JOURNAL OF
HYGIENE SCIENCES
Committed to the advancement of Clinical & Industrial Disinfection & Microbiology
VOLUME - XV ISSUE - II JUN - JUL 2022

Editorial

Contents

Mini review section – Fermentation is one of the oldest technologies used for food preservation. Today a variety of fermented foods is produced both in industrialised and developing countries using this technology. A wide range of raw materials is used as substrates and panoply of products is concocted. Foods derived from fermentation are major constituents of the human diet all over the world. Although advances in food science and technology have given rise to a wide range of new food technologies, fermentation has remained an important technology throughout the history of mankind.

Current Trends section – The Indian Council of Medical Research (ICMR) has been supporting research on antimicrobial resistance through the Antimicrobial Resistance Research & Surveillance Network (AMRSN) since 2013. The data collected from the network has enabled compilation of drug resistance data on six pathogenic groups on antimicrobial resistance from the country.

In Profile Scientist – Maurice Hilleman was responsible for developing more than 40 vaccines, including measles, mumps, hepatitis A, hepatitis B, meningitis, pneumonia, *Haemophilus influenzae* bacteria, and rubella. His vaccines have been credited with saving millions of lives and with eradicating common childhood diseases. The measles vaccine alone has prevented approximately one million deaths. Among other accomplishments, he succeeded in characterising and isolating many viruses, including the hepatitis A vaccine in culture.

Bug of the month – *Cronobacter* infections are rare, but they can be deadly in newborns. Infections in infants usually occur in the first days or weeks of life. About two to four cases are reported to CDC every year, but this figure may not reflect the true number of illnesses. That's because most hospitals and laboratories are not required to report *Cronobacter* infections to health departments.

Did You Know? – Studies of workers exposed to high levels of formaldehyde, such as industrial workers and embalmers, have found that formaldehyde causes **myeloid leukemia and rare cancers, including cancers of the paranasal sinuses, nasal cavity, and nasopharynx**.

Best Practices – The air conditioning requirements for operation theatre in HCO have been revisited in the context of points raised by various HCOs during surveys. These standards were examined by Technical committee and various latest international and national standards on air conditioning were reviewed.

Tickle yourself with the jokes in our **Relax Mood section**.

We are looking forward for your continuous support in making this journal better each time. Feedback & suggestions are always welcomed.

FOOD AND FERMENTATION (II)

Fermentation is one of the oldest technologies used for food preservation. Over the centuries it has evolved refined and diversified. Today a variety of fermented foods is produced both in industrialised and developing countries using this technology. A wide range of raw materials is used as substrates and panoply of products is concocted. Foods derived from fermentation are major constituents of the human diet all over the world. Although advances in food science and technology have given rise to a wide range of new food technologies, fermentation has remained an important technology throughout the history of mankind. Many benefits are attributed to fermentation. It preserves and enriches food, improves digestibility, and enhances the taste and flavour of foods. It is also an affordable technology and is thus accessible to all populations. Furthermore, fermentation has the potential of enhancing food safety by controlling the growth and multiplication of a number of pathogens in foods. Thus, it makes an important contribution to human nutrition, particularly in developing countries, where economic problems pose a major barrier to ensuring food safety.

Fermentation process

Fermentation is nothing more than a chemical reaction. It all starts with glucose. This glucose might already be present (e.g. sugars), but the microorganism might also have to convert another larger carbohydrate into glucose.

This molecule of glucose then reacts in a series of chemical reactions, ultimately releasing ethanol and carbon dioxide reaction scheme looks as follows:

$C_6H_{12}O_6 \rightarrow 2\,C_2H_5OH + 2\,CO_2$

1 glucose molecule ($C_6H_{12}O_6$) is converted into 2 ethanol (C_2H_5OH) and 2 carbon dioxide (CO_2) molecules. No oxygen is required for the reaction to occur.

Stages of the Fermentation Process

Depending upon what you're fermenting, the process can have several stages.

- Primary fermentation. In this brief phase, microbes begin rapidly working on raw ingredients such as fruit, vegetables, or dairy. The microbes present or in the surrounding liquid (such as brine for fermented vegetables) prevent putrefying bacteria from colonizing the food instead. Yeasts or other microbes convert carbohydrates (sugars) into other substances such as alcohols and acids.
- Secondary fermentation. In this longer stage of fermentation, which lasts several days or even weeks, alcohol levels rise and yeasts and microbes die off and their available food source (the carbohydrates) becomes scarcer. Winemakers and brewers use secondary fermentation to create their alcoholic beverages. The pH of the ferment can differ significantly from when it started out, which affects the chemical reactions taking place between the microbes and their environment. Once alcohol is between 12–15% and it kills the yeast, preventing further fermentation, distillation is needed to remove water, condensing alcohol content to create a higher percentage of alcohol

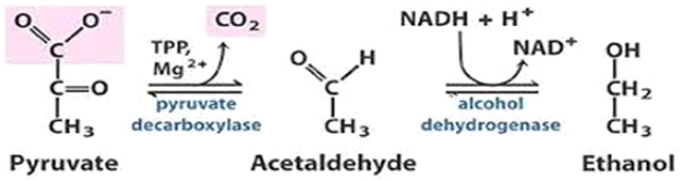
Main types of fermentation

Alcoholic fermentation

It generally means production of ethanol (CH_3CH_2OH). Commonly yeasts, particularly Saccharomyces cerevisiae, are used for production of various alcoholic beverages, as well as industrial alcohol. Yeasts are essentially aerobic organisms, but they can also grow as facultative anaerobes.

The energy-yield under anaerobic conditions is much lower and hence the growth is slower with much lower cell-yield. When grown with aeration, the cell-yield increases dramatically, but alcohol production falls. Thus, oxygen inhibits fermentation. This is known as Pasteur-effect.

Conversion of pyruvic acid to ethanol proceeds in two steps: pyruvic acid to acetaldehyde and acetaldehyde to ethanol. The first step is catalysed by pyruvic acid decarboxylase which requires TPP as coenzyme, and the second step by alcohol dehydrogenase which requires $NADH_2$ as coenzyme.



Various strains of yeasts, mostly belonging to *Saccharomyces cerevisiae*, have been developed and carefully selected for large-scale manufacture of alcohol for different purposes. Also, various materials and conditions are used depending on the nature of the product desired.

For production of baker's yeast used in bread industry, strongly aerated cultures favour large cell-yield with little or no alcohol. Extract of malted (partly germinated) barley serves as substrate for beer production. The starting material contains large amount of maltose (a dissacharide of two glucose units) produced by hydrolysis of starch present in barley seeds. Maltose is split into glucose and serves as substrate for alcohol fermentation under anaerobic conditions.

Similarly, for production of wine, grape juice is the substrate of choice. Specific selected strains are employed to impart characteristic flavour and taste of different alcoholic beverages. For manufacture of industrial alcohol, generally molasses is used as the starting material. Also sulfite liquor, which is a waste product of paper industry, is used as a cheap substrate for industrial alcohol production. Besides yeasts, some bacteria can also carry out alcoholic fermentation. A well-known example is *Zymomonas mobilis*. This organism dissimilates glucose by EDP producing pyruvic acid which is converted to ethanol by decarboxylation and dehydrogenation as in yeast. *Pseudomonas saccharophila* is another bacterium which is used in alcoholic fermentation.

Lactic Acid Fermentation

Lactic acid fermentation is a metabolic process by which glucose or other six-carbon sugars are converted into cellular energy and the metabolite lactate, which is lactic acid in solution. It is an anaerobic fermentation reaction that occurs in some bacteria and animal cells.

There are various types of lactic acid bacteria and there are also different ways in how they transform sugars into lactic acid. Also, it depends on the types of sugars available for the bacteria. Glucose can be fermented into lactic acid through two main pathways:

Homofermentative:

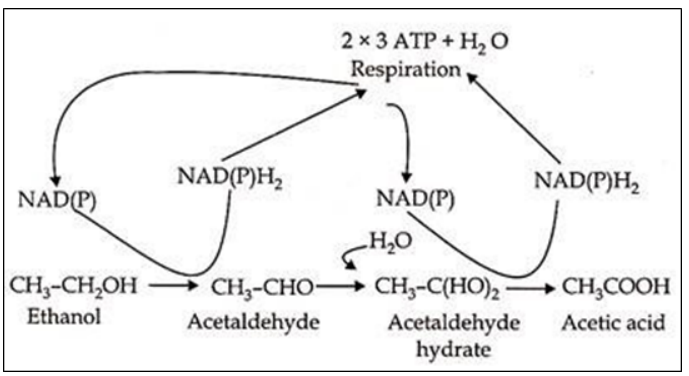
Lactic acid is produced as the sole product by reduction of pyruvic acid with the help of the enzyme lactic acid dehydrogenase. The reaction regenerates NAD from $NADH_2$ which is reused for oxidation of GAP to DPGA in the glycolytic pathway. Homolactic fermentation is the simplest of all fermentations, involving only a single step in which pyruvic acid is reduced to lactic acid.

Heterofermentative:

In heterofermentative type, the products are lactic acid and ethanol or acetic acid and CO_2. The heterofermentative lactic acid bacteria dissimilate glucose via PPC. They produce lactic acid from one-half of the glucose molecule, and ethanol or acetic acid and CO_2 from the other half.

Lactic acid bacteria are widely used for production of various fermented food throughout the world. The bacteria ferment the milk sugar (lactose) to produce lactic acid which curdles milk protein. Various species are used to yield products of variable consistency, taste and aroma. In different countries the products are variously known as yogurt in Europe and America, dahi in India, Kefir in Russia, Kumiss, butter milk, acidophilus milk.

Acetic acid fermentation



Acetic acid (CH_3COOH) is also called as vinegar. Vinegar fermentation is one of the oldest fermentations known to man. It is formed naturally due to spoilage of wine.

The production of vinegar actually involves two fermentation processes- the first utilizing yeast to produce alcohol from sugar and the second utilizing acetic acid bacteria to oxidize ethyl alcohol acetic acid through acetaldehyde.

The microbial oxidation of ethanol to acetic acid is an aerobic fermentation that has high oxygen requirement. Acetobacter bacteria are employed for industrial production of vinegar. Acetobacter bacteria can be divided into two groups – Gluconobacter and

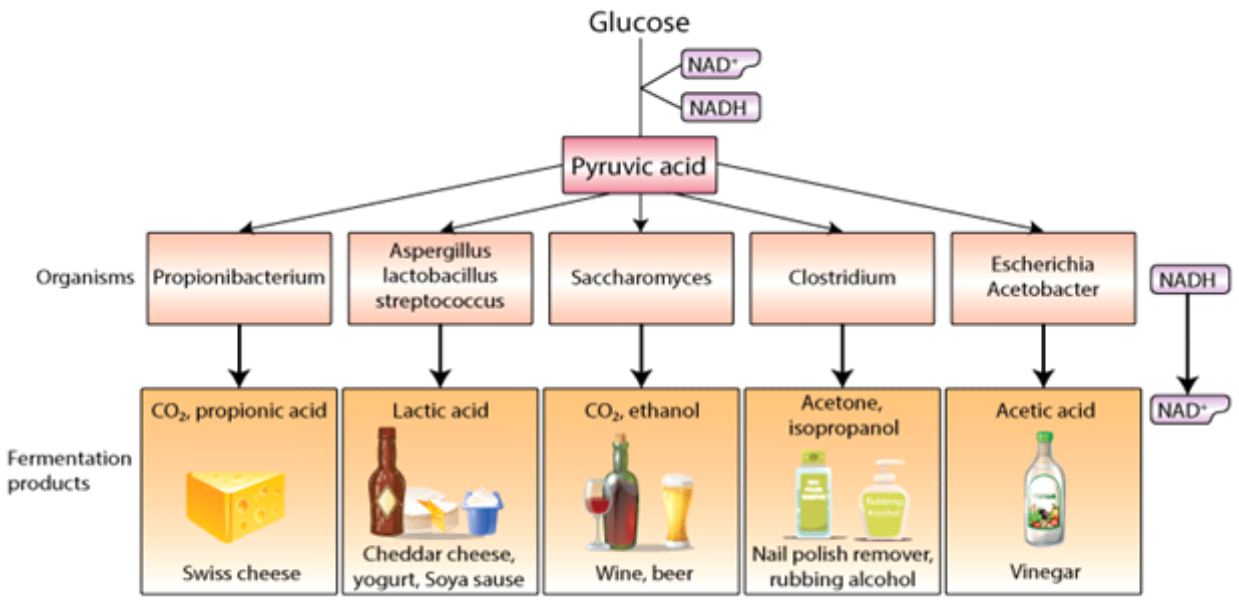
Acetobacter. Gluconobacter oxidizes ethanol to acetic acid, while Acetobacter oxidizes ethanol first to acetic acid and then to CO_2 and H_2O.Species of the Acetobacter used commercially are *Acetobacter aceti* and *Acetobacter pasteurianum*. Similarly, *Gluconobacter oxydans* and its subspecies are employed in the commercial production of vinegar. Mixed cultures, sometimes appear during production even though pure culture is used especially in surface process.

Two oxidation steps occur during the conversion of ethanol to acetic acid. In the first step ethanol is oxidized to acetaldehyde in the presence of NAD or NADP and in the second step acetaldehyde is changed to acetic acid and render the catalytic action of the enzyme alcohol dehydrogenase In this oxidation one liter of 12% acetic acid is produced from one liter of 12% alcohol that is one mole of acetic acid is formed from one mole of alcohol.

Commercially acetic acid is produced by two methods, surface fermentation process and submerged fermentation process. If materials with low alcohol content are used such as wine, whey, malt or cider there is no need of addition of any component to constitute a complete nutrient solution. However, if potato or grain spirits or technical alcohol is used, nutrients must be added to obtain optimal growth and acetic acid production. Nutrient concentration that is used in submerged fermentation is generally five times greater than surface fermentation.

Advantages of Fermentation:

Fermentation is suitable for all kinds of environments. It is one of the oldest metabolic processes which is common to prokaryotes and eukaryotes. Fermentation is widely used in various industries.



Using suitable microorganisms and specified conditions different kinds of fermentation products are formed namely:-

- Beer
- Biofuels
- Yoghurt
- Pickles
- Bread
- Sour foods containing lactic acid
- Certain antibiotics and vitamins

Fermentation can make food nutritious, digestible and flavoured. There are many benefits of consuming fermented food.

- It improves digestion and helps to maintain intestinal bacteria
- It has an anti-cancer effect.
- Improves immune system
- Reduces lactose intolerance

Other than the food industry, there are many other areas where the fermentation process is used. Methane is produced by fermentation in sewage treatment plants and freshwater sediments.

Antimicrobial Resistance in India

Executive Summary

The Indian Council of Medical Research (ICMR) has been supporting research on antimicrobial resistance through the Antimicrobial Resistance Research & Surveillance Network (AMRSN) since 2013. The data collected from the network has enabled compilation of drug resistance data on six pathogenic groups on antimicrobial resistance from the country.

(i) *Enterobacterales* causing sepsis

(ii) Gram-negative non-fermenters

(iii) Typhoidal *Salmonella*

(iv) Diarrhoeagenic bacterial organisms

(v) Gram-positives: staphylococci and enterococci,

(vi) Fungal pathogens from thirty tertiary care hospitals/laboratories across the country.

Data collected from the network is used to track resistance trends and to better understand mechanisms of resistance in the key priority pathogens using molecular characterisation techniques and whole genome sequencing (WGS).

Highlights of Data

This report presents data from January 1, 2020 to December 31, 2020. Total number of culture positive isolates studied during the year 2020 was 65,561.

- *Escherichia coli* was most commonly isolated followed by the *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter baumannii* and *Staphylococcus aureus*.
- Imipenem susceptibility of *E. coli* has dropped steadily from 86% in 2016 to 63% in 2019 and showed slight recovery to 72% in 2020 and that of *Klebsiella pneumoniae* dropped steadily from 65% in 2016 to 46% in 2019 and remained at 45% in 2020.
- *Staphylococcus aureus* has shown increasing trends of resistance to most antibiotics over the years, no such prominent trend could be observed with MSSA isolates. Susceptibility to erythromycin, clindamycin, ciprofloxacin, co-trimoxazole and high level mupirocin was more evident in MSSA when compared to MRSA. The anti MRSA antibiotics such as vancomycin and tigecycline showed excellent in vitro activity (100% against MRSA isolates). Teicoplanin and linezolid resistance was encountered in MRSA isolates albeit at very low rates of 0.5 and 1 %, respectively.
- Fungal infections among hospitalized patients are significantly increasing. Majority of the fungal infections are caused by few common fungal agents nevertheless rare species are also increasing requiring newer treatment strategies.
- *C. auris*, multidrug resistant yeast known to cause hospital outbreaks has been consistently isolated from regional centers across India. Majority of the *C. auris* isolates were resistant to fluconazole and incidences of echinocandin resistance is on the rise.
- In *A. baumannii*, reduced susceptibility of 10-20% was observed against cephalosporins, carbapenems, monobactams and β-lactam-β-lactamase inhibitors.
- In *Pseudomonas aeruginosa*, the least susceptibility of 40% was observed for fluoroquinolones; and 60-70% to cephalosporins, carbapenems, and aminoglycosides.

This is the fourth detailed report on AMR trends and patterns from the country, published by ICMR. Since the network collects data from tertiary care hospitals, the data presented in this report is not reflective of the community levels of AMR in the country and should not be extrapolated to community settings. In this report, we also present trends of resistance of key pathogens to the critically important antimicrobials which should guide the prevention and treatment interventions for AMR in the country. Since India experienced COVID-19 pandemic in the year 2020, the report includes a chapter on AMR profile in isolates from COVID-19 patients.

Systematic collection, evaluation and analysis of resistance data of specific pathogens for last five years have highlighted that certain pathogens have become highly drug resistant and have become clinians dilemma. Aggressive action for prevention, containment and treatment are needed at the national level. Based on the laboratory evidence and the inputs of clinicians, ID physicians and clinical microbiologists, these drugs resistant difficult to pathogens can be classified into three groups (Table I):

- **Group I** includes pathogens that have become resistant to last-resort antibiotics including carbapenems, the best available antibiotics for treating multi-drug resistant bacteria and pose a high risk to patients. They can cause severe and often deadly infections such as ventilator-

associated or hospital-acquired pneumonia, bloodstream infections and urinary tract infections. *Candida auris*, pathogenic yeast has also been included under urgent threat that causes bloodstream and other invasive infections and is resistant to most of the antifungal drugs.

- **Group II** includes multidrug resistant bacteria, conferring high risk to patients, mainly prevalent in hospital acquired infections and is associated with serious multidrug-resistant infections and ventilator associated pneumonia, complicated urinary tract infections and surgical site.
- **Group III** includes drug resistant bacteria that are responsible for only a small number of infections but detection and early prevention of such infections can have significant impact on public health and need to be carefully watched in future.

Table I: Difficult to treat drug resistance pathogens in Indian Hospitals

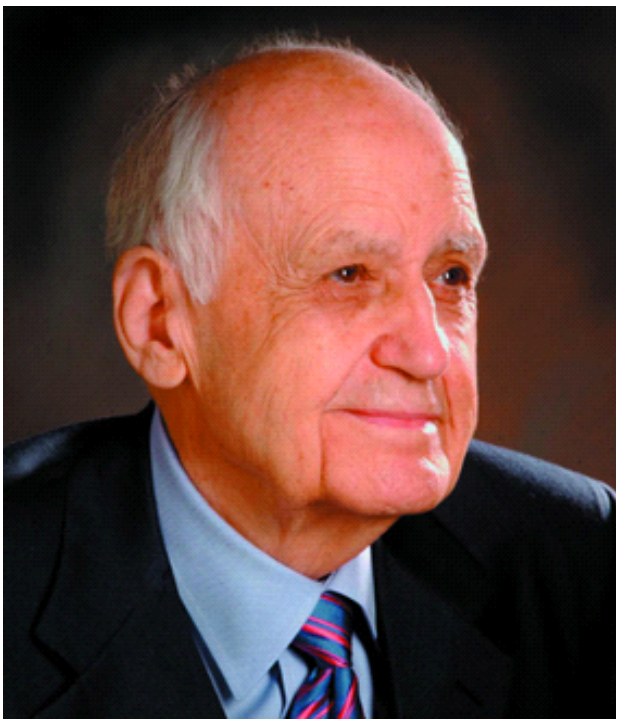
	Group I	Group II	Group III
Pathogens	● Carbapenem Resistant Enterobacterales ● Carbapenem Resistant *A. baumannii* ● Drug resistant Salmonella Typhi ● *Candida auris*	● ESBL producing Enterobacterales ● Multidrug resistant *P. aeruginosa* ● Vancomycin-resistant enterococci ● Azole Resistant *Candida* spp	● Methicillin Resistant Staphylococcus aureus ● Azole resistant *Aspergillus fumigatus* ● Amphotericin B resistant *Aspergillus flavus* ● Drug-resistant *Stenotrophomonas maltophilia* ● Colistin Resistant Enterobacterales ● Colistin resistant *Acinetobacter* spp.
Action required for comment	Aggressive Action	Sustained Action	Cotinuous monitoring and prevention efforts

The infections caused by the pathogens listed under Group I and II have been documented to be associated with high rates of mortality and morbidity, both in India and globally. Additionally, they increase hospital lengths of stay and result in major increase in healthcare expenditure and healthcare resource utilization. Detailed summaries on each of the high risk pathogens have been included in this document. This list intends to flag the imminent threat of rising resistance to higher generation antimicrobials and highlight the urgent need to implement appropriate interventions to prevent development of resistance, contain the spread of drug resistant pathogens and improve treatment of drug resistant infections.

Reference:

www.icmr.org.in

Maurice Hilleman



Maurice Hilleman was responsible for developing more than 40 vaccines, including measles, mumps, hepatitis A, hepatitis B, meningitis, pneumonia, *Haemophilus influenzae* bacteria, and rubella. His vaccines have been credited with saving millions of lives and with eradicating common childhood diseases. The measles vaccine alone has prevented approximately one million deaths. Among other accomplishments, he succeeded in characterising and isolating many viruses, including the hepatitis A vaccine in culture.

Despite Hilleman's many breakthroughs in immunology and vaccinology, he has never been a household name. Anthony Fauci, director of the US National Institute of Allergy and Infectious Diseases, said Hilleman had "little use for self credit." Dr Fauci told the *BMJ* that Hilleman's contributions were "the best kept secret among the lay public. If you look at the whole field of vaccinology, nobody was more influential."

Hilleman's interest in microbiology and science had its roots in his childhood. Born in 1919, he grew up during the Great Depression on a farm in the southeastern plains of Montana. To help his family through the Depression, he needed to be economical and tenacious. It was a building block he later used for keeping his focus.

After the Depression, he entered Montana State University on a full scholarship. In a 1999 issue of *Immunological Reviews,* he described Montana State as a "no-nonsense institution where professors taught and where teaching assistants, other than laboratory aides, did not exist." He gained a bachelor's degree in microbiology and chemistry.

His graduate education at the University of Chicago reinforced his independence and self reliance. It was a tough environment, in which Hilleman said you would either "sink or swim." In 1944 he was awarded a PhD in microbiology and chemistry. Hilleman told his professors at Chicago that he was going into industry, where he thought he would be best positioned not only for conducting research, but also for ensuring and expediting clinical applications. His professors told him that he belonged in academia and that they had not trained him for a career in industry. Hilleman strongly disagreed, maintaining that academic institutions lacked the resources to move scientific innovations forward and to market.

Paul Offit, chief of infectious diseases at the Children's Hospital of Philadelphia, told the *BMJ*, "His commitment was to make something useful and convert it to clinical use. Maurice's genius was in developing vaccines, reliably reproducing them, and he was in charge of all pharmaceutical facets from

research to the marketplace." Hilleman felt that scientists had a responsibility to provide a return on knowledge gained in the laboratory.

In 1944 he joined the virus laboratories of E R Squibb & Sons in New Brunswick, New Jersey, where he developed a vaccine against Japanese B encephalitis, urgently needed to immunise troops fighting in the Pacific.

Hilleman characterised several viruses and identified changes that could result when a virus mutated. This concept, which he worked out while at the Walter Reed Institute of Army Research, helped prevent a huge pandemic of Hong Kong flu in 1957. Learning that the flu was a new strain, 40 million doses of vaccine were rapidly made available in the United States.

He joined Merck on New Year's Eve, 1957, as director of a new department of virus and cell biology research. Under Hilleman's aegis, by 1984 Merck had garnered 37 product licences, with an additional three vaccines ready for development. He retired from Merck at age 65, but stayed on as a consultant.

Hilleman's style of working was icono-clastic. Dr Offit said, "To give you an example of how he worked, in 1963, [when his daughter had the classic symptoms of the mumps,] he swabbed the back of his daughter's throat, brought it to the lab to culture, and by 1967, there was a vaccine." He added, "Today's regulation would preclude that from happening... If Maurice was alive today, I doubt he would be able to be Maurice. He was a very strong willed person and a person like him could face a high level of inertia."

During his more than 60 years in basic and applied research, he earned a reputation as an often harsh, impatient fellow who tangled with industry and government bureaucracies. Hilleman defended his pushy and prickly behaviour, which offended some colleagues and coworkers, as crucial for science to advance. He argued that politics, not science, determined which breakthroughs were brought to the marketplace.

Hilleman received many honours, including a special lifetime achievement award from the World Health Organization.

He leaves his second wife, Lorraine; two daughters; and five grandchildren.

Maurice Hilleman, microbiologist Philadelphia, United States (b Miles City, Montana, 1919), died from cancer on 11 April 2005.

Jokes

Foreigner: In India where does the,
Ice fall more?
Smart answer by Santa…..
Santa: Before 8 p.m. in Kashmir,
& after 8 p.m. in glass of whiskey…

Boy: Where are you going??
Girl: For doing suicide.
Boy: Then why have you done,
So much of make up…?
Girl: Oh! Stupid, tomorrow my,
Photo will come in the newspaper…

Santa by mistake goes into a ladies toilet.
All ladies suddenly stand up
Santa : Izzat dil me ho yehi kaafi hai,
Baitho Baitho…:)

A police asked to a thief,
" Why you went to stole same rack 3 times in a store? "
The thief replied,
" Sir, I stole one dress for my wife,
& I came to change it twice. "

A man in Hell asked Devil:
Can I make a call to my Wife?
After making call he asked how much to pay.
Devil : Nothing, Hell to hell is Free.

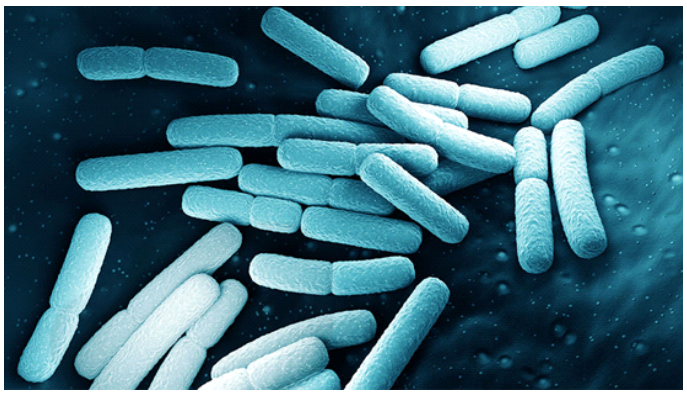
Madam to Student : Last Semester you were roaming
with that girl and this semester you are roaming with other.
What you think of yourself?
Boy: Syllabus changed mam.

In bio practical:
Examiner: Tell me the name of this bird by seeing its legs only?
Sardar: I don't know.
Examiner: You are failed, what's your name?
Sardar: See my legs & tell my name

A successful man is one
who makes more money
than his wife can spend.
A successful woman is one
who can find such a man.

Having "WIFE" Is A
Part Of Living...
But
Having "GIRLFRIEND"
Along With The "WIFE" Is
Art Of Living

Cronobacter Infection and Infants



Getting sick from *Cronobacter* does not happen often, but infections in infants can be deadly. *Cronobacter* infections in infants less than 12 months old are often linked to powdered infant formula. If your baby is fed with powdered infant formula, you can take steps to protect your baby from sickness.

Cronobacter sakazakii is a germ found naturally in the environment.
These germs can live in dry foods, such as:

- Powdered infant formula
- Powdered milk
- Herbal teas
- Starches

Cronobacter infections are rare, but they can be deadly in newborns. Infections in infants usually occur in the first days or weeks of life. About two to four cases are reported to CDC every year, but this figure may not reflect the true number of illnesses. That's because most hospitals and laboratories are not required to report *Cronobacter* infections to health departments.

Cronobacter germs can cause a dangerous blood infection or make the linings surrounding the brain and spinal cord swell.

Infants who are more likely to get sick include:

- Infants 2 months and younger. These infants are most likely to develop meningitis if they get sick from *Cronobacter*.
- Infants born prematurely.
- Infants with weakened immune systems. Babies with this condition can't fight germs as well because of illness or medical treatment, such as chemotherapy for cancer.

Cronobacter illness in infants will usually start with a fever and poor feeding, excessive crying, or very low energy. Some infants may also have seizures. You should take an infant with these symptoms to a medical provider as soon as possible.

Cronobacter infection can also be serious for:

- People 65 years and older.
- People whose immune systems are weakened by illnesses or conditions, such as HIV, organ transplants, or cancer.

You may want to take extra precautions if your baby is younger than 2 months old, was born prematurely, or has a weakened immune system:

Follow These Five Guidelines to Protect Your Baby from *Cronobacter:*
Wash your hands with soap and water, especially before preparing bottles and feeding your baby.

1. **Breastfeed if you can**. Breastfeeding is one of the best things you can do for your baby's health and development. Health officials and medical providers report very few cases of *Cronobacter* infection in infants fed only breast milk.

2. **Clean, sanitize, and store feeding items such as baby bottles and breast pump parts safely.** Help prevent germs from growing on these items and keep your baby's milk safe by carefully cleaning, sanitizing, and storing bottles and breast pump parts. Take apart bottles and breast pump equipment after use for thorough cleaning.

3. **Keep hands clean!** Always wash your hands with soap and water for at least 20 seconds during key times:

- Before preparing and feeding bottles or food to your baby
- Before touching your baby's mouth
- Before touching pacifiers or other things that go into your baby's mouth
- After using the toilet or changing diapers

If soap and water are not available, use a hand sanitizer with at least 60% alcohol. Check the product label to be sure. Wash hands with soap and water as soon as possible after using hand sanitizer. Hand sanitizer with

at least 60% alcohol kills *Cronobacter*. But hand sanitizer does not kill all types of germs. It may not work as well if hands are visibly greasy or dirty.

4. **If your baby is fed with formula, consider using liquid formula when possible. Powdered infant formula is not sterile and might have germs in it.** Using a liquid formula instead of powdered is especially important if your baby:

- Is less than 2 months old
- Was born prematurely, or
- Has a weakened immune system.

Liquid infant formula is made to be sterile (without germs). This means liquid formula should not make your baby sick with *Cronobacter* infection when you follow the instructions on the container.

You do not need to warm infant formula before feeding, but some people like to warm their baby's bottle. If you do warm the bottle, never use a microwave. Microwaves heat milk and food unevenly, resulting in "hot spots" that can burn your baby's mouth and throat.

- To warm a bottle, place it under warm running water. Keep the running water from getting into the bottle or on the nipple. Put a couple drops of infant formula on the inside of your wrist to make sure it is not too hot.

Keep all surfaces and feeding items clean when preparing infant formula. This includes all countertops, feeding items (nipples, caps, rings, valves), and objects that may enter the baby's mouth, such as pacifiers and teethers.

5. **Prepare and store powdered infant formula safely.** Make sure that your formula is not expired or recalled. The container should be in good condition with no dents, puffy ends, or rust spots. Keep powdered formula lids and scoops clean. Close containers of formula as soon as possible.

In most cases, it is safe to mix powdered infant formula following manufacturer's instructions on the container. **But, if your baby may be at higher risk, consider taking these extra steps to prepare your powdered formula with hot water (at least 158°F/70°C):**

1. Wash hands with soap and water before preparing infant formula.
2. Clean work surfaces, such as countertops and sinks, with soap and water, or use a disinfectant wipe or paper towel sprayed with cleaning product. Do not place feeding items directly in the sink, because germs in sinks or drains could contaminate these items.
3. Boil water and let it cool for about 5 minutes.
4. Pour the water into a clean bottle or feeding cup.
5. Add the exact amount of formula listed on the container, and carefully shake the capped bottle rather than stirring the mixture.
6. If you plan to use the prepared formula right away, cool the formula to body temperature to ensure it is not too hot before feeding your baby. Run the prepared, capped bottle under cool water or place it into an ice bath. Do not let the cooling water get into the bottle or on the nipple.
7. Before feeding the baby, test the formula's temperature by putting a few drops on the inside of your wrist. It should feel warm, not hot.

Use prepared infant formula within 1 hour from start of feeding and within 2 hours of preparing it. If your baby does not finish the entire bottle of formula, throw away leftover formula.

If you do not plan to start feeding your baby with the prepared formula right away, put it in the refrigerator immediately. Use formula in the refrigerator within 24 hours. Throw out formula if you can't remember how long you have kept it in the refrigerator. Do not feed it to your baby.

Formaldehyde & Cancer Risk

What is formaldehyde?
Formaldehyde is a colorless, flammable, strong-smelling chemical that is used in building materials and to produce many household products. It is used in pressed-wood products, such as particleboard, plywood, and fiberboard; glues and adhesives; permanent-press fabrics; paper product coatings; and certain insulation materials. In addition, formaldehyde is commonly used as an industrial fungicide, germicide, and disinfectant, and as a preservative in mortuaries and medical laboratories. Formaldehyde also occurs naturally in the environment. It is produced in small amounts by most living organisms as part of normal metabolic processes.

How is the general population exposed to formaldehyde?
According to a 1997 report by the U.S. Consumer Product Safety Commission, formaldehyde is normally present in both indoor and outdoor air at low levels, usually less than 0.03 parts of formaldehyde per million parts of air (ppm). Materials containing formaldehyde can release formaldehyde gas or vapor into the air. One source of formaldehyde exposure in the air is automobile tailpipe emissions.

During the 1970s, urea-formaldehyde foam insulation (UFFI) was used in many homes. However, few homes are now insulated with UFFI. Homes in which UFFI was installed many years ago are not likely to have high formaldehyde levels now. Pressed-wood products containing formaldehyde resins are often a significant source of formaldehyde in homes. Other potential indoor sources of formaldehyde include cigarette smoke and the use of unvented fuel-burning appliances, such as gas stoves, wood-burning stoves, and kerosene heaters.

Industrial workers who produce formaldehyde or formaldehyde-containing products, laboratory technicians, certain health care professionals, and mortuary employees may be exposed to higher levels of formaldehyde than the general public. Exposure occurs primarily by inhaling formaldehyde gas or vapor from the air or by absorbing liquids containing formaldehyde through the skin.

What are the short-term health effects of formaldehyde exposure?
When formaldehyde is present in the air at levels exceeding 0.1 ppm, some individuals may experience adverse effects such as watery eyes; burning sensations in the eyes, nose, and throat; coughing; wheezing; nausea; and skin irritation. Some people are very sensitive to formaldehyde, whereas others have no reaction to the same level of exposure.

Can formaldehyde cause cancer?
Although the short-term health effects of formaldehyde exposure are well known, less is known about its potential long-term health effects. In 1980, laboratory studies showed that exposure to formaldehyde could cause nasal cancer in rats. This finding raised the question of whether formaldehyde exposure could also cause cancer in humans. In 1987, the U.S. Environmental Protection Agency (EPA) classified formaldehyde as a probable human carcinogen under conditions of unusually high or prolonged exposure. Since that time, some studies of humans have suggested that formaldehyde exposure is associated with certain types of cancer. The International Agency for Research on Cancer (IARC) classifies formaldehyde as a human carcinogen. In 2011, the National Toxicology Program, an interagency program of the Department of Health and Human Services, named formaldehyde as a known human carcinogen in its *12th Report on Carcinogens.*

What have scientists learned about the relationship between formaldehyde and cancer?
Since the 1980s, the National Cancer Institute (NCI), a component of the National Institutes of Health (NIH), has conducted studies to determine whether there is an association between occupational exposure to formaldehyde and an increase in the risk of cancer. The results of this research have provided EPA and the Occupational Safety and Health Administration (OSHA) with information to evaluate the potential health effects of workplace exposure to formaldehyde.

The long-term effects of formaldehyde exposure have been evaluated in epidemiologic studies (studies that attempt to uncover the patterns and causes of disease in groups of people). One type of epidemiologic study is called a cohort study. A cohort is a group of people who may vary in their exposure to a particular factor, such as formaldehyde, and are followed over time to see whether they develop a disease. Another kind of epidemiologic study is called a case-control study. Case-control studies begin with people who are diagnosed as having a disease (cases) and compare them to people without the disease (controls), trying to identify differences in factors, such as exposure to formaldehyde, that might explain why the cases developed the disease but the controls did not.

Several NCI surveys of professionals who are potentially exposed to formaldehyde in their work, such as anatomists and embalmers, have suggested that these individuals are at an increased risk of leukemia and brain cancer compared with the general population. However, specific work practices and exposures were not characterized in these studies. An NCI case-control study among funeral industry workers that characterized exposure to formaldehyde also found an association between increasing formaldehyde exposure and mortality from myeloid leukemia. For this study, carried out among funeral industry workers who had died between 1960 and 1986, researchers compared those who had died from hematopoietic and lymphatic cancers and brain tumors with those who died from other causes. (Hematopoietic or hematologic cancers such as leukemia develop in the blood or bone marrow. Lymphatic cancers develop in the tissues and organs that produce, store, and carry white blood cells that fight infections and other diseases.) This analysis showed that those who had performed the most embalming and those with the highest estimated formaldehyde exposure had the greatest risk of myeloid leukemia. There was no association with other cancers of the hematopoietic and lymphatic systems or with brain cancer.

A number of cohort studies involving workers exposed to formaldehyde have recently been completed. One study,

conducted by NCI, looked at 25,619 workers in industries with the potential for occupational formaldehyde exposure and estimated each worker's exposure to the chemical while at work. The results showed an increased risk of death due to leukemia, particularly myeloid leukemia, among workers exposed to formaldehyde. This risk was associated with increasing peak and average levels of exposure, as well as with the duration of exposure, but it was not associated with cumulative exposure. An additional 10 years of data on the same workers were used in a follow-up study published in 2009. This analysis continued to show a possible link between formaldehyde exposure and cancers of the hematopoietic and lymphatic systems, particularly myeloid leukemia. As in the initial study, the risk was highest earlier in the follow-up period. Risks declined steadily over time, such that the cumulative excess risk of myeloid leukemia was no longer statistically significant at the end of the follow-up period. The researchers noted that similar patterns of risks over time had been seen for other agents known to cause leukemia.

A cohort study of 11,039 textile workers performed by the National Institute for Occupational Safety and Health (NIOSH) also found an association between the duration of exposure to formaldehyde and leukemia deaths. However, the evidence remains mixed because a cohort study of 14,014 British industry workers found no association between formaldehyde exposure and leukemia deaths.

Formaldehyde undergoes rapid chemical changes immediately after absorption. Therefore, some scientists think that formaldehyde is unlikely to have effects at sites other than the upper respiratory tract. However, some laboratory studies suggest that formaldehyde may affect the lymphatic and hematopoietic systems. Based on both the epidemiologic data from cohort and case-control studies and the experimental data from laboratory research, NCI investigators have concluded that exposure to formaldehyde may cause leukemia, particularly myeloid leukemia, in humans.

In addition, several case-control studies, as well as analysis of the large NCI industrial cohort, have found an association between formaldehyde exposure and nasopharyngeal cancer, although some other studies have not. Data from extended follow-up of the NCI cohort found that the excess of nasopharyngeal cancer observed in the earlier report persisted.

Earlier analysis of the NCI cohort found increased lung cancer deaths among industrial workers compared with the general U.S. population. However, the rate of lung cancer deaths did not increase with higher levels of formaldehyde exposure. This observation led the researchers to conclude that factors other than formaldehyde exposure might have caused the increased deaths. The most recent data on lung cancer from the cohort study did not find any relationship between formaldehyde exposure and lung cancer mortality.

What has been done to protect workers from formaldehyde?

In 1987, OSHA established a Federal standard that reduced the amount of formaldehyde to which workers can be exposed over an 8-hour workday from 3 ppm to 1 ppm. In May 1992, the standard was amended, and the formaldehyde exposure limit was further reduced to 0.75 ppm.

How can people limit formaldehyde exposure in their homes?

The EPA recommends the use of "exterior-grade" pressed-wood products to limit formaldehyde exposure in the home. These products emit less formaldehyde because they contain phenol resins, not urea resins. (Pressed-wood products include plywood, paneling, particleboard, and fiberboard and are not the same as pressure-treated wood products, which contain chemical preservatives and are intended for outdoor use.) Before purchasing pressed-wood products, including building materials, cabinetry, and furniture, buyers should ask about the formaldehyde content of these products. Formaldehyde levels in homes can also be reduced by ensuring adequate ventilation, moderate temperatures, and reduced humidity levels through the use of air conditioners and dehumidifiers.

Importance of Air Conditioning in Operation Theatres in Healthcare Organizations

As per NABH guidelines, operation theatres have been divided into 2 groups:

1. **Type A (Erstwhile Super speciality OT):** Type A OT means operation threatres for Neurosciences, Orthopedics (Joint Replacement), Cardiothoracic and Transplant Surgery (Renal, Liver, Heart etc.)
2. **Type B (Erstwhile General OT):** Type B OT means operation threatres for Opthalmology, Daycare surgeries, and all other basic surgical disciplines

Requirements – Type A (Erstwhile Super speciality OT)

1. **Air Changes Per Hour:**

- Minimum total air changes should be 20 based on biological load and the location.
- The fresh air component of the air change is required to be minimum 4 air changes out of total minimum 20 air changes
- If Healthcare Organization (HCO) chooses to have 100% fresh air system then appropriate energy saving devices like heat recovery wheel, run around pipes etc. should be installed.

2. **Air Velocity:** The airflow needs to be unidirectional and downwards on the OT table. The air face velocity of 25-35 FPM (feet per minute) from non-aspirating unidirectional laminar flow diffuser/ceiling array is recommended.
3. **Positive Pressure**: The minimum positive pressure recommended is 2.5 Pascal (0.01 inche of water). There is a requirement to maintain positive pressure differential between OT and adjoining areas to prevent outside air entry into OT. Positive pressure will be maintained in OT at all times (operational & non-operational hours).
4. **Air Handling in the OT including air quality**: Air is supplied through terminal HEPA (High Efficiency Particulate Air) filters in the ceiling. The HEPA can be at AHU level if it not feasible at terminal level inside OT. The minimum size of the filtration area should extend one foot on all sides of the OT table.
5. **Air Filtration**: The AHU (air handling unit) must be an air purification unit and air filtration unit. There must be two sets of washable flange type filters of efficiency 90% down to **10 microns** and 99% down to **5 microns** with aluminium / SS304 frame within the AHU. The necessary service panels to be provided for servicing the filters, motors & blowers. HEPA filters of efficiency 99.97% down to **0.3 microns** or high efficiency are to be provided. Air quality at the supply i.e. at grille level should be Class 100/ISO Class 5 (at rest condition). Note: Class 100 means a cubic foot of air should not have more than 0.5 microns or larger.
6. **Temperature & Relative Humidity**: It should be maintained $21^0C \pm 3^0C$ (except for joints replacement where it should be $18^0C \pm 2^0C$) with corresponding relative humidity between 20 to 60%, though the ideal RH is considered to be 55%. Appropriate devices to monitor and display these conditions inside the OT may be installed.

REQUIREMENTS – Type B (Erstwhile General OT)

1. **Air Changes per Hour**: Same as Type A OT requirements above
2. **Air Velocity**: Same as Type A OT requirements above
3. **Positive Pressure**: Same as Type A OT requirements above
4. **Air Filtration**: The AHU (i.e. air handling unit) must be air purification unit and air filtration unit. There must be two sets of washable flange type filters of efficiency 90% down to **10 microns** and 99% down to **5 microns** with aluminium/SS304 frame within the AHU. The necessary service panels to be provided for servicing the filters, motors & blowers. HEPA filters of efficiency 99.97% down to **0.3 microns** or higher efficiency may be provided. The air quality at the supply i.e. at grille level should be Class 1000/ISO Class 6 (at rest condition). Note: Class 1000 means a cubic foot of air must have no more than 1000 particles

measuring 0.5 microns or higher.

5. **Temperature & Humidity**: The temperature should be maintained at $21^0C \pm 3^0C$ inside the OT at all times with corresponding relative humidity between 20 to 60%. Appropriate devices to monitor and display these conditions inside the OT may be installed.

Design considerations for Operation Theatres

A. The AHU of each OT should be dedicated one and should note be linked to air conditioning of any other area in the OT and surroundings.

✓ One AHU for multiple OTs is permitted provided there is a back-up/contingency plan to accommodate surgeries in other OTs in the eventuality of failure of infection control in these OTs. Redundancy in terms of multiple fans for return and input air with UPS and DG set supply is provided to such type of common AHU. Direct drive fans will be required in such common AHU. The specific evidence of validation for the above will have to be provided either by the vendor/third party.

B. Outdoor Air Intakes: The location of outdoor air intake for an AHU must not be located near potential contaminated sources like DG exhaust hoods, lab exhaust vents, and vehicle parking area.

C. Window & split A/c **should not** be used in any type of OT because they are pure recirculating units and have pockets for microbial growth, which cannot be sealed.

D. For old constructions and for retrofitting (constructed/renovated prior to 2015)

1. Where space is a constraint, ceiling suspended AHU is permitted provided there is accessibility for maintenance of filters and other parts of AHU.
2. Dx unit with AHU is recommended for OTs where retrofitting solution is possible. It is also recommended as cost effective solution for OTs in **SHCO/Eye care** hospitals.
3. All requirements spelt out for new constructions and Type A and Type B OTs above in terms of air changes, particle count, positive pressure, temperature, humidity and air velocity will have to be met by such OTs in old constructions/HCOs.

E. During the non-functional hours AHU blower will be operational round the clock (may be without temperature control). Variable frequency devices (VFD) may be used to conserve energy. Air changes can be reduced to **25%** during non-operating hours thru VFD provided positive pressure relationship is not disturbed during such period.

Maintenance of the system

Validation of system should be done every 6 months and as per ISO 14644 standards. This should include:

✓ Temperature and humidity
✓ Air particulate count
✓ Air change rate calculation
✓ Air velocity at outlet of terminal filtration unit/filters
✓ Pressure differential levels of the OT with respect to ambient/adjoining areas
✓ Validation of HEPA filters by appropriate tests

Preventive maintenance of the system: It is recommended that periodic preventive maintenance be carried out in terms of cleaning pre filters, micro vee filters at the interval of 30 days. Preventive maintenance of all the parts of AHU is carried out as per manufacturer recommendations.

References:

ANSI/ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) /ASHE standards 170-2017.

Previous NABH guidelines for air conditioning in operation theatre 2015

Memarazadeh I,and A. Manning 2002. Comparison of operating room ventilation systems in the protection of surgical site.

HVAC Design Manual for hospitals and clinics 2nd edition, ASHRAE 2016.

CPWD design guidelines HVAC guide 2017 Ministry of Public works New Delhi 2017.

Highlights of the coming issue

Published by D.G. Tripathi, Edited by Akshaya Tendulkar for and on behalf of Tulip Diagnostics (P) Ltd., Tulip House, Dr. Antonio Do Rego Bagh, Alto Santacruz, Bambolim Complex, Post Office Goa- 403 202, India. Fax: 0832 2458544, **Website: www.tulipgroup.com.**