Hypothesis testing:

Hypothesis testing;

The purpose of hypothesis testing is to help (aid, lead) the clinician, the researcher, or the administrator in reaching a decision concerning a population by examining a sample from that population

It involves conducting a test of statistical significance and qualifying the degree to which sampling variability may account for the results observed in a particular study

Hypotheses; May be defined simply as a statement about one or more populations, it is usually concerned with the parameters of the population about which the statement is made and by means of hypothesis testing one can determine whether or not such statements are compatible with the available data, researchers are concerned with two types of hypotheses;

Types of hypothesis

1. **Research hypothesis**
2. **Statistical hypothesis**

Research hypothesis; is the supposition (conjecture) that motivates the researcher to do a research, it may be the result of years of observations, clinical experience, or from scientific speculation

Research projects often result from the desire of health practitioners to determine whether or not their theories or suspicions can be supported when subjected to the rigors or scientific investigations

For example, the birth weight of newborn babies born to diabetic mothers;
4.3;
4.5;
4.7;
and 5 kilograms,
and for many newborn babies of diabetic mothers it tends to be higher than 3.5 Kg, which is higher than the normal mean of birth weight of healthy newborn babies especially of non diabetic mothers

- **Research hypothesis here form the desire to determine whether or no the suspicions of the researcher, that the mother condition (being diabetic) had effect on birth weight, can be supported when subjected to scientific investigation**

So research hypothesis leads directly to the statistical hypothesis (the hypothesis that is going to be tested through certain statistical procedures), later on the statistical hypotheses evaluated by appropriate statistical techniques

Test of significance;

There are many tests of significance developed and utilized. Most common are "Z" test or "normal curve test", student's "t" test. Chi-square test "χ^2", F-test (ANOVA), etc .....

Procedure and steps;

The steps involved, in general may be presented as a **SEVEN-STEPS** procedure, in the utilization of any test of significance are;

1=Data

The nature of the data that form or represent the basis of testing is determined and well understood. The data must be determined whether quantitative or qualitative, and it is presented in mean, SD for quantitative data, and in frequency and proportion for the qualitative data

2=Assumptions;

The assumptions that are of importance in hypothesis testing include;
 a-Randomly selection of a sample
 b-Independence of samples
 c-Normality distribution of the population
 d-Equality of variances of the populations

And each test of significance has its own proper assumption

3=Hypothesis;

We have two types of statistical hypotheses;

a- Null hypothesis
b- Alternative hypothesis

Null hypothesis (H_o);

The hypothesis to be tested, symbolized by (H_o) which is defined as the hypothesis of no difference, it is a statement of agreement with (or no difference) conditions presumed to be true in the population of interest

The samples or populations being compared in an experiment, study or test are similar. Any difference occurs is related to chance and not to any other factor

Ho is either not rejected (meaning that the data tested do not provide sufficient evidence to cause rejection) or it is rejected (data are not compatible with, but are supportive to some other hypothesis which is the alternative hypothesis)

Alternative hypothesis (H$_A$);

It is the hypothesis of difference (so it is the hypothesis adopted when we reject Ho). It is important to remember that when we fail to reject Ho, we do not say that it is true; but that it may be true (the data fail to support our decision or our suspicion)

If m1 = m2 → this is → H$_o$ (No difference)

If m1 ≠ m2 → this is → H$_A$ (Difference)

In general statistical inference leads to the proof of a hypothesis, it merely indicates whether the hypothesis is supported or is not supported by the available data. When we fail to reject a null hypothesis, therefore we do not say that it is true, but that it is may be true

4=Level of significance;

It specifies the area under the curve of the distribution of test statistics that represent the basis on which determination of the rejection region and acceptance region for the tested data
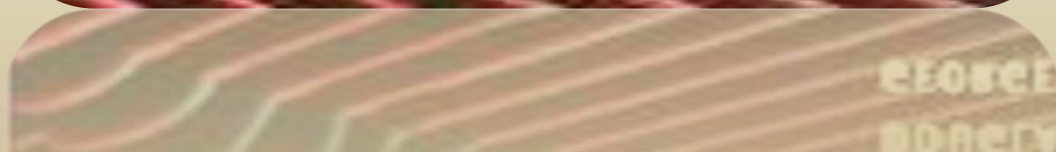
A tabulated value "critical value" is going to be obtained from certain tables (each test has its own table to obtain the tabulated value) according to the level of significance (α) "0.05, 0.025, 0.01" and according to the degree of freedom
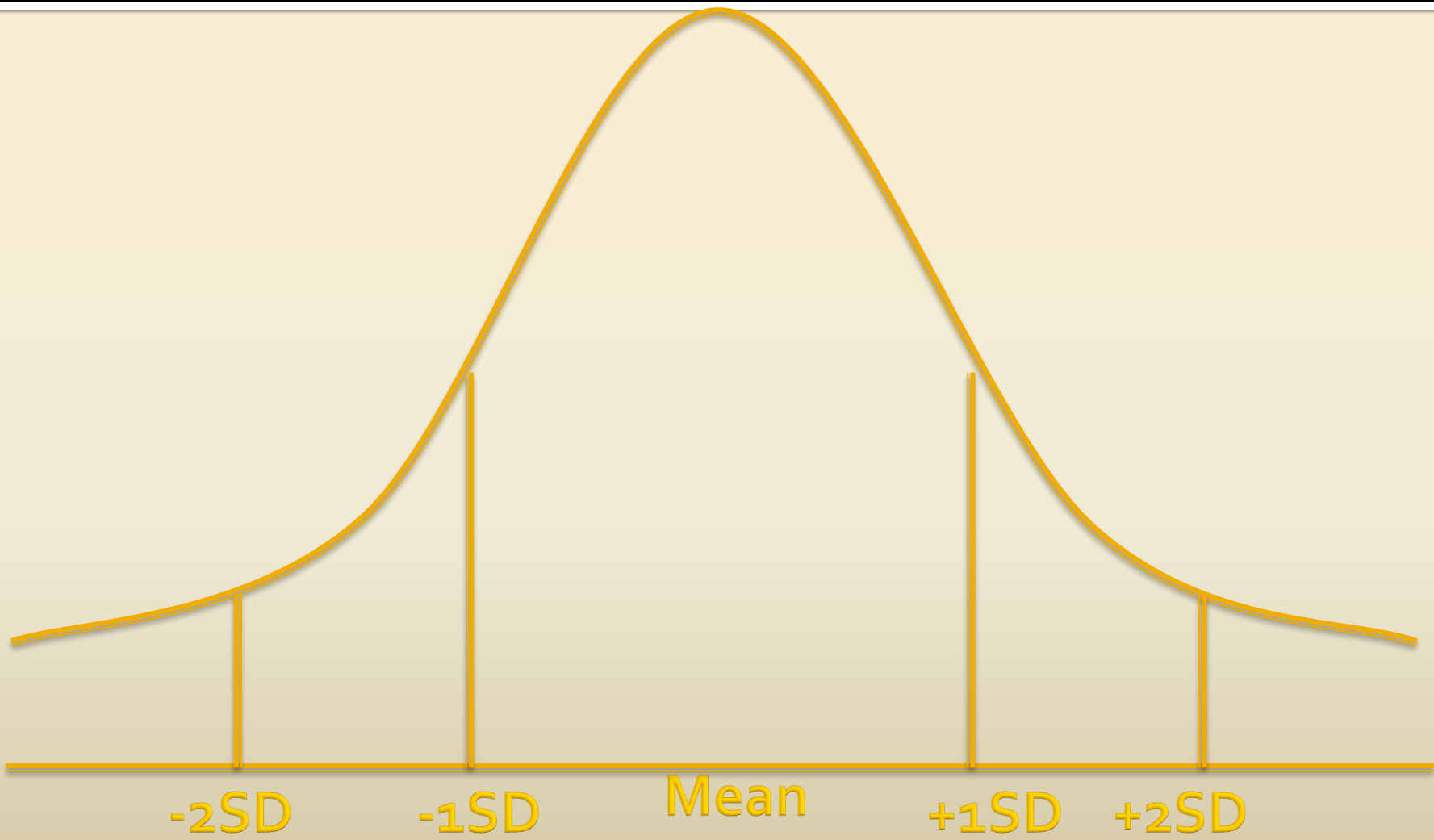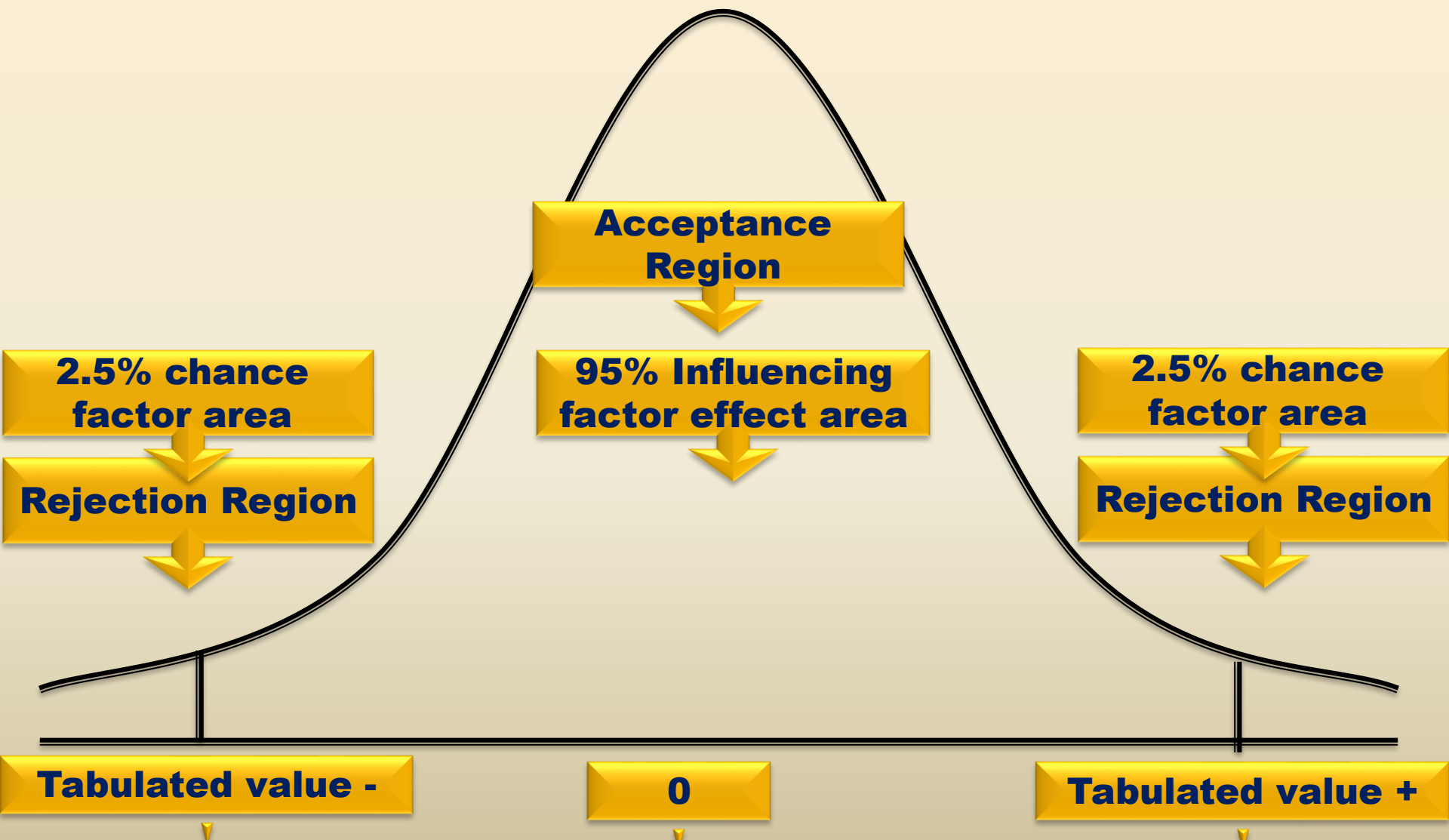
Acceptance Region

2.5% chance factor area

95% Influencing factor effect area

2.5% chance factor area

Rejection Region

Rejection Region

Tabulated value -

0

Tabulated value +
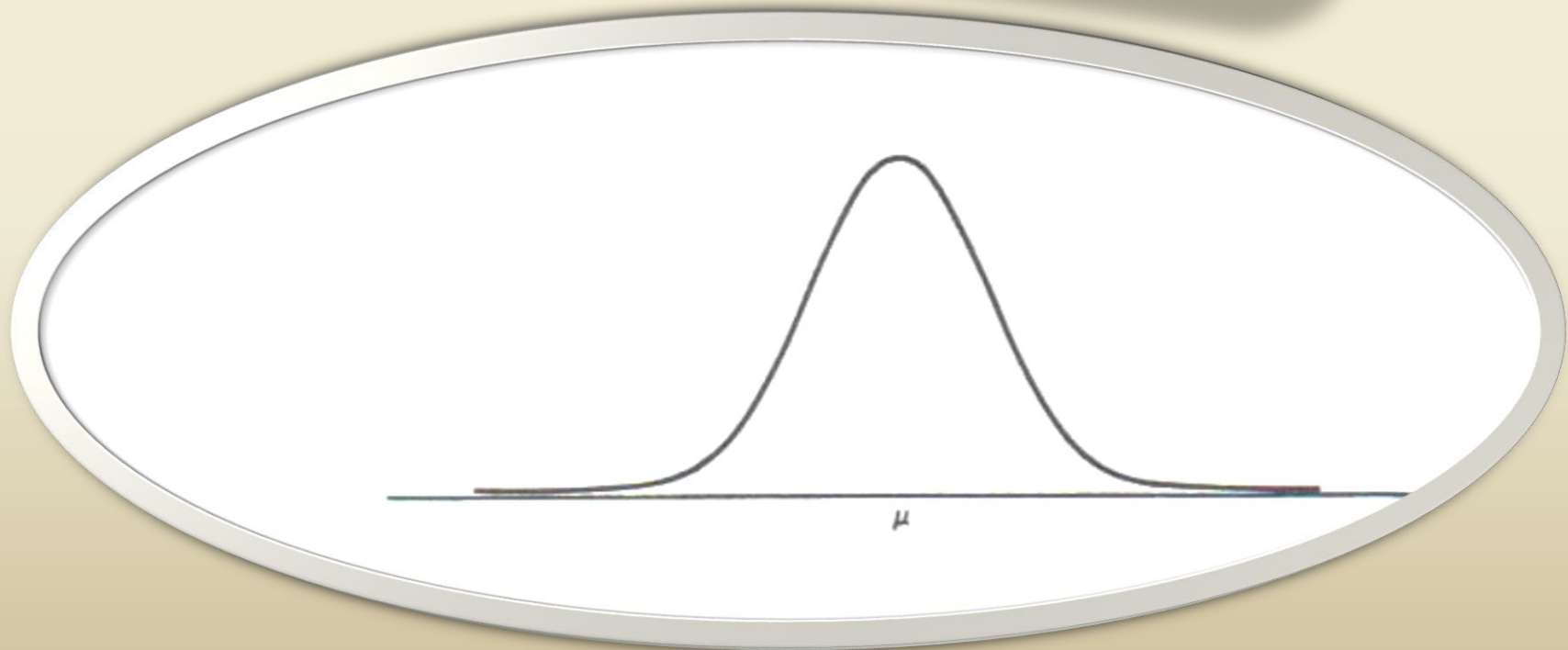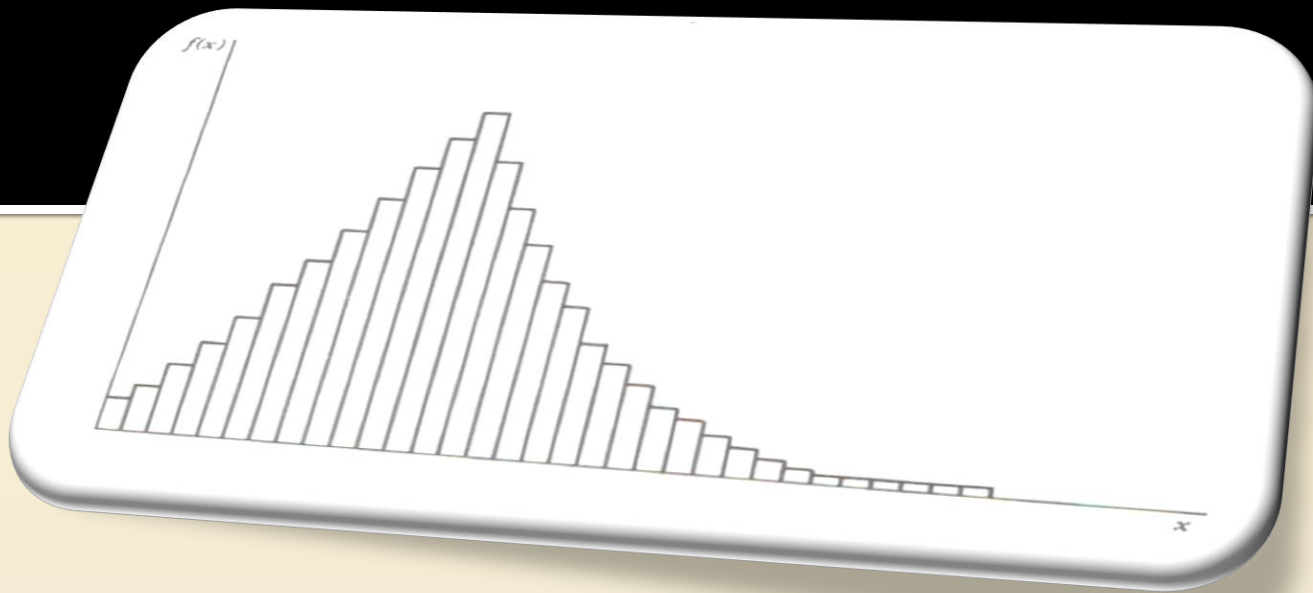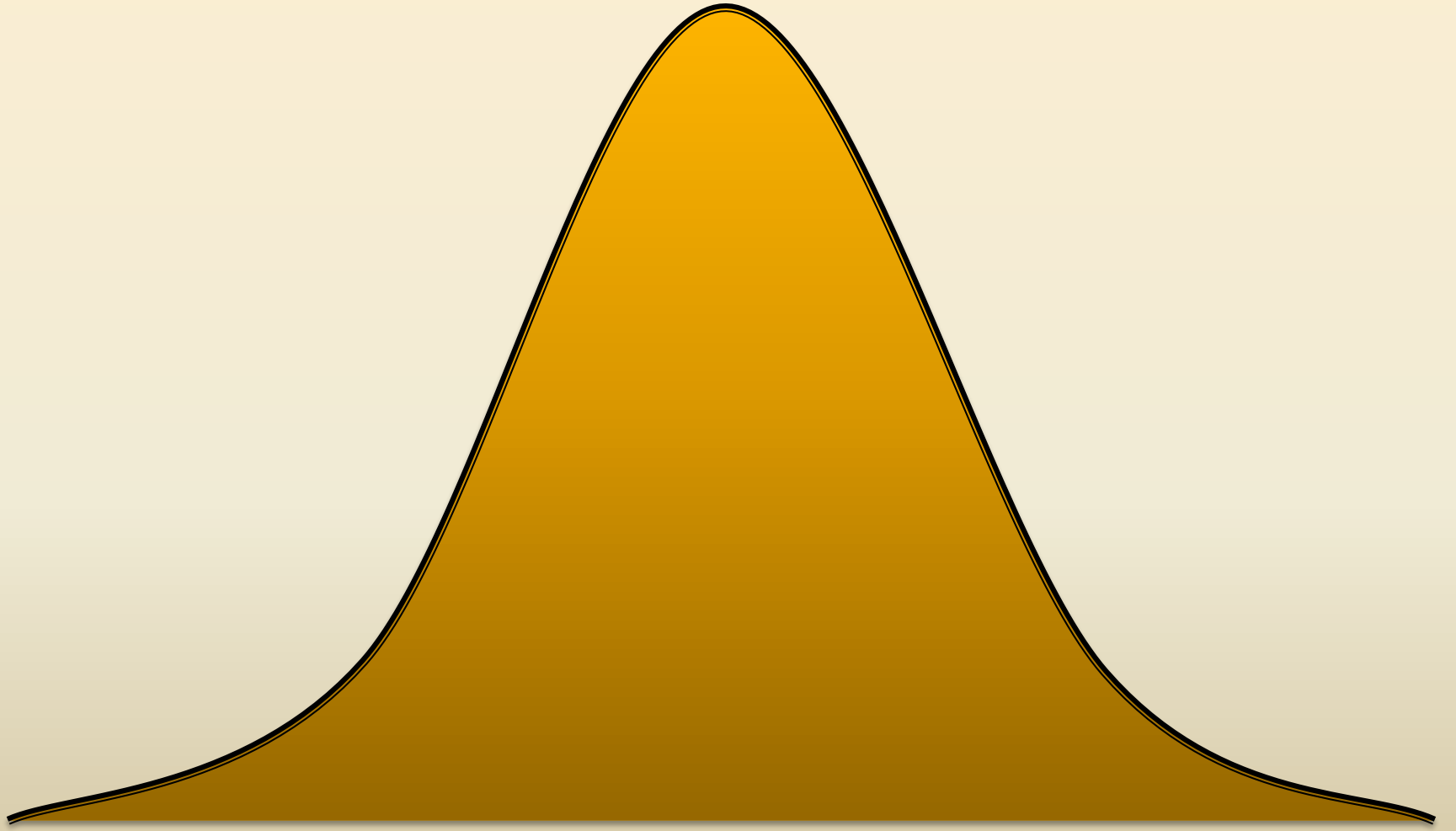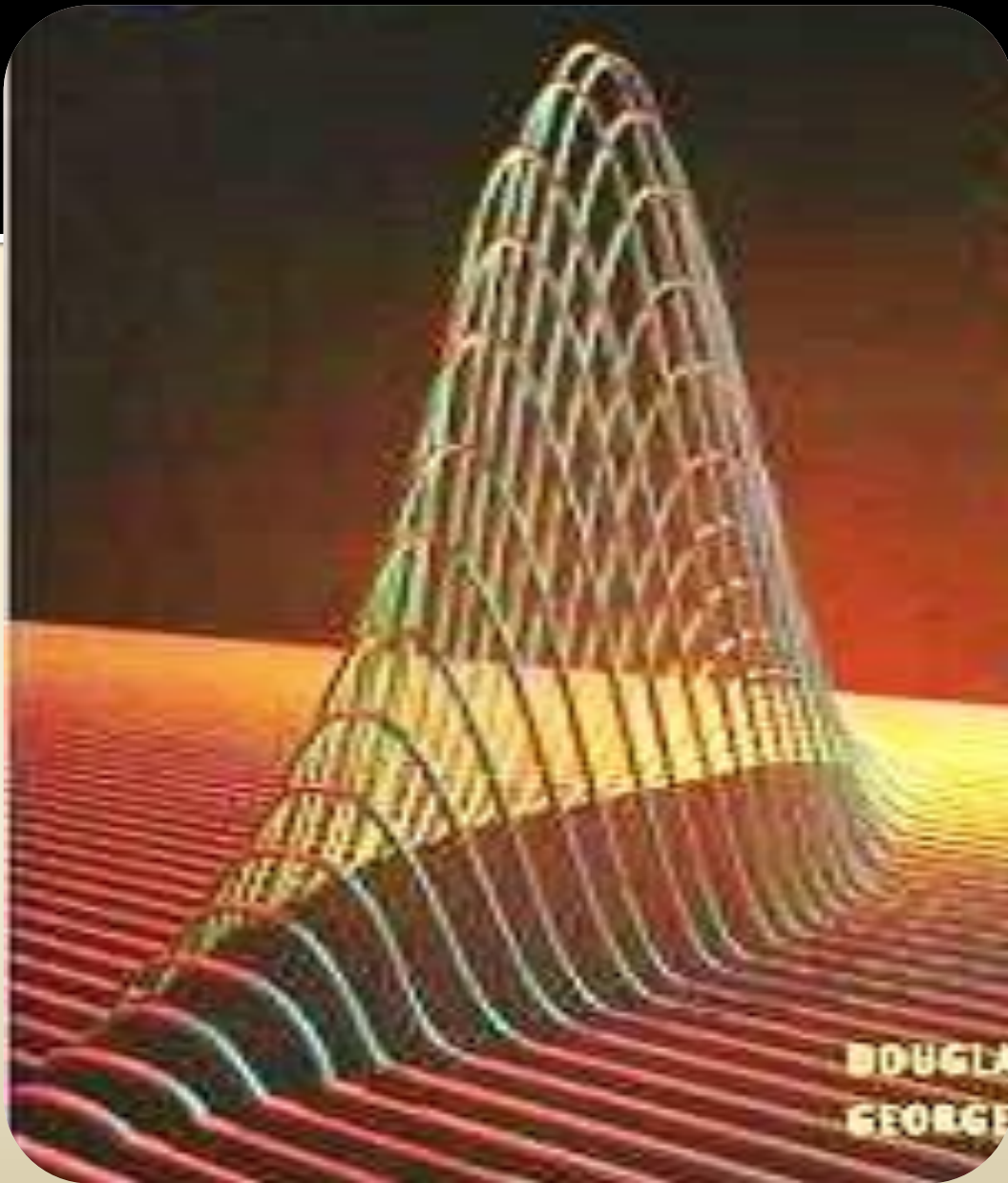
It is defined as α, the level of significance, α specify the area under the curve of the distribution of the test of statistical significance, that above the value is the rejection region of Ho

α is a probability of rejecting a true null hypothesis, and since it is an error we should make it small, so we select a small values of α, in order to make the probability of rejecting a true null hypothesis small, the more frequently used values of α are 0.05 (5% chance factor), 0.025 (2.5% chance factor), and 0.01 (1% chance factor)

Reject Ho → if it is true it is called Type I error, or α type of error

Accept Ho → if it is false it is called Type II error, or β type of error

α Type of error: It is the probability of rejecting null hypothesis although it is really true.

β Type of error: It is the probability of accepting null hypothesis although it is really false.

Conclusion of significance testing	Reality	
	Ho is True	**Ho is False**
Reject Ho		
Accept Ho		

The probability that we do not make a type II error ($100-\beta\%$) is called the power of the test, and increasing sample size will increases the power, since the sampling distribution curve would be taller and narrower and therefore overlaps less

5=Apply the proper test of significance;

In which the data derived from the sample is used to compute the difference, the value will make he decision of reject or not reject Ho

The selection of the appropriate test to be utilized and calculation of the test criterion based on the type of data

There are many tests of significance, the most common are "Z" test, "t" test, "χ^2", F-test, …

From applying the test we are going to determine calculated value or called "test statistic" to be compared with the tabulated one obtained at the step of level of significance

6- Statistical decision;

a... **P value determination**; in which we calculate the magnitude of P value (which is the probability of effect of chance factor) that depend on the level of significance

In biostatistics and medicine we use to make it as 0.05 or less as the level of significance

6- Statistical decision;

b... **Decision of reject or accept Ho;** Comparison of the calculated test criterion value with that of the theoretical value at 5%, 1%.

-If the calculated test criterion value is higher than the theoretical value of the level of significance point so we fall in the rejection region and the P value is ≤ 0.05, so we reject Ho and the H_A is accepted
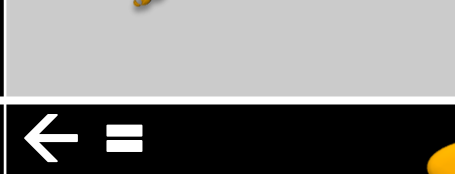
-If the calculated test criterion value is lower than the theoretical value of the level of significance point so we fall in the acceptance region and the P value is > 0.05, so we accept Ho

Reject or Accept

Drawing of the conclusion (or inference) on the basis of level of significance is deciding whether the difference observed is due to chance or due to some other known factors

The value of the calculated test statistic tells us to reject Ho if it falls in the rejection region (larger than the value determined by α) and not to reject (or accept) Ho if the calculated value falls in the acceptance region (less than the value determined by α)

Conclusion

Calculated > Tabulated	Calculated = Tabulated	Calculated < Tabulated
P	P	P>0.05
A	A	A
Th...is ←		Th...no
T...s ← =		T...no

7=Conclusion

-If Ho is rejected so we conclude that H_A is true

-If Ho is not rejected so we conclude that Ho may be true

Notice

Meaning of statistically significant and not statistically significant results; statistical significance is not synonymous with biologic or clinical relevance, conversely, the failure to demonstrate statistical significance does not rule out the existence of a clinically important difference between two populations

Important;

Any difference, however small, may be found statistically significant (unlikely to have occurred by random chance) if the sample size (n) is sufficiently large

However, a difference of small magnitude, while statistically significant, may not be clinically important

Emphasize

Hypothesis testing purpose is to assist us in making decision, we must emphasize that, however, the outcome of the statistical test is, it represent only one piece of evidence that influence our decision

Emphasize

The statistical decision should not be interpreted as definitive, but should be considered along with all the other relevant information available to the researcher (pathological, medical, cytological, microbiological, and immunological, etc....)