In [1]:
```
import numpy as np
import pandas as pd
import plotly.express as px
import matplotlib.pyplot as plt
from scipy.integrate import solve_ivp
```

In [2]:
```
#Parameters value

lamda=706994
mu=0.006017
delta=0.20
beta=0.9
sigma=0.125
eta=0.8
p=0.93
alpha=0.58
N=27139076
```

In [3]:
```
#Initial condition

S0=17055439
E0=156312
I0=19539
R0=15631
V0=9892155
```

In [4]:
```
#Define SEIRV Model

def f(t,y):

    S=y[0]
    E=y[1]
    I=y[2]
    R=y[3]
    V=y[4]

    dSdt=              lamda - (beta*S*I)/N - alpha*S - mu*S
    dEdt= (beta*S*I)/N + ((1-p)*beta*V*I)/N - sigma*E - mu*E
    dIdt=                    sigma*E - eta*I - delta*I - mu*I
    dRdt=                                p*V + eta*I - mu*R
    dVdt=          alpha*S - ((1-p)*beta*V*I)/N - p*V - mu*V

    return np.array([dSdt,dEdt,dIdt,dRdt,dVdt])
```

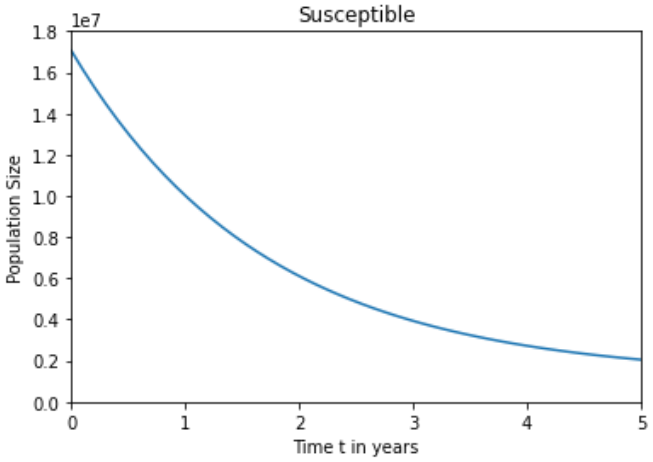
In [5]:
```
#Solve SEIRV Model

t_span=np.array([0,5])
t_eval=np.linspace(t_span[0],t_span[1])
y0=np.array([S0,E0,I0,R0,V0])

sol=solve_ivp(f,t_span,y0,method='RK45',t_eval=t_eval)
t=sol.t
S=sol.y[0]
E=sol.y[1]
I=sol.y[2]
R=sol.y[3]
V=sol.y[4]
```

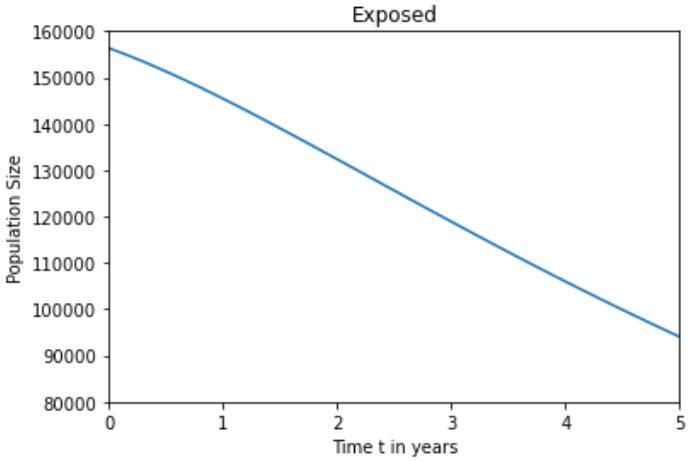
In [6]:
```
#Plot Susceptible
plt.title('Susceptible')
plt.xlabel('Time t in years')
plt.ylabel('Population Size')
plt.xlim(0,5)
plt.ylim(0,18*pow(10,6))
plt.plot(t, S)
```

Out[6]:
```
[<matplotlib.lines.Line2D at 0x22f4e3e160>]
```



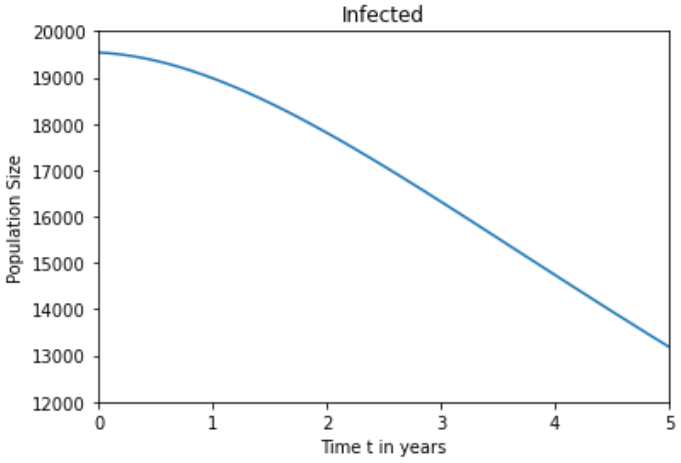
In [7]:
```
#Plot Exposed
plt.title('Exposed')
plt.xlabel('Time t in years')
plt.ylabel('Population Size')
plt.xlim(0,5)
plt.ylim(0.8*pow(10,5),1.6*pow(10,5))
plt.plot(t, E)
```

Out[7]: [<matplotlib.lines.Line2D at 0x22f4f1baf0>]



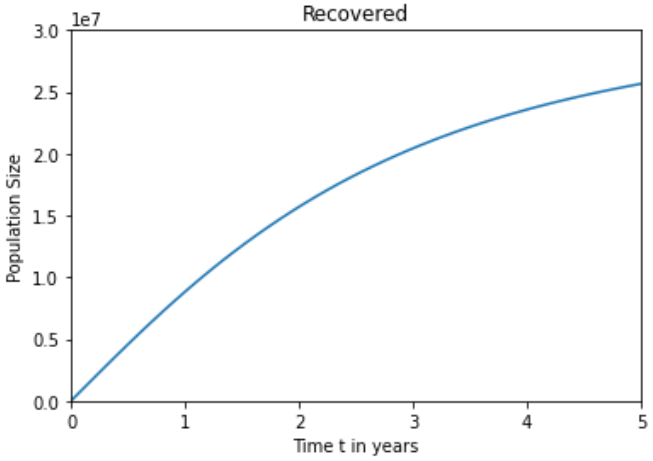
In [8]:
```
#Plot Infected
plt.title('Infected')
plt.xlabel('Time t in years')
plt.ylabel('Population Size')
plt.xlim(0,5)
plt.ylim(1.2*pow(10,4),2.0*pow(10,4))
plt.plot(t, I)
```

Out[8]: [<matplotlib.lines.Line2D at 0x22f4f78d00>]



In [9]:
```
#Plot Recovered
plt.title('Recovered')
plt.xlabel('Time t in years')
plt.ylabel('Population Size')
plt.xlim(0,5)
plt.ylim(0,3*pow(10,7))
plt.plot(t, R)
```

Out[9]:
```
[<matplotlib.lines.Line2D at 0x22f4fdb0d0>]
```



In [10]:
```
#Plot Vaccinated
plt.title('Vaccinated')
plt.xlabel('Time t in years')
plt.ylabel('Population Size')
plt.xlim(0,5)
plt.ylim(0,12*pow(10,6))
plt.plot(t, V)
```

Out[10]:
```
[<matplotlib.lines.Line2D at 0x22f5ffe070>]
```