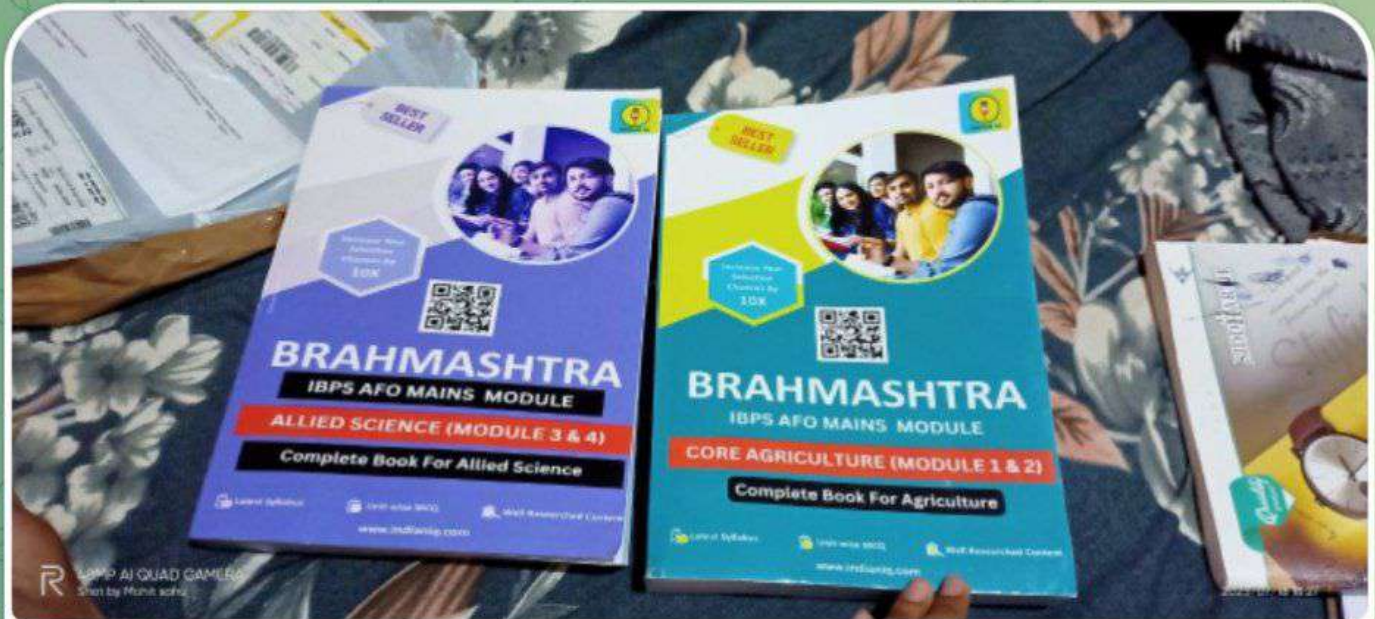
Ji sir attend kiye ,bahoot help mila
Thankyou sir

1:36 PM



1:44 PM ✓

July 18



Thankyou sir ❤️❤️❤️

6:29 PM



7:03 PM ✓



Today Most awaited books received.

9:14 AM



6:59 PM ✓✓

Achhe se 4-5 baar padh ke khatam kijiye, nischint hoke exam dijiye fir

6:59 PM ✓✓

Kal ek mail jaayega aapke paas 10:48 PM ✓✓

You

Kal ek mail jaayega aapke paas

Ok sir

10:50 PM

Today



अंततः ब्रम्हास्त्र ❤️ आ ही गया सर...

5:43 PM

बहुत-बहुत शुक्रिया सर 🙏😊

5:44 PM



6:57 PM ✓

Yashashwi bhava 👍👍

6:57 PM ✓

Richard- Term

12:30 PM ✓✓

Thank you sir 12:31 PM

I have received Bramhastra books two days back sir. From that day itself started reading. Best books i have ever encountered. To the point to the syllabus.

Thank you so much sir.

12:33 PM



Must revise the books 4-5 times before exam and you will definitely get Selection, that is my guarantee. Make me proud.

12:35 PM ✓

Sir nodal centre dtcd mein bat hui unhone bola
ki hum parcel deliver denge jaldi se..
Recv hone ke bad mein apko confirm kar dunggi
sir

3:56 PM



5:02 PM ✓✓

Sir ap jese bole the ki target ke liye wo portal
mein show kar dete hai....

8:18 PM

↓ 104 kB

Now I received two excellent books
and tq so much sir for ur concerns and
response 🥰🥰🎉🎉🎉🥰

8:19 PM

+91 [Redacted]

Sir ap jese bole the ki target ke liye wo portal mein
show kar dete hai....

Haan ji

9:07 PM 📎