In [1]:
```python
import numpy as np
from scipy.integrate import odeint
from scipy.optimize import curve_fit
from scipy.optimize import differential_evolution
%matplotlib inline
import matplotlib.pyplot as plt
from matplotlib.backends.backend_pdf import PdfPages
import pandas as pd
```

In [2]:
```python
from endpoint_maker import sqres
from endpoint_maker import func
from endpoint_maker import t
from endpoint_maker import new
from endpoint_maker import lightdata
from endpoint_maker import rawdata
```

In [3]:
```python
if __name__ == '__main__':
    def initparams():
        #bounds = ([0.00001,10000],[0,4],[0.00001,1000],[0.00001,1000],[0.00001,100
        bounds = ([0.00001,1000],[0.00001,1000],[0.00001,10000],[0.00001,10000])
        result = differential_evolution(sqres,bounds,maxiter=100,popsize=20,polish=
        return result
```

In [4]:
```python
initialp = initparams()
print(initialp)
```

```
message: Maximum number of iterations has been exceeded.
success: False
    fun: 2.9696749412043038
      x: [ 1.286e+02  9.509e+02  5.694e+03  2.502e+03]
    nit: 100
   nfev: 8080
```

In [5]:
```python
#def tester(t,Kd,n,d2,k2,k3,i):
def tester(t,d2,k2,k3,k7,i):

    inivalues = [1,0,0,0,0,0,0]
    arrayvalues = np.asarray([])

    #for i in range(Len(lightdata[:,0])):
    def I(t):
        tindex = t/5
        if tindex > 12241:
            tindex = 12240
        return lightdata[i][int(tindex)]

    #def odes(z,t,Kd,n,d2,k2,k3):
    def odes(z,t,d2,k2,k3,k7):
        Pu,Pb,Pa,mRNA,mCherry1,mCherry2,mCherry3 = z
        d1 = 0.019905
        k1 = 0.08299
        Kd = 90.41
        n = 0.964487
        #d2= 486.67
```

```python
            #k2= 6.597
            #k3= 0.0539


            d3 = 0.000077
            k4 = 1.25
            d4 = 0.000031
            k5 = 0.00283
            k6 = 0.00283

            Pu = z[0]
            Pb = z[1]
            Pa = z[2]
            mRNA = z[3]
            mCherry1 = z[4]
            mCherry2 = z[5]
            mCherry3 = z[6]

            dPudt = d1*Pb - k1*I(t)*Pu - k7*I(t)*Pu
            dPbdt = k1*I(t)*Pu - k2*Pb - d1*Pb + d2*Pa
            dPadt = k2*Pb - d2*Pa + k7*I(t)*Pu
            dmRNAdt = k3*Pa - d3*mRNA
            dmCherry1dt = k4*mRNA-(d4 + k5)*mCherry1
            dmCherry2dt = k5*mCherry1-(d4+k6)*mCherry2
            dmCherry3dt = k6*mCherry2 - d4*mCherry3

            return [dPudt,dPbdt,dPadt,dmRNAdt,dmCherry1dt,dmCherry2dt,dmCherry3dt]

        #solver = odeint(odes,inivalues,t,args = (Kd,n,d2,k2,k3),hmax=0.1)
        solver = odeint(odes,inivalues,t,args = (d2,k2,k3,k7),hmax=0.1)

        mCherryout = solver[:,6]
        #mCherryout = mCherryout[0:24480:240]
        return mCherryout
```

```python
In [6]:  print(initialp.x)
```

```
[ 128.59949445  950.90049285 5693.8881506   2501.64041538]
```

```python
In [7]:  popt, covt = curve_fit(func,t,new,initialp.x,maxfev=1000000)

         #popt, covt = curve_fit(func,t,newdata,initialp.x, maxfev=10000000, bounds=((0.0000
         #popt, covt = curve_fit(func,t,newdata,initialp.x, maxfev=1000000)

         #Kd,n,d2,k2,k3 = popt
         #print('Kd=',Kd,'n=',n,'d2=',d2,'k2=',k2,'k3=',k3)

         #d3,k4,d4,k5,k6 = popt
         #print('d3=',d3,'k4=',k4,'d4=',d4,'k5=',k5,'k6=',k6)

         d2,k2,k3,k7 = popt
         print('d2=',d2,'k2=',k2,'k3=',k3,'k7=',k7)
```

```
C:\Users\Leandra\anaconda3\Lib\site-packages\scipy\integrate\_odepack_py.py:248: ODE
intWarning: Excess work done on this call (perhaps wrong Dfun type). Run with full_o
utput = 1 to get quantitative information.
  warnings.warn(warning_msg, ODEintWarning)
d2= 128.59949445334564 k2= 950.9004928545289 k3= 5693.888150603836 k7= 2501.64041538
1583
```

```
C:\Users\Leandra\anaconda3\Lib\site-packages\scipy\optimize\_minpack_py.py:1010: Opt
imizeWarning: Covariance of the parameters could not be estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```

In [8]:
```python
import sys
import numpy
#params = [1,1,1,1,1,1,1]
params = [1,1,1,1]
numpy.set_printoptions(threshold=10)
#model1 = np.asarray(func(t,Kd,n,d2,k2,k3))
model1 = np.asarray(func(t,d2,k2,k3,k7))
print(len(model1))
#print(model1)

#a,b,c,d,e,f,g = params
a,b,c,d= params

ydata = np.asarray(new)
print(len(ydata))

ssr = np.sum((ydata-model1)**2)
#ssr2 = np.sum((ydata-model2)**2)
sst = np.sum((ydata-np.mean(ydata))**2)
R2=1-ssr/sst
print('R2 is:', R2)
```

```
102
102
R2 is: -1.7735601382497155
```

In [9]:
```python
pp = PdfPages('multipage.pdf')
ydata = np.asarray(new)

#condition = [1,2,3,4,5,6,7,8,9]
for i in range(2):
    #model = tester(t,Kd,n,d2,k2,k3,i)
    model = tester(t,d2,k2,k3,k7,i)

    #print(model)
    #a,b,c,d,e,f,g= params
    a,b,c,d= params

    plt.plot(t,model,'.', label = 'model')
    #print(model)
    #t = np.linspace(0,34800, num=6961)
    #raw = rawdata[0:13920:240]
    plt.plot(t,raw[i],'.',label = 'data')
    #print(rawdata[i])
    plt.legend()
    pp.savefig()
```
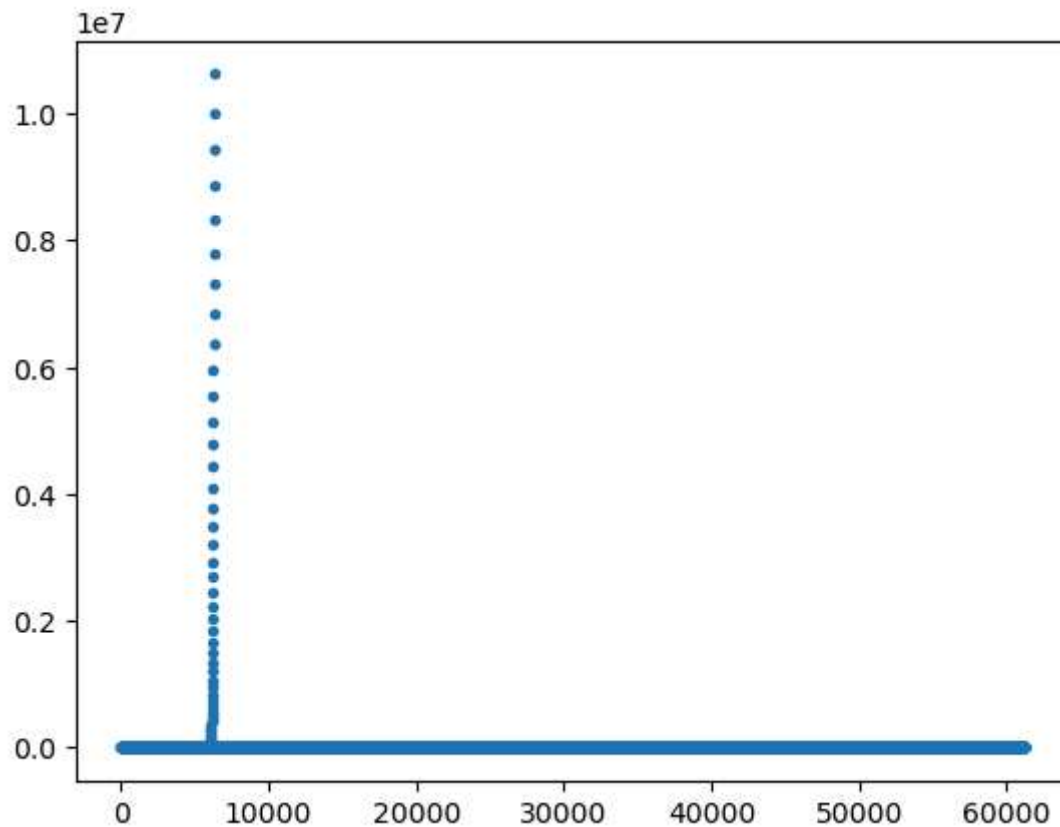
```
    plt.show()

pp.close
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[9], line 17
     13 plt.plot(t,model,'.', label = 'model')
     14 #print(model)
     15 #t = np.linspace(0,34800, num=6961)
     16 #raw = rawdata[0:13920:240]
---> 17 plt.plot(t,raw[i],'.',label = 'data')
     18 #print(rawdata[i])
     19 plt.legend()

NameError: name 'raw' is not defined
```



```
In [ ]:
```

```
In [ ]:
```