Difference Between CFU and MPN

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Key Difference - CFU vs MPN

Colony forming unit (CFU) and Most probable number (MPN) are two methods used to enumerate microorganisms in samples. Both parameters are used to detect water quality and fecal indicator bacteria in water samples. Colony forming unit is a measure used to enumerate the number of viable bacterial cells or fungal cells in specific volume or weight of a given sample. The standard unit for this parameter is CFU/ml or CFU/g. Most probable number is another unit used to measure the number of viable bacterial cells in a liquid sample. The key difference between CFU and MPN is that **CFU is calculated from the bacterial and fungal colonies growing on a solid agar plate** while **MPN is calculated from viable bacteria growing in a liquid medium.**

What is CFU?

Colony forming unit (CFU) is a parameter which measures the number of viable bacterial or fungal cells in a given sample. The method which counts colony forming units is referred as standard plate count. The viable colonies that appear on the agar plates are expressed as CFU per 1 ml (colony forming unit per milliliter) of the sample for liquids or CFU per 1 g (colony forming unit per one gram) of the sample for solids.

There are two common methods used to measure CFU in a sample. They are **spread plate method** and **pour plate method.** These two methods are supported by a technique called serial dilution. Serially diluted samples enable obtaining a countable number of colonies on the agar surface. A known volume of sample can be spread onto the surface of an agar plate, or mixed with agar and poured onto a plate. The plate is then incubated and the arising colonies are counted. The number of colonies relates to the number of microorganisms within the original sample. The plates which show too many colonies or too few colonies are excluded from counting because the results may not statistically accurate on those plates. Statistically, the best range is 30 – 300 colonies on an agar plate. Hence, the correct plates should be selected for accurate enumeration. Serial dilution is performed for the above function.

Once you count the number of viable colonies on plates, CFU/ml can be calculated using the following equation.

CFU per ml of original sample = number of colonies on a plate X dilution factor

Dilution factor = (1/ Dilution of the plate)

For example, if you get 149 colonies on the plate of the 10^{-4} dilution, then the number of bacteria in 1 ml of the original sample can be calculated as follows:

CFU/ml = (149) x ($1/10^{-4}$)

= 149×10^4 or 1490000

= 1. 49 x 10^6

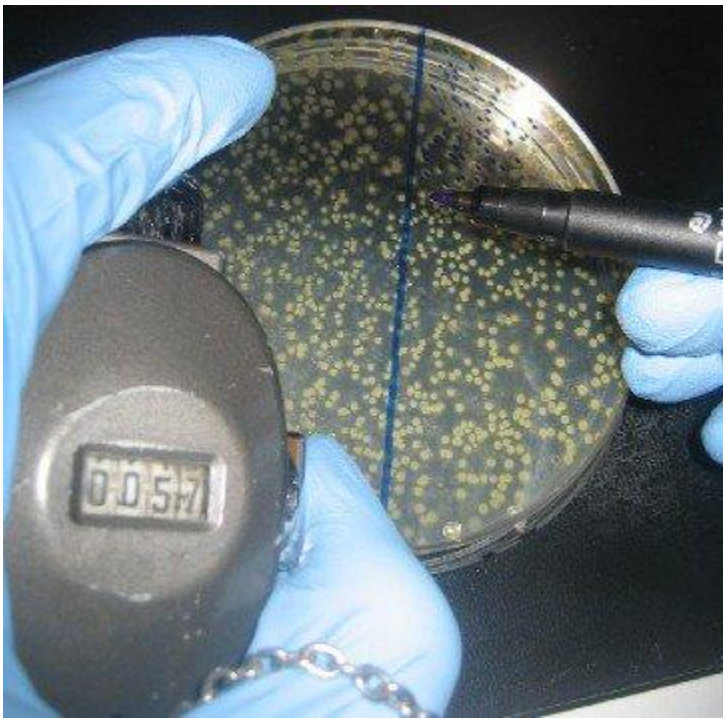

Figure 01: Colony Forming Unit

What is MPN?

The **most probable number** is an alternative measure to CFU/ml. MPN also estimates the viable cells in a liquid sample. It counts organisms growing in a liquid culture and is a predominantly bacteriological technique. This method is particularly useful for samples which contain low concentrations of bacterial cells; for example, milk, potable water etc. MPN value is expressed for 100 ml of volume. MPN relies on a statistical method based on probability theory. There are statistical tables designed to find MPN values per 100 ml of the sample. These tables show the results at 95% confidence limits.

MPN value is calculated after performing a technique called multiple tube fermentation method. Three sets of tubes containing a suitable culture medium are inoculated with three different volumes of the sample such as 10 ml, 1 ml, and 0.1 ml and incubated for the growth. After the incubation period, tubes are scored + (positive) or – (negative) for the presence or absence of growth. The pattern of positive and negative results are then compared with an MPN table of statistical probabilities to estimate the number of microorganisms. Then MPN value is given for 100 ml of the sample. MPN is widely used to detect coliform bacteria present in water samples.

Most Probable Number Table					
Number of tubes giving a positive reaction for a 5-tube set			MPN (per 100 ml)	95% Confidence Limits	
10 ml	*1 ml*	*0.1 ml*		*Low*	*High*
0	0	0	<2	<1	7
0	1	0	2	<1	7
0	2	0	4	<1	11
1	0	0	2	<1	7
1	0	1	4	<1	11
1	1	0	4	<1	11
1	1	1	6	<1	15
2	0	0	5	<1	13
2	0	1	7	1	17
2	1	0	7	1	17
2	1	1	9	2	21
2	2	0	9	2	21
2	3	0	12	3	28
3	0	0	8	1	19
3	0	1	11	2	25
3	1	0	11	2	25
3	1	1	14	4	34
3	2	0	14	4	34
3	2	1	17	5	46
3	3	0	17	5	46
4	0	0	13	3	31
4	0	1	17	5	46
4	1	0	17	5	46
4	1	1	21	7	63
4	1	2	26	9	78
4	2	0	22	7	67
4	2	1	26	9	78
4	3	0	27	9	80
4	3	1	33	11	93
4	4	0	34	12	93
5	0	0	23	7	70
5	0	1	31	11	89
5	0	2	43	15	110
5	1	0	33	11	93
5	1	1	46	16	120
5	1	2	63	21	150
5	2	0	49	17	130
5	2	1	70	23	170
5	2	2	94	28	220
5	3	0	79	25	190
5	3	1	110	31	250
5	3	2	140	37	340
5	3	3	180	44	500

Figure 02: MPN table

What is the difference between CFU and MPN?

CFU vs MPN	
CFU is a measure used to express the number of viable bacterial or fungal colonies in a given sample.	MPN is an alternative measure to CFU and measures the number of viable bacterial cells in a liquid sample.
Unit	
CFU/ml or CFU/g	MPN/100 ml
Calculation	
CFU is calculated by counting the number of colonies grown on agar plates.	MPN is calculated by comparing positive and negative patterns of the tubes with MPN statistical table.
Serial Dilution Technique	
Serial dilution is performed before placing the samples on agar plates.	Serial dilution is not normally performed when MPN is calculated

Methods	
Spread plate method and pour plate method are two types of methods perform to obtain CFU.	Multiple tube fermentation is the method performs to obtain MPN value.

Summary - CFU vs MPN

Measuring the microbial growth is required for many reasons. In food processing plants, it is necessary to measure the level & type of microorganisms in food. In food industry and medicine, it is necessary to ensure that sterilization treatments are effectively applied. In sewage treatment plants, it is required to take microbial count routinely. When optimizing procedure in molecular biology, it is required to measure the number of colonies on plates. Hence, there are different enumeration and growth measurement methods available. CFU and MPN are two such methods widely adopting in various fields. CFU is a measure of the number of viable bacterial and fungal colonies present in a given sample. It is calculated using standard plate count method or viable plate count method. MPN is another measure which expresses the number of bacterial cells present in a given volume of the liquid sample. It is calculated using multiple tube fermentation method and MPN table. This is the difference between CFU and MPN.

References:

1. "Colony-forming unit." Wikipedia. Wikimedia Foundation, 28 May 2017. Web. Available here. 01 June 2017.
2. "Microbiology - 014 - Most Probable Number." Microbiology - 014 - Most Probable Number | Microbiology Undergraduate Program. N.p., n.d. Web. Available here. 01 June 2017.

Image Courtesy:

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