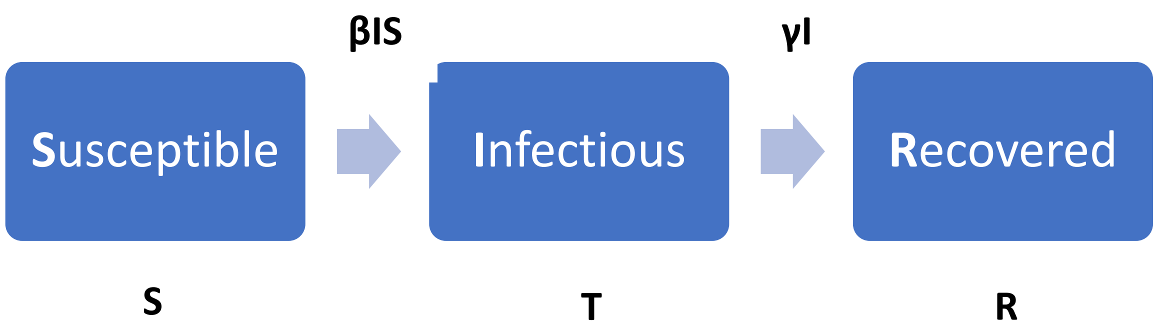
Epidemiology Models :

SIR model :

SIR model is a kind of compartmental model describing the dynamics of infectious disease. You may wonder why it is called the "compartmental model." The model divides the population into compartments. Each compartment is expected to have the same characteristics. SIR represents the three compartments segmented by the model.

- **S**usceptible
- **I**nfectious
- **R**ecovered

Susceptible is a group of people who are vulnerable to exposure with infectious people. They can be patient when the infection happens. The group of **infectious** represents the infected people. They can pass the disease to susceptible people and can be recovered in a specific period. **Recovered** people get immunity so that they are not susceptible to the same illness anymore. SIR model is a framework describing how the number of people in each group can change over time.



SIR model allows us to describe the number of people in each compartment with the ordinary differential equation. β is a parameter controlling how much the disease can be transmitted through exposure. It is determined by the chance of contact and the probability of disease transmission. γ is a parameter expressing how much the disease can be recovered in a specific period. Once the people are healed, they get immunity. There is no chance for them to go back susceptible again.

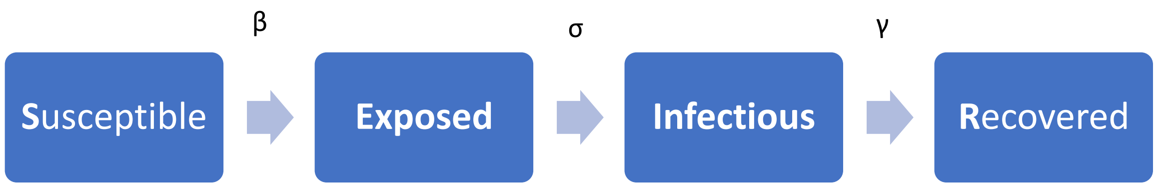
$$\frac{dS}{dt} = -\beta IS$$

$$\frac{dI}{dt} = \beta IS - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

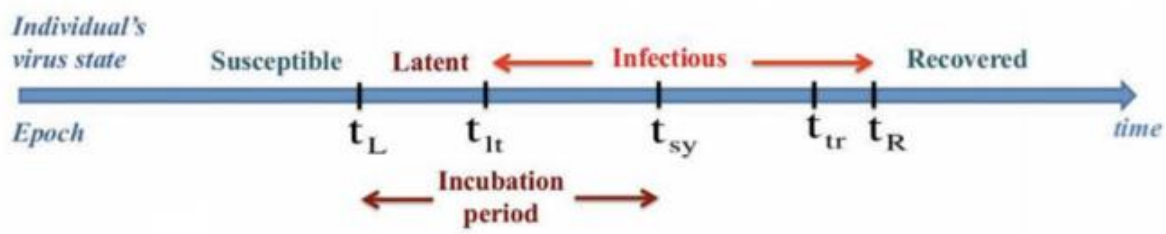
SIER Model :

Here we will briefly discuss the properties of basic Susceptible-Exposed-InfectedRemoved (SEIR) system that will be used to describe the recent outbreak of COVID-19 in Moroco. We considered a simple SEIR epidemic model for the simulation of the infectious disease spread. Individuals were each assigned to one of the following disease states; Susceptible (S), Exposed (E), Infections (I) and Removed (R) which refers to segment not yet infected and diseasefree, individuals that are experiencing incubation duration, the confirmed (isolated) cases, recovered individuals, respectively. The SEIR diagram shows how individuals move through each compartment in the model.



α is the conversion parameter for exposed individuals that transformed into infected ones.

Figure shows the diagrammatic representation of virus progress in an individual, where infectious occurs at t_L, during the latent period, infected individual is not infectious, and at t_{sy}, symptoms appear . The first transmission to the left healthy individuals is at t_{tr}. After t_{R},, the removed (recovered) people are considered no longer infectious.



Virus progress in an individual by using the SEIR model

We can describe the virus transmission by the following nonlinear ordinary differential equation as shown in equation below

$$\frac{dS}{dt} = -\frac{\beta SI}{N},$$

$$\frac{dE}{dt} = \frac{\beta SI}{N} - \sigma E,$$

$$\frac{dI}{dt} = \sigma E - \gamma I,$$

$$\frac{dR}{dt} = \gamma I,$$

Modified SEIRD model considering quarantine lockdown (SEIRD-Q) :

This is a modified model which takes into account the elimination rate of susceptible, exposed and infected individuals in quarantine. The main assumption is that this conversion is under a constant elimination parameter (by time, ie 1 / times), and after the conversion, the individual becomes "recovered" and can no longer transmit disease. The new system is written :

$$\begin{aligned}
\dot{S} &= -\beta SI - \gamma SE - \omega S \\
\dot{E} &= \beta SI - \alpha E + \gamma SE - \omega E \\
\dot{I} &= \alpha E - \zeta I - \delta I - \omega I \\
\dot{R} &= \zeta I + \omega(S + E + I) \\
\dot{D} &= \delta I
\end{aligned}$$

ω is the conversion rate parameter for Susceptible, Exposed and Infected individuals that becomes Recovered due to a removal to a quarantine.