**Rumen Eco**-**system and Functions**

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**Rumen microorganism**

|  |  |
| --- | --- |
| **Microbes population** | **%contribution of total microbial mass** |
| Bacteria 1010-1012 | 40-45% of total biomass |
| Protozoa 104 -106 | 45-50% of total biomass |
| Fungi 103 -104 | 3-5 or 8% of total biomass |
| Bacteriophage 1010-1011 | - |

**Rumen environment**

1. **Anaerobiosis**

* Low redox potential of about -350 mvolts (oxidation-reduction potential needs to be maintained within the range of -250 to 450 mV)
* It is maintained by the gases generated during the fermentation process like CO2, N2, CH4, traces of hydrogen, traces of oxygen etc.

1. **Buffering capacity**

* Important factor affecting the consortium of rumen
* pH ranging from 6.5 to 6.9
* Post prandial changes may vary from 5.5 to 7.0 and depend on the diet
* Carbonates, phosphates and volatile fatty acids determine the buffering capacity of rumen contents

1. **Osmotic pressure**

* Very high osmotic pressure of 240-300 m Osm/kg rumen liquor before feeding
* After offering feed it rises by 50%
* Osmotic pressure more than 400 m Osm/kg is detrimental for cellulose degradation
* This high pressure is only for short duration just after feeding so no effect on cellulose degradation
* Rumen microbes can sustain this high osmotic pressure and therefore, are classified as moderately halophiles

**Rumen microbial compartments**

|  |  |
| --- | --- |
| **Microbes’ location** | **Substrate** |
| Microbes freely suspended in rumen liquor | * Mainly soluble sugars utilizing microbes |
| Microbes loosely attached with the feed particles | * Pectinolytic bactetria, e.g. *Lachnospira multiparus* * Some cellulolytic bacteria * Can be easily detached by pressing or by spinning at very low speed * Main function is to scavenge the nutrients and toxic end products released during fibrolysis |
| Microbes tightly attached with the feed particles | * Major cellulolytic bacteria * Fungi * Difficult to detach |
| Microbes attached with the rumen wall | * Facultative anaerobes * Constitute only less than 1% total rumen microbiota |

**General characteristics of rumen bacteria**

* Majority gram negative
* pH optimum 6-7
* Obligate anaerobes
* Temperature optimum 39ºC
* Partially halophiles

**Digestion kinetics in reticulorumen**

**Digestion kinetics in the reticulorumen involve various stages and processes:**

**Ingestion**: Ruminants consume plant materials, which enter the reticulorumen.

**Prehension and Mastication**: The ingested feed undergoes prehension (grabbing) and mastication (chewing).

**Rumination**: After initial chewing, the partially broken-down food (cud) is regurgitated and re-chewed. This allows for further mechanical breakdown and increased surface area for microbial action.

**Fermentation:** The finely chewed food particles, along with saliva are mixed with the microbial populations in the reticulorumen. Microorganisms degrade complex carbohydrates, such as cellulose and hemicellulose, into simpler compounds like volatile fatty acids (VFAs) and gases (CH4 and CO2).

**Absorption:** The host animal absorbs the produced VFAs and other nutrients through the reticulorumen wall. VFAs serve as an energy source for the animal.

* The kinetics of digestion in the reticulorumen are influenced by various factors, including the composition of the diet, microbial populations, pH levels and the rate of passage of digesta.
* The optimal conditions for microbial activity include a slightly acidic pH range (5.5 to 7.0), depending on the type of microbes involved.

**Role of rumen microbes, classification of rumen microbes**

* The microbes degrade feed to produce volatile fatty acids, which are used by the animals as energy for maintenance and production.
* The small intestine of the animals’ digests and absorbs the rumen microbes, serving as the primary protein source for milk production, meeting around 70-90% of the cow’s protein needs.

|  |  |
| --- | --- |
| **Substrate** | **Microbes** |
| **Cellulolytic bacteria** | *Butyrivibrio fibrisolvens*  *Ruminococcus albus*  *Ruminococcus flavifaciens*  *Fibrobacter succinogens* |
| **Amylolytic** | *Streptococcus bovis*  *Succinomonas amylolytica*  *Selenomonas ruminantium* |
| **Hemicellulolytic** | *Bacteriodes ruminocola*  *Ruminococcus albus*  *Ruminococcus flavifaciens* |
| **Lactate utilisers** | *Meghasphera elsdenni*  *Selenomonas ruminantium* |
| **Oxalate utilizers** | *Euryoxic bacterium*  *Oxalobacter formingenes* |
| **Methanogenic bacteria** | *Methanobacterium ruminantium*  *Methanobacterium formicicum*  *Methanomicrobium mobile* |

**Fore gut fermentation**

* The fermentation vat, known as the rumen, precedes the "stomach."
* Food is acted by microorganisms and resulting short-chain fatty acids (SCFAs) are absorbed through the walls of the rumen (provide energy).
* Microorganism and UDP are digested in the true stomach (ruminants get their protein).

**Hindgut fermentation**

* Fermentation chamber(s) comes after the “stomach” and the small intestine.
* VFA’s are absorbed through hindgut walls and excess microorganisms are excreted (most of the microbial protein excreted)

**Characteristics Foregut /Ruminants Hindgut**

|  |  |  |
| --- | --- | --- |
| **Items** | **Foregut fermenter** | **Hind gut fermenter** |
| Where are the microbes? | Before stomach | After stomach |
| Are microbes digested? | Yes | No |
| Source of energy | Volatile fatty acids | Diet and VFA |
| Source of protein | Microbes | Diet |

**Significance of rumen fungi**

* Fungi are less in number than bacteria and protozoa and it contribute to the breakdown of fibrous plant materials, particularly lignin.
* They are important for the degradation of more complex components of the plant cell wall.
* Rumen fungi is the novel source of cellulase enzyme, active cellulase, microcrystalline cellulase, xylanase, acetyl esterase, P-coumaroyl esterase, feruloyl esterase etc.

**Effect of removal of fungi from rumen**

* No change in population of bacteria and protozoa in the rumen
* Intake of feed depressed
* Lower digestibility of fibrous feeds
* Increase in propionate content in the rumen
* Fungal protein supply (fungal cell has amino acid profile suitable to the host and is easily digestible

**Defaunation-** It is the removal or elimination of protozoa from rumen.

**Methods of defaunation**

**Physical Methods Chemical Methods**

1. Separation of Newborn 1. Copper sulphate
2. Heating of rumen contents (50 ml 2% CuSO4 for 2 consecutives)
3. Freezing & thawing of rumen contents 2. Hydrochloric acid, Acetic acid

**Diet Manipulation 3. Detergents**

1. Feeding of starch rich diet 1. Dioctyl sodium sulphosuccinate
2. Long chain poly-unsaturated fatty acids 2. Calcium alkyl benzene sulfonate

3. Alkyl phenoxy poly-oxyethylene sulphate

4. Sodium lauryl diethoxy sulphate

5. Polypropylene glycol

6. Sodium lauryl sulphate (9 g/100 kg

body wt.)

**Effect defaunation on rumen metabolism**

1. **Fibre degradation**

* Protozoal contribution in fibre degradation (25-33%)
* No effect or negative effect of defaunation on fibre degradation has been reported

1. **Starch degradation**

* Control of starch degradation absent in defaunated animals, thus no pH stabilization
* Always lower pH in defaunated animals
* Contribution of starch degradation significantly (about 40-50%), but no adverse effect in defaunated animals due to increased number of starch degrading bacteria

1. **Protein degradation**

* Protozoa are very active in protein degradation
* Protozoa are not able to synthesize AA from ammonia, thus depend upon protein degradation for supply of AA
* Protein degradation depressed in defaunated animals
* Protozoa also have high deaminase activity, therefore depressed ammonia levels observed in defaunated animals
* At high roughage diet, protozoa do not have any specific function to perform, thus their number is also lower on high roughage diet
* At high roughage and protein deficient diet, there is a positive influence of defaunation on productivity of the animals.

1. **Methane emission**

* Methane production is lower in defaunated animals as methanogens have symbiotic relationship with protozoa.
* Higher sulphur amino acid availability due to defaunation increases wool growth in sheep.

**Transfaunation**

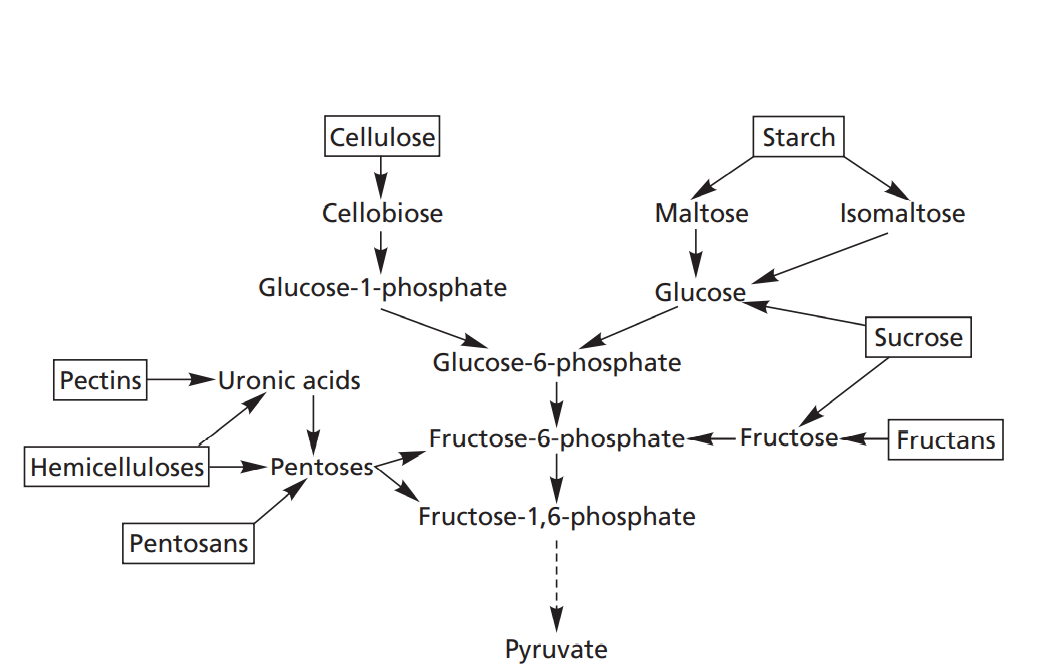
* Transfaunation is the transfer of rumen fluid from rumen of a donor animal to the rumen of a recipient.
* Transfaunation is the common practice to treat digestive disorders such as simple indigestion (by transfer of cud from donor animals to the recipient).
* The volume transferred ranges from 1 L for calves and small ruminants to 8-16 L for adult cattle.

**Microbial fermentation in rumen**

* Microbial fermentation in the rumen is a key aspect of the digestive process in ruminant animals.
* The rumen is the largest compartment of the ruminant stomach and serves as a fermentation chamber where complex plant materials are broken down by microorganisms, primarily bacteria, protozoa and fungi.
* This microbial activity is essential for the digestion of fibrous plant materials, allowing ruminants to derive nutrients indigestible components of their diet.
* Microbes in the rumen degrades complex carbohydrates, such as cellulose and hemicellulose, into simpler compounds, primarily volatile fatty acids (VFAs).
* VFAs are important energy sources for the ruminant host, providing a significant portion of their energy needs.
* Fermentation in the rumen produces gases, including methane (CH4) and carbon dioxide (CO2). These gases are released by eructation (belching) and contribute to the greenhouse gas emissions associated with ruminant digestion.

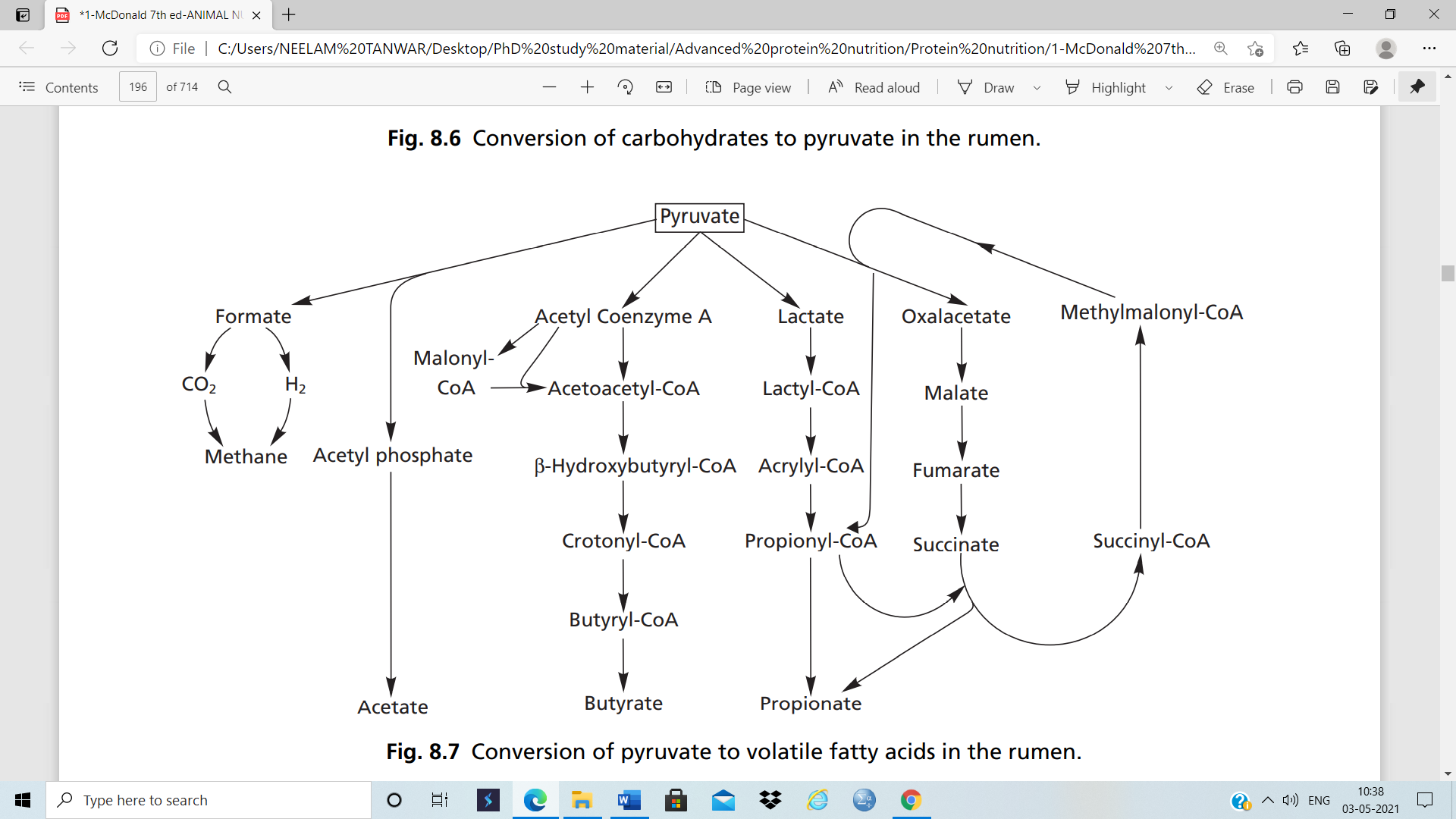
**VFA production and utilization**

* The ruminant's diet consists of significant amounts of cellulose, hemicelluloses, starch, and water-soluble carbohydrates
* All the carbohydrate are attacked by the rumen microorganism.
* The carbohydrate breakdown in the rumen can be divided into two stages, with the initial stage involving the digestion of complex carbohydrates into simple sugars. This process is facilitated by microbial enzymes located outside the microbial cells and is therefore similar to the carbohydrate digestion observed in non-ruminant animals.



**Conversion of carbohydrates to pyruvate in the rumen**

* Simple sugars resulting from the initial stage of carbohydrate digestion in the rumen are seldom identifiable in the rumen fluid due to their prompt uptake and metabolized intracellularly by the microorganisms to volatile fatty acids.



**Conversion of pyruvate to volatile fatty acids in the rumen**

* Absorption of VSAs occurs by simple diffusion.
* During absorption metabolism of VFA also occurs.
* About 80 to 90 percent of butyrate is converted into ketone body.
* Up to 50 percent of propionate may be metabolized to lactate and pyruvate during absorption.
* The absorbed VFAs are transported to the liver, where they can be further metabolized. The fate of VFAs in the liver includes:
* **Acetate:** Converted to acetyl-CoA and then further metabolized through the citric acid cycle.
* **Propionate:** Enters the gluconeogenic pathway, contributing to glucose synthesis.
* **Butyrate:** Converted to β-hydroxybutyrate, which can be used as an energy source.

**Dietary protein breakdown**

* Very high protease activity is present in protein degraders.
* About 70% of dietary protein is degraded to peptides, AA and ammonia.
* About 40-45% activity is due to bacteria.
* The bacterial species include Eubacterium, Selenomonas, Succinivibrio, Bacteroides, *Butyrivibrio fibrisolvens*.
* Cellulose degrading bacteria are protease negative.

**Microbial protein synthesis**

* It accounts about 75% of the total amino acids absorbed by ruminants.
* The microbial protein synthesis is defined as grams of microbial crude protein (MCP)/100 g of organic matter (OM) digested in the rumen.
* The efficiency of microbial protein synthesis varies in animals with different diets fed.
* The mean efficiency of microbial protein synthesis is 14.8 g MCP/100g of OM truly digested in the rumen.
* Microbial biomass provides about 20 percent of nutrient absorbed by the host animal.
* Bacterial dry matter contains 100g N/kg, 80 percent of which is in the form of amino acids while the remaining 20 percent as nucleic acid.
* Microbial fermentation of carbohydrate and proteins yield volatile and short chain fatty acids which provides 60-80 percent of ME of ruminants on most diets.

**Limitations of estimation microbial crude protein synthesis**

* High quality protein also gets destructed and resulting in MCP formation.
* Protein needs of high yielding animals and fast growing animals cannot met by MCP alone.

**Variables influencing microbial protein synthesis in the rumen**

1. Dry matter intake
2. Availability of nitrogen compounds
3. Availability of fermentable energy
4. Ratio of forage to concentrate
5. Rumen environment
6. Matching the release of nitrogen and energy in feeds
7. Flow rate of digesta
8. Minerals and vitamins

**Estimation of microbial protein production**

1. TCA precipitable -N
2. Markers DAPA, AEP, Chitin etc
3. Urinary purine derivatives: allatoin, uric acid, xanthene, hypoxanthene etc.
4. Tracer techniques
5. Molecular techniques

**NPN compounds and their utilization**

* Non-protein nitrogen (NPN) compounds are nitrogen-containing compounds that are not classified as true proteins. eg. urea, ammonia and biuret.
* Urea is hydrolysed to ammonia and CO2 by the urease enzyme (secreted by rumen microbes).
* Microbial fermentation of carbohydrate yield volatile fatty acid and keto acid.
* Rumen bacteria use ammonia and ketoacids to synthesize amino acids which are linked through peptide bonds and thus protein is synthesized.
* This microbial protein is source of amino acids for the host animal (microbes are digested in the lower digestive tract).
* Microbial protein contributes significantly to the overall protein supply for ruminants, especially in diets with low-quality forages or limited protein sources.

**Recycling of urea in ruminant**

* In ruminant animals, urea, a non-protein nitrogen (NPN) compound, can undergo a process known as urea recycling.
* Urea recycling is a key aspect of nitrogen metabolism in ruminants.
* Urea is synthesized in the liver through the urea cycle, a series of biochemical reactions that convert ammonia and carbon dioxide into urea.
* Ammonia, derived from the breakdown of amino acids and other nitrogen-containing compounds, is the primary precursor for urea synthesis.
* Once synthesized in the liver, urea is released into the bloodstream.
* Urea circulates in the blood and is transported to various tissues, including the mammary gland, kidneys and salivary glands.
* Ruminants secrete urea in their saliva. Saliva containing urea is continuously added to the rumen during chewing.
* Urea in the saliva can be recycled in the rumen when it is hydrolyzed by the enzyme urease, produced by rumen microbes. This hydrolysis releases ammonia, which becomes a nitrogen source for microbial protein synthesis.
* Microbes in the rumen, particularly bacteria and protozoa, utilize ammonia derived from urea and other nitrogen sources to synthesize microbial protein.
* Microbial protein becomes a source of amino acids for the host animal when the microbes are digested in the lower digestive tract.

**Importance of urea recycling**

* Urea recycling contributes to the efficiency of nitrogen utilization in ruminants.
* It allows the animal to make use of urea (waste product from amino acid catabolism) as a valuable nitrogen source for microbial protein synthesis.
* The continual cycling of urea between the blood and the rumen helps maintain a steady supply of ammonia for microbial fermentation.
* The efficiency of urea recycling is influenced by factors such as diet composition, availability of fermentable carbohydrates and overall nitrogen balance.

**Ammonia toxicity - Role of slow-release urea compounds**

* Ammonia is a natural byproduct of microbial fermentation in the rumen, derived from the breakdown of nitrogen-containing compounds, such as dietary protein and non-protein nitrogen (NPN) sources like urea.
* Excessive ammonia concentrations can occur when there is a rapid release of ammonia, overwhelming the capacity of rumen microbes to utilize it for protein synthesis.
* High concentrations of ammonia can be detrimental to rumen microbes and, consequently, the overall health and performance of the ruminant.
* Slow-release urea compounds are designed to mitigate the risk of ammonia toxicity by providing a controlled and sustained release of ammonia in the rumen.

**Slow-Release Urea Compounds (SRN)**

* Slow-release urea compounds are designed to release urea at a slower and more controlled rate in the rumen.
* These compounds may include coated or encapsulated forms of urea, which gradually release urea over an extended period.
* The slow release helps to match the rate of ammonia utilization by rumen microbes, reducing the risk of an ammonia surge.

**Balancing nitrogen release:**

* The goal of slow-release urea compounds is to balance the release of nitrogen with the microbial capacity to use it for protein synthesis.
* By providing a more gradual release of urea, these compounds aim to optimize the efficiency of nitrogen utilization in the rumen and minimize the risk of ammonia toxicity.

**Advantages of SRN feeding**

1. **Improved nutrient utilization:**

* Slow-release urea compounds contribute to improved nutrient utilization by supporting the sustained production of microbial protein in the rumen.
* This can be particularly beneficial in diets with lower-quality forages or when there is a need to supplement additional nitrogen for microbial fermentation.

1. **Environmental Considerations:**

* Controlling the rate of urea release in the rumen not only benefits the animal but also has environmental implications.
* Reduced ammonia surges in the rumen can lead to lower nitrogen losses through urine, contributing to more efficient use of dietary nitrogen.

**Manipulation of rumen fermentation**

* Rumen fermentation manipulation aims to improve the efficiency of protein utilization and reduction of emission gases.

**Criteria for direct fed microbials**

1. Can sustain the GIT environment
2. Can compete with the wild microbes
3. Should be non-pathogenic
4. Should induce beneficial effect
5. Can tolerate the processing procedure during industrial production
6. Should have long shelf life
7. High number of viable cells
8. Metabolically highly active
9. Source of microbes

**Factors affecting probiotic efficiency**

1. Diet of the animal
2. Age of the animal
3. Production potential
4. Stage of lactation
5. Management
6. Environmental conditions
7. Dose

**Bio-hydrogenation and utilization of dietary lipids**

Ruminants consume plant materials that contain various lipids, including unsaturated fatty acids (UFAs) such as linoleic and linolenic acid.

**The fate of dietary lipids in the rumen takes place in two steps**

1. **Lipolysis-** Is the hydrolysis or breakdown of the fat into its compounds mainly free fatty acids and glycerol.

* The main bacteria involved in the lipolysis is *Anaerovibirio lipolytica* and others also responsible like Clostridium, Propionibacterium and treponema etc.
* Lipolysis is the prerequisite process for biohydrogenation of the unsaturated fatty acids in the rumen because it occurs only in the free carboxyl group which is not available if the esterified fatty acids are not hydrolysed to free fatty acids.

1. **Biohydrogenation-** It involves the transformation of unsaturated fatty acids, present in dietary lipids, into saturated fatty acids by rumen microorganisms.

* It occurs with the help of *Butyrivibirio fibrosolvens* and protozoa also have very good biohydrogenation property.
* Intermediates formed during bio-hydrogenation include trans fatty acids. These can have implications for the nutritional quality of the resulting fats.

**Methanogenesis** - **their mechanism of production, essentiality and methane inhibitors**

* Microorganisms utilize lignocellulosic feed to produce organic acids and synthesize microbial protein as energy and protein sources for the host animal and in turn, the animal offers nutrients and appropriate environmental conditions for microbial habitation in the rumen.
* During the whole process of feed fermentation in the rumen, CO2 and H2 gases are produced as the end by-products and rumen methanogenic archaea use H2 to convert CO2 into methane which is eructed out through mouth in the environment.
* Methanogenesis is an important means to remove H2 from the rumen, which otherwise hampers feed fermentation.
* Methanogenesis metabolic pathway wastes 2-12% of the ingested energy and lowers the potential conversion of dietary energy into metabolizable energy, thus reducing animals' feed utilization efficiency.
* Apart from wasting dietary energy, methane traps atmospheric heat 23 times more effectively than CO2 and is classified as a greenhouse gas (GHG) that contributes to global warming and has detrimental effects on the global ecosystem.
* Methanogenesis occurs both in the rumen and the hindgut of ruminants, but the majority of the CH4 originates from the rumen, nearly 90% of the total CH4 production.
* Methanogens- No peptidoglycan polymer
* Differ in intracellular lipids composition
* Triacylglycerol is replaced by ether linkages between glycerol and polyisoprenoid chains
* Cell wall may be categorized into three characteristics classes: (i) pseudomurein layer (ii) protein or glycoprotein layer; and (iii) heteropolysaccharides layer
* No muramic acid or D-amino acids have been detected so far

**Methane reduction -Why?**

* Conservation of dietary energy
* Reduce environmental pollution
* Improve livestock production

**Strategies for methane mitigation**

* Replacing low-producing livestock with high-producers
* Enhancing degradability of poor-quality roughages
* Inhibiting ciliate protozoa
* Use of alternate hydrogen sinks like reductive acetogenes and unsaturated fatty acids
* Feed additives includes chemical feed additives, microbial feed additives, plant secondary metabolites
* Biotechnology techniques

**Interaction with bacteria**

* Syntropic interaction between rumen bacteria and methanogens.
* B**acteria provide hydrogen and formic acid as substrates for methanogenesis and** Methanogens reduce the concentration of metabolic byproducts from bacterial activity

**Opportunity to improve rumen efficiency**

* Large amount of dietary fibre escape rumen hydrolysis
* Rapid conversion of dietary nitrogen into ammonia
* Loss of dietary energy
* Detoxification of plant toxin
* The genetic and ecological manipulation of rumen fermentation has many constraints

Fill in the blanks with most appropriate words

1. Osmotic pressure of rumen liquor -------------- before feeding.
2. Cellulose degrading bacteria are ------------------negative.
3. The storage form of polysaccharide by holotrich protozoa in the rumen is in the form of------------------.
4. The definite shape of ciliate protozoa present in the rumen is due to--------------.
5. -----------is used as bacterial marker for estimating bacterial protein production in ruminants.
6. The toxin present in *Leucaena leucocephala* leaves is known as --------------.
7. The oxalate degrading bacteria present in the rumen is--------------------*.*
8. ----------------is a mimosine degrading bacteria present in the rumen.
9. Two chemicals which can be used for removing fungi from the rumen are----------------and---------------.
10. Rumen fungi can survive outside rumen for longer period by the formation of ----------------like structure.
11. ----------------do not secrete significant amount of sucrase enzyme.
12. --------and----------accounts about 60 percent capacity of gastrointestinal tract in horses and rabbit.
13. Methanogenesis metabolic pathway wastes -------------- of the ingested energy.
14. Methanogenesis occurs both in the rumen and the hindgut of ruminants, but the majority of the CH4 originates from the rumen--------------- of the total CH4 production.
15. Rusitech “rumen simulation technique” was given by---------------------.
16. Gastric ulcers are observed in swine on feeding finely ground feeds of particle size-----------------.
17. The loss of the protein absorptive function in the neonates referred to as--------------.
18. Pancreatic amylase requires inorganic -----------------for activity.
19. Methanogenesis is the complicated process that involves----------------and------------------.
20. -------------------- g methane is produced per 100 g of carbohydrate digested.
21. Up to 50 percent of the propionate production may be metabolized to-------------------and---------------during absorption.
22. About 80 to 90 percent butyrate is converted to --------------------during absorption through rumen wall.
23. Lipolysis can be defined as the hydrolysis or breakdown of the fats into its compound mainly-------------------.
24. ----------------------plays an important role in biohydrogenation of lipid.
25. --------------- is combination of probiotics and prebiotics.
26. Sulphur hexafluoride technique developed by--------------.
27. Ruminants’ protozoa have -------------------- role on utilization of nitrogen by ruminants.
28. Insoluble protein fraction of CNCPS contains --------------and ----------------------------.
29. Urea is converted to ammonia by urease enzymes secreted by---------------------.
30. The efficiency of microbial protein in given by YATP g of bacterial dry matter produced------------------.
31. The VIVAR technique is used for studying nutrient utilization by rumen microorganism ----------------------in rumen.
32. The rumen protozoa were first discovered by------------------------.
33. Rate of excretion of MFN is controlled by -------------------by the animals.
34. Probiotics are feed additives generally preferred more than------------------ in feeding of farm animals.
35. Level of DM intake of the animals does not affect the rate of excretion of-------------------.
36. One gram of propionic acid theoretically provides----------------------.
37. In ruminant animals’ adaption period for urea should be------------------.
38. Addition of which amino acid improve the urea utilization----------------------.
39. In urea molasses liquid feed urea should be restricted at the level of ------------------.
40. Ruminant’s milk is the good source of CLA containing about---------------.

Select the most suitable answer from the options provided below:

1. The cellulose degrading enzymes consist of

1. Endo- β -glucanase (b) Exo- β -glucanase

(c) β-glucosidase (d) all of the above

2. Honey comb like interior structure is present in

1. Rumen (b) Omasum

(c) Abomasum (d) Reticulum

3. The majority of the fibrolytic microbes are included in compartment

(a) Compartment-1 (b) Compartment-2

(c) Compartment-3 (d) Compartment-4

4. The type A population of ciliate protozoa of a rumen of bovine consist of

(a) *Epidinium* spp. (b) *Diplastron offine*

(c) both a&b (d) none of the above

1. In defaunated sheep, the production of wool will
2. Decrease (b) Increase

(c) Both a & b (d) None of the above

1. Efficiency of animal production depend on
2. Genetic makeup (b) Nutritional status

(c) Management practice (d) All of the above

7. Principal organ for prehension horse, ruminants and pigs

(a) Lips, tongue and pointed lower lip

(b) Tongue and pointed lower lip and lips

(c) Pointed lower lip and lips and tongue

(d) none of the above

8. Example of post gastric fermenter

(a)Swine (b) Horse

(c)Rabbit and guinea pig (d) All of the above

9. Amylase (ptyalin) present in

(a) Man (b) Pig

(c)Rat (d) All of the above

10. Amylase or ptyalin splits carbohydrate linkage

(a) alpha 1,4 glycosidic linkage

(b) alpha 1,6 glycosidic linkage

(c) Both of the above

(d) none of the above

11. Microbial fermentation occur in sacculated stomach of

(a) Hippopotamus (b) Kangaroo

(c) Both of above (d) poultry

12. Which statement is correct about holotricus protozoa

(a) Less in number than oligotricus

(b) Regular in shape and cilia is covering the whole body

(c) Nucleus centrally placed

(d) All of the above

13. Which statement is correct about oligotricus protozoa

(a) Higher in number than holotrichus

(b) Irregular in shape and cilia is present on one part of body

(c) Nucleus attached to wall

(d) All of the above

14. Who coined the term ‘probiotic’

(a) Parker (b) Stephan

(c) Fuller (d) Laplace

15. How probiotics exert their effect

* 1. Adhering to the lining of the digestive tract to deter colonization by pathogenic
  2. microorganisms.
  3. Neutralization of endotoxin produced by pathogenic bacteria
  4. Bactericidal activity
  5. All of the above

16. Conditions that may cause the urea toxicity

(a) Poor mixing of urea in feed

(b) Inadequate period of adaption

(c) Feeding of urea in conjugation with poor quality roughage

(d) All of the above

17. Methods of feeding urea to ruminants

(a) Urea mixed in concentrate

(b) Liquid supplements

(c) Urea mixed with silage and added to dry roughage

(d) All of the above

18. Functions of saliva in ruminants

1. Moistens and lubricates feeds and water balance
2. Bloat prevention and intake control
3. Recycling of nitrogen and minerals to the rumen and buffering the rumen fermentation
4. All of the above

19.Substrates for methanogens

1. H2 and Formate
2. Acetate and methanol
3. Mono-, di- and tri-methylamine and CO2
4. All of the above

20. Factor affecting water requirement of livestock and poultry

1. Biological factors
2. Environmental factors
3. Dry matter intake of animals
4. All of the above

21. Urea excretion in mammals requires more water than is required to excrete a similar

amount of uric acid in birds.

1. 20-40 times
2. 50-60 times
3. 10-15 times
4. 5-10 times

22. Microbial mass supplies how much percent of total nutrients to ruminants

1. About 10 %
2. About 20%
3. About 50 %
4. About 45%

23. Factors affecting microbial digestion of fibre in ruminants

1. Character of feed and roughage
2. Chemical and physical nature of fibre
3. Rumen environment
4. All of the above

24. The total amount volatile fatty acid produced in rumen in a day

1. 1.5 kg
2. 4 kg
3. 10 kg
4. 15 kg

25. Starch fermenting bacteria in ruminants

1. *Megaspaera elsdenni*
2. *Bacertiodes ruminecola*
3. *Selenomonas ruminentium*
4. All of the above

26. Acidic pH favours the absorption of which short chain fatty acid

1. Acetic acid
2. Butyric acid
3. Lactic acid
4. Propionic acid

27. Which vitamin is required for conversion of methyl melonyl to succinyl coenzyme A

1. Vit. B6
2. Vit. B3
3. Vit. A
4. Vit.B12

28. Accumulation of methyl malonyl (intermediate product of propionate metabolism) contribute to occurrence of which metabolic disease.

1. Milk fever
2. Ketosis
3. Parturient patesis
4. Lactation tetany

29. Why ruminants are unable to convert glucose to fat

1. Because they are lacking ATP citrate lyase
2. Because they are lacking NADP malate dehydrogenase
3. Both of the above
4. None of the above

30. Mark the right statement about endogenous urinary nitrogen

1. Mammals excrete about 2 mg of EUN per kilocalorie of basal metabolism
2. EUN is highest in young animals and lowest during hibernation
3. EUN reflect energy metabolism
4. All of the above

31. Buffaloes are more efficient in digesting fibre than cattle because of

1. Higher rumen volume
2. Efficient rumination and nitrogen recycling capacity
3. Increased retention time in the rumen
4. All of the above

32. Factors affecting saliva flow in ruminants

a) Activity of animal b) Feed consumption

c) Type and physical form of diet d) All of the above

33. What are the main drawbacks of using buffers in animals’ diets

a) Unpalatable b) Response are short lived

c) Causes health problems d) All of the above

34. Mark the statement which is not correct about the rumen environment

1. Majority of bacteria are gram positive
2. Optimum pH- 6.7
3. Microbes are obligate anaerobes
4. Majority of bacteria are gram negative

35. What type of biochemical changes occur in rumen liquor by defaunation

1. Decrease in rumen pH
2. Decrease in methanogenesis
3. Increase in bacterial population
4. All of the above

36. Factors that affect the probiotics efficiency

1. Diet and age of animal
2. Production potential and stage of lactation
3. Management and environment condition
4. All of the above

37. What is the need of reduction in methane emission

1. Conservation of dietary energy
2. Reduction in environmental pollution
3. Improve livestock production
4. All of the above

38. The mean efficiency of microbial protein synthesis

1. 14.8g MCP/100 g of TDOM
2. 24.8g MCP/100 g of TDOM
3. 8.8g MCP/100 g of TDMO
4. 34.8g MCP/100 g of TDMO

39. Factors influencing microbial protein synthesis in the rumen

1. Dry matter intake
2. Availability of nitrogen compounds
3. Availability of fermentable energy
4. All of the above

40. Estimation of microbial protein production

1. TCA precipitable -N and tracer techniques
2. Markers DAPA, AEPA, Chitin etc
3. Urinary purine derivatives: allantoin, uric acid, xanthene, hypoxanthine etc.
4. All of the above

41. Choose the correct statement about the ‘Hungate 1000 project’

1. It was named in the honour of Dr. Robert Hungate
2. It is the catalogue of reference genome from the rumen microbiome
3. The goal of project was to sequence the genome of 1000 microorganisms cultured from the rumen of different host species
4. All of the above

42. What are the methods of sampling of rumen liquor

1. Sampling from dead or slaughtered animals
2. From fistulated animals
3. From intact animals by using stomach tube
4. All of the above

43. What is the thickness of stomach tube (used for rumen liquor collection) from large ruminants

1. 3-4 cm
2. 5-6 cm
3. 0.5 cm
4. 1-2 cm

44. What is the thickness of stomach tube (used for rumen liquor collection) from small ruminants

1. 3-4 cm
2. 5-6 cm
3. 0.5 cm
4. 1-2 cm

45. Mark the correct statement about sub-acute ruminal acidosis (SARA)

1. It is a metabolic disorder
2. Caused by ingestion of diets rich in rapidly fermentable carbohydrate
3. Caused by diet lacking physically effective fibre
4. All of the above

46. Significance of omics technique with respect to rumen

1. Helpful for the identification of unculturable organism
2. Helps to find out link between community structure and ruminal function
3. Helpful for identification of rumen core microbiome and used to improve productivity, for identification of enzymes and their beneficial effect on host
4. All of the above

47. Factors affecting methane production

1. Level of feeding
2. Type and quality of feed
3. Environmental temperature
4. All of the above

48. Strategies to reduce methane emission

1. Increasing productivity
2. Improving nutritional management
3. Methane inhibitors and rumen manipulation
4. All of the above

49. Mark the incorrect statement

1. Protozoa have very high lipolytic activity
2. Biohydrogenation occurs with the help of *Butyrivibirio fibrosolvense*
3. Protozoa have no lipolytic activity
4. Lipolysis is the prerequisite for biohydrogenation

50. Choose the incorrect statement

1. The term probiotic means ‘for life’
2. Probiotic term coined by Parker in 1989
3. The probiotics culture should have positive effect on host
4. Probiotics helps in maintaining the intestinal microbial balance of host animal

51. Mark the incorrect statement about SF6 technique

1. The SF6 technique was developed by Zimmerman in 1993
2. The SF6 technique was developed by Fuller in 1983
3. Johanson *et al*. (1994) first time used this technique for the quantification of methane emission
4. This technique assumes that the SF6 emission simulates the methane emission and the release rate of both gases are identical

52. Mark the incorrect statement

1. Protozoa in ruminants play a detrimental role in nitrogen utilization.
2. Protozoa engulf and break down a large number of ruminal bacteria, consequently reducing the net flow of microbial protein from the rumen to the duodenum.
3. Protozoa also exhibit proteolytic and deaminating activity
4. None of the above

53. What will the effect of removal of fungi from rumen

1. No change in the population of bacteria and protozoa in the rumen
2. Lower digestibility of fibrous feed
3. Increase in propionate content and decrease in fungal protein supply to the animal
4. All of the above

54. Why urea is not well utilized in low quality roughages

1. Urea is not properly mixed with low quality roughages
2. Poor quality roughages do not have mineral content
3. Poor quality roughages are low in vitamin content
4. Carbohydrates in poor quality roughages are slowly available and rumen microbes have difficulty in using energy from it to make bacterial protein

55. Factors essential for optimum use of urea

1. Supply adequate and balanced level of minerals
2. Nitrogen and sulphur ratio should be 10:1
3. Source of readily available energy
4. All of the above

56. Inclusion level of urea in concentrate mixture

1. 1% of DM
2. 0.5% of DM
3. 3% of DM
4. 5 % of DM

57. Inclusion level of urea in succulent feed

1. 1% of DM
2. 0.5% of DM
3. 3% of DM
4. 5 % of DM

58. Inclusion level of urea in silage

1. 1% of DM
2. 0.5% of DM
3. 3% of DM
4. 5 % of DM

59. Inclusion level of urea in total ration

1. 1% of DM
2. 0.5% of DM
3. 3% of DM
4. 5 % of DM

60. Mark the right statement about the VIVAR technique

1. It is an artificial rumen technique
2. This system consists of porcelain tube fitted with biological membrane
3. This technique uses for study of rumen fermentation
4. All of the above

61. What is residual feed intake (RFI)

1. It is the measure of feed efficiency
2. It represents the variance between an animal's observed feed intake and the anticipated intake derived from its nutritional needs
3. Both of the above
4. It is the calculated feed intake

62. Factors affecting rumen development

1. Milk and milk replacer
2. Roughages and concentrate feeding
3. Organic acid production
4. All of the above

63. Grams of urea recycled in the rumen of cattle

1. 10-20 g
2. 10-22 g
3. 05 -10 g
4. 60-65 g

64. Grams of urea recycled in the rumen of sheep

1. 10-20 g
2. 10-22 g
3. 05 -10 g
4. 0.5 -2.5g

65. Factors affecting ME utilization in animals

1. Species of animals
2. Composition of feed with respect to amino acid profile
3. Level of feeding and processing of feed
4. All of the above

66. Methods of determination of endogenous nitrogen includes

1. By offering nitrogen free diet
2. Calculate the nitrogen content in the digesta after the consumption of fully digested protein
3. Isotope detection method
4. All of the above

67. Mark the right option about the ruminant fermentation

1. The digestion process of carbohydrates in the rumen can be devided into two phases
2. In first stage complex carbohydrate is broken down to simple sugars and this is brought about by extracellular microbial enzymes
3. In second stage all simple sugars taken up by microbes and converted into volatile fatty acids
4. All of the above

68. Defaunation increases the microbial protein supply to the host

1. About 25 %
2. About 50 %
3. About 75 %
4. About 10 %

69. Factors affecting protein quality

1. Amino acid profile
2. Content and balance of essential and non-essential amino acid
3. Content of limiting amino acid
4. Protein digestibility and bioavailability
5. All of the above

70. Example of tannin degrading bacteria

1. *Streptococcus caprinus*
2. *Oxalobacter formigenous*
3. *Synergestis jonsii*
4. *Streptpcoccus bovis*

71. Example of oxalate degrading bacteria

1. *Streptococcus caprinus*
2. *Oxalobacter formigenous*
3. *Synergestis jonsii*
4. *Streptpcoccus bovis*

72. Example of mimosine degrading bacteria

1. *Streptococcus caprinus*
2. *Oxalobacter formigenous*
3. *Synergestis jonsii*
4. *Streptpcoccus bovis*

73. What are the example of detergent used for defaunation

1. Sodium lauryl diethoxy sulphate
2. Polyproplyene glycol
3. Sodium lauryl sulphate
4. All of the above

74. Buffalo manage to digest fibre more efficiently than cattle because of

1. Higher rumen volume
2. Efficient rumination and higher retention time
3. Higher nitrogen recycling capacity
4. All of the above

75. Metabolizable protein (g/kg W0.75) system as per ICAR (2013)

a) 2.65 g/kg W0.75

b) 0.65 g/kg W0.75

c) 3.65 g/kg W0.75

d) 1.65 g/kg W0.75

76. Steaming up generally practised

1. One month after calving
2. 14 days prior calving
3. One month before calving
4. Three months after calving

77. What is the purpose of lead feeding or challenge feeding

1. For prevention of metabolic disorder
2. To take maximum output from animal
3. For better health of calves
4. To prevent occurrence of kidney diseases

78. Nucleic acid of microbes constitute how much percentage of nitrogen

1. 10-20 %
2. 40-50%
3. 60-70%
4. About 50%

79. Rumen bacterial population

1. 1010-1012
2. 104 -106
3. 103 -104
4. 1015-1017

80. Rumen protozoa population

1. 1010-1012
2. 104 -106
3. 103 -104
4. 1015-1017

81. Rumen fungi population

1. 1010-1012
2. 104 -106
3. 103 -104
4. 1015-1017
5. Mark the correct statement about osmotic pressure of rumen
6. Very high osmotic pressure of 240-300 m Osm/kg rumen liquor before feeding
7. After offering feed it rises by 50%
8. Osmotic pressure more than 400 m Osm/kg is detrimental for cellulose degradation
9. Rumen microbes can sustain this high osmotic pressure therefore are classified as moderately halophiles
10. All of the above

83. Physical method of defaunation not includes

1. Separation of newborn
2. Copper sulphate
3. Heating of rumen contents
4. Freezing & thawing of rumen contents

84. Mark the incorrect statement

1. Transfaunation is the transfer of rumen fluid from rumen of a donor to the rumen of a recipient
2. Transfaunation is the common practice to treat digestive disorders such as simple indigestion
3. The volume transferred for transfaunation ranges from 1 L for calves and small ruminants to 8-16 L for adult cattle
4. Defaunation is the transfer of rumen liquor from one animal to other

85. Advantage of slow urea nitrogen feeding to ruminants

1. Increases the nutrient utilization
2. Reduces the environmental pollution
3. Better utilization of nitrogen
4. All of the above
5. Mark the incorrect statement
6. Absorption of VFAs occurs by simple diffusion
7. During absorption metabolism of VFA not occurs
8. About 80 to 90 percent of butyrate is converted into ketone body
9. Up to 50 percent of propionate may be metabolized to lactate and pyruvate during absorption
10. Mark the incorrect statement
11. Acetate is converted to acetyl-CoA and then further metabolized through the citric acid cycle
12. Propionate enters the gluconeogenic pathway, contributing to glucose synthesis
13. Butyrate converted to β-hydroxybutyrate, which can be used as an energy source
14. Butyrate converted to lactate, which can be used as an energy source
15. Goats are more capable than sheep for using call wall rich and nitrogen poor forages
16. Because of higher retention time
17. Higher number of cellulolytic bacteria in the rumen
18. More efficient in recycling of blood urea
19. All of the above
20. Who discovered the rumen bacteria
21. R. E. Hungate
22. Gruby and delafond
23. Orpin
24. Bryant
25. Who have discovered the rumen fungi
26. R. E. Hungate
27. Gruby and delafond
28. Orpin
29. Bryant
30. Who have discovered the rumen protozoa
31. R. E. Hungate
32. Gruby and delafond
33. Orpin
34. Bryant
35. Animal health and production depend on
36. Genetic makeup
37. Nutritional status of the animal
38. Management practices
39. All of the above
40. Rumen protozoa get established in young calves when they are about
41. 10 days of age
42. One month of age
43. 3 to 4 months of age
44. Eight months of age
45. Mark the incorrect answer about protozoa
46. Rumen protozoa are firstly discovered by Gruby and delafond
47. Protozoa population is up to 106 per ml of RL
48. Protozoa are strictly anaerobic
49. Protozoa are facultative aerobic in nature
50. Mark the name of bacterial marker
51. DAPA
52. AEPA
53. Phosphatidyl choline
54. Isotopes includes-S35, C14, P32 and N15
55. Name of protozoal marker
56. DAPA
57. AEPA and Phosphatidyl choline
58. Isotopes includes-S35, C14, P32 and N15
59. All of the above
60. Rumen development rumen occurs at the age of
61. 3 months
62. 6 months
63. 9 months
64. 12 months
65. Which volatile fatty acid plays a role in the synthesis of milk fat?
    1. Acetate
    2. Propionate
    3. Butyrate
    4. None of the above

99. Which volatile fatty acid contributes to glucose synthesis in cows

1. Acetate
2. Propionate
3. Butyrate
4. None of the above

100. Urea can substitute for approximately ... percent of the requirement for digestible crude protein (DCP).

1. 15-20
2. 20-30
3. 45-55
4. 70-80

101. The net ATP yield per mole of acetic, propionic, and butyric acid is... moles, ... moles, and ... moles, respectively.

1. 10, 17, 25
2. 20, 25, 45
3. 8, 15, 18
4. 17, 25, 35

102. Bacteria are ineffective in utilizing NH3 if its concentration in the rumen exceeds (in mg) per 100 ml.

1. 5-8
2. 12-15
3. 18-22
4. 24-28

103. The production of microbial protein varies within the range of ... grams per kilogram of organic matter digested.

1. 200-250
2. 300-330
3. 90-230
4. 200-450

104. The biological value of microbial protein is approximately

1. 58%
2. 68%
3. 78%
4. 88%

105. Gas in the rumen consists of approximately...........percent CO2 and...........percent methane

1. 20, 80
2. 80, 20-30
3. 80, 20
4. 50-60, 30-40

106. Methane contains energy roughly equivalent to.

a) 13.34 Kcal/g

b) 33.34 Kcal/g

c) 03.34 Kcal/g

d) none above

107. Amount of gases (litres per day) produced in the rumen of dairy cows

1. 100-200
2. 50-70
3. 300-400
4. 10-20

108. Amount of feed energy lost in rumen as methane

1. 5-8%
2. 25-30%
3. 17-19%
4. 1-2%

109. The trans fatty acid produced in the rumen which is shortly called

1. Conjugated linolenic acid
2. Conjugated linoleic acid
3. Conjugated lactic acid
4. None of the above

110. Incomplete hydrogenation of polyunsaturated fatty acids in rumen forms

1. Conjugated linoleic acid
2. Oleic acid
3. Linolenic acid
4. Stearic acid

111. Which of these are exopeptidases?

1. Carboxypeptidase A
2. Trypsin
3. Pepsin
4. Chymotrypsin

112. When incorporating urea into the diet, it is advisable to supplement with

1. S
2. P
3. N
4. Ca

113. After rumen microbial digestion, mimosine generates a goitrogen known as

1. PEG
2. 3 hydroxy 4 (1H) pyridine (3,4 DHP)
3. PVP
4. Vinyloxazolidinethione

114. Estimated value of methane emission from Indian Livestock is

1. 3-5 Tg
2. 50-60 Tg
3. 9-11 Tg
4. 30-40 Tg

115. Defaunation in ruminants is

1. Removal of bacteria
2. Removal of protozoa
3. Removal of fungi
4. Removal of microbes

116. Addition of urea is not beneficial when dietary protein content exceeds

1. 3%
2. 6%
3. 9%
4. 13%

117. In defaunated animals’ methane production is

1. Decreased
2. Increased
3. Not affected
4. Completely stopped

118. Which of the following is the tannin degrader in the rumen

1. *Streptococcus ruminantium*
2. *Streptococcus caprinus*
3. *Treponema sachharophillum*
4. None of the above

119. Methane oxidation in rumen occur by bacteria attached to

1. Particle
2. Protozoa
3. Both of the above
4. None of the above

120. Ideally under normal feeding condition the number of bacteria and protozoa per ml of rumen liquor

1. 1011 and 106
2. 103 and 106
3. 106 and 106
4. 105 and 106

121. What proportion of propionic acid gets converted to lactic acid during ruminal epithelial absorption

1. 2-5%
2. 5-10%
3. 10-15%
4. 20-40%

122. Moles of ATP/100g nutrient is highest from

1. Butyric acid
2. Propionic acid
3. Acetic acid
4. Lactic acid

123. Urea ammonia treated wheat and paddy straw could be added safely to

1. Young calves
2. Early age heifers
3. Adult buffaloes
4. New born calves

124. Rumen microbial yield and microbial products are better measured in a

1. Continuous fermentation system
2. Closed fermentation system
3. Nylon bag technique
4. Hohenheim gas test

125. Rumen microbial yield increases as the dilution rate

1. Decreases
2. Increases
3. Remain constant
4. Reached to homeostasis stage

126. The omasum is absent in

1. Camel
2. Cattle
3. Sheep
4. Goat

127. Ruminant saliva contains

1. Excessive amylolytic activity
2. No amylolytic activity
3. Meagre amylolytic activity
4. Lipolytic activity

128. In ruminants urea toxicity occur when blood ammonia level

1. 1mg/100ml
2. 2mg/100ml
3. 4mg/100ml
4. Nil concentration

129.About---------of methane produced for every 100 gm of organic matter digested in the rumen.

1. 2.5g
2. 3.5g
3. 4.5g
4. 5.5g

130. Disintegration of microbes takes place in

1. Rumen
2. Reticulum
3. Abomasum
4. Omasum

131. Rumen temperature exceeds as rectal temperature by as

1. 8ºC
2. 7ºC
3. 2ºC
4. 5ºC

132. The anaerobic fungi present in the rumen belongs to the genus

1. Fibrobacter
2. Ruminococcus
3. Neocallimastrix
4. Oligotrichus

133. The fungi breaks the fibre of feed by

1. Engulfing particle
2. Surface erosion
3. Fragmentation of particle
4. Breaking lignin bonding

134. Saponin can be used for ruminant feeding to decreases

1. Lactic acid
2. Protozoa
3. Bacteria
4. Acetic acid

**Matching type**

* 1. **Match the column**

**Table -A Table -B**

1. Leng and Nolan (a) Fungi
2. Hungate (b) Probiotic
3. Gruby and delafond (c) Protozoa
4. Orpin (d) Isotope method
5. Parker (e) Rumen bacteria
   1. **Match the column**

**Microbes Life span**

1. Amylolytic Bacteria (a) 24 hours
2. Cellulolytic bacteria (b)18 hours
3. Protozoa (c) 6-36 hours
4. Fungi (d) 70 % energy need
5. VFA (e) 20-30 min
   1. **Match the column**

**Table -A Table -B**

1. MCP (a) Topps and Elliot
2. Digestibility of purine in gut (b) 83%
3. Purine derivatives (c) uric acid and hypoxanthine
4. Osmotic pressure (d)240-300 m Osm/kg
5. Chemical defaunation (e) Copper sulphate
   1. **Match the column**

**Table -A Table -B**

1. Valine (a) 2-methyl butyric acid
2. Prolein (b) 3-methyl butyric acid
3. Isoleucine (c) Isobutyric acid
4. Leucine (d) Valeric acid
   1. **Match the column**

**Table -A Table -B**

1. pH (a) 39ºC
2. Redox potential (b) -270-360mvolt
3. Temperature (c) 6.7
4. Microbes (d) gram negative
   1. **Match the column**

**Table -A Table -B**

1. Microbes freely suspended in rumen (a) Mainly soluble sugars utilizing microbes

liquor

1. Microbes loosely attached with the (b) Some cellulolytic bacteria

feed particles

1. Microbes tightly attached with the (c) Major cellulolytic bacteria

feed particles

1. Microbes attached with the rumen wall (d) Facultative anaerobes
   1. **Match the column**

**Table -A Table -B**

|  |  |
| --- | --- |
| 1. Cellulolytic bacteria (a) | *Meghasphera elsdenni* |
| 1. Amylolytic (b) | *Bacteriodes ruminocola* |
| 1. Hemicellulolytic (c) | *Streptococcus bovis* |
| 1. Lactate utilisers (d) | *Ruminococcus albus* |

* 1. **Match the column**

**Table -A Table -B**

1. Ruminant saliva contains (a) 4 .5g methane
2. 100 gm OM digested (b) No amylolytic activity4
3. urea toxicity (c) 1mg/100ml blood
4. urea toxicity (d) 80mg/100ml RL
   1. **Match the column**

**Table -A Table -B**

1. Tannin degrading bacteria (a) Streptococcus caprinus
2. Mimiosine degrading bacteria (b) Syntergesis jonessi
3. Oxalate degrading bacteria (c) Oxalobacter formigenous
4. Mathanogens (d) Methanobaceter ruminentium
   1. **Match the column**

**Table -A Table -B**

1. Bacteria (a) 1010-1012
2. Protozoa (b) 103 -104
3. Fungi (c) 104 -106
4. Bacteriophage (d) 1010-1011
   1. **Match the column**

**Table -A Table -B**

1. Amylase (a) Less in number
2. Sacculated stomach (b) Higher in number
3. Oligotrichus (c) Hippopotamus
4. Holotrichus (d) Pig
   1. **Match the column**

**Table -A Table -B**

1. CLA (a) Conjugated linoleic acid
2. Exopeptidases (b) Sulphur
3. Urea (c) Carboxypeptidase A
4. Mimosine (d) 3,4 DHP

**Fill ups**

1. 240-300 m Osm/kg

2. Protease

3. Sugar

4. Cell membrane

5. Purine derivatives

6. Mimosine

7. Oxalobacter formigenes

8. Synerjestis jonesii

9. Cyclohexamide, sodium chlorite

10. Chitin

11. Ruminants

12. Caecum and colon

13. 2-12%

14. Nearly 90%

15. Czerkawski and Breckenridge

16. Less than 600 microne

17. Gut closure

18. Chloride ions

19. Folic acid and vitamin B12

20. 4.5

21. Lactate and pyruvate

22. Ketone body

23. Free fatty acids and glycerol

24. Butyrovibrio fibrosolvens

25. Synbiotic

26. Zimmerman in 1993

27. Negative

28. Maillard products and nitrogen bound to lignin

29. Rumen microbes

30. Per mole of ATP

31. Under controlled condition

32. RE Gruby and delafond

33. DM intake

34. Antibiotics

35. EUN

36. 1.23 g of glucose

37. 2 to 4 weeks

38. Methionine

39. 2 to 3 percent

40. 0.5 to 1.5 percent

**Multiple choice type**

1. All of the above

2. Reticulum

3. Compartment-3

4. *Diplastron offine*

5. Increase

6. All of the above

7. Lips, tongue and pointed lower lip

8. Horse

9. All of the above

10. Alpha 1,4 glycosidic linkage

11. Both of above

12. All of the above

13. All of the above

14. Parker

15. All of the above

16. All of the above

17. All of the above

18. All of the above

19. All of the above

20. All of the above

21. 20-40 times

22. About 20 percent

23. All of the above

24. 4 kg

25. All of the above

26. Propionate

27. Vitamin B12

28. Ketosis

29. Both of the above

30. All of the above

31. All of the above

32. All of the above

33. All of the above

34. Majority of bacteria are gram positive

35. All of the above

36. All of the above

37. All of the above

38. 14.8g MCP/100 g of organic matter truly digested

39. All of the above

40. All of the above

41. All of the above

42. All of the above

43. 3-4 cm

44. 1-2 cm

45. All of the above

46. All of the above

47. All of the above

48. All of the above

49. Protozoa have very high lipolytic activity

50. Probiotic term coined by Parker in 1989

51. The SF6 technique was developed by Fuller in 1983

52. None of the above

53. All of the above

54. Carbohydrates in poor quality roughages are slowly available and rumen microbes have difficulty in using energy from it to make bacterial protein

55. All of the above

56. 3% of DM

57. 0.5% of DM

58. 1% of DM

59. 1% of DM

60. All of the above

61. Both of the above

62. All of the above

63. 60-65 g

64. 0.5-2.5 g

65. All of the above

66. All of the above

67. All of the above

68. About 25 percent

69. All of the above

70. Streptococcus caprinus

71. Oxalobacter formigenous

72. Synergestis jonsii

73. All of the above

74. All of the above

75. 2.65 g/kg W0.75

76. 14 days prior calving

77. To take maximum output from animal

78. 10-20 %

79. 1010-1012

80. 104 -106

81. 103 -104

82. All of the above

83. Copper sulphate

84. Defaunation is the transfer of rumen liquor from one animal to other

85. All of the above

86. During absorption metabolism of VFA not occurs

87. Butyrate converted to lactate, which can be used as an energy source

88. All of the above

89. R. E. Hungate

90. Orpin

91. Gruby and delafond

92. All of the above

93. One month of age

94. Protozoa are facultative aerobic in nature

95. DAPA

96. All of the above

97. 3 months

98. Acetate

99. Propionate

100. 20-30

101. 10, 17, 25

102. 5-8

103. 90-230

104. 78%

105. 50-60, 30-40

106. 13.34 Kcal/g

107. 100-200

108. 5-8%

109. Conjugated linoleic acid

110. Conjugated linoleic acid

111. Carboxypeptidase A

112. Sulphur

113. 3 hydroxy 4 (1H) pyridine (3,4 DHP)

114. 9-11 Tg

115. Removal of protozoa

116. 13%

117. Decreased

118. Streptococcus caprinus

119. Both of the above

120. 1011 and 106

121. 20-40%

122. Butyric acid

123. Adult buffaloes

124. Continuous fermentation system

125. Increases

126. Camel

127. No amylolytic activity

128. 1mg/100ml

129. 4.5g

130. Abomasum

131. 2ºC

132. Neocallimastrix

133. Breaking lignin bonding

134. Protozoa

**Matching type**

1. (d), (e), (c), (a), (b)

2. (e), (b), (c), (a), (d)

3. (a), (b), (c), (d), (e)

4. (c), (d), (a), (b)

5. (c), (b), (a), (d)

6. (a), (b), (c), (d)

7. (d), (c), (b), (a)

8. (b), (a), (c), (d)

9. (a), (b), (c), (d)

10. (a), (c), (b), (d)

11. (d), (c), (b), (a)

12. (a), (c), (b), (d)