Autoimmune Tweets using the mostly preprocessed file from R and testing on Stemmed Tweets with 8 categories of autoimmune diseases¶

Those being: 0:Leukemia, 1: Fibromyalgia, 2:Kidney Disease, 3: Celiac Disease, 4: MS, 5: Hashimoto, 6: RA, 7: Chron's Disease

Tweets were taken from respective diseases in early December 2019 from 13 to 119 tweets for each disease, as many as were found that weren't mostly marketing, using '' treatment' in the search

In [3]:

```
%matplotlib inline
import pandas as pd
import matplotlib.pyplot as plt
from textblob import TextBlob
import numpy as np
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import classification_report, f1_score, accuracy_score, confusion
_matrix


np.random.seed(47)
```

In [4]:

```
reviews = pd.read_csv('LemmaPythonRead.csv', encoding = 'unicode_escape')
#the encoding needed for python3 handling nonASCII chars
```

In [5]:

```
reviews.head()
```

Out[5]:

	LemmatizedTweets	StemmedTweets	AutoImmuneDisorder
0	unknown research unknownresearch the center fo...	unknown research\r\nunknownresearch\r\nthe cen...	Celiac_Disease
1	lynn barter abc mc lbarter · dec reply to thre...	lynn barter abc mc\r\nlbarter\r\n·\r\ndec \r\n...	Celiac_Disease
2	theona layne theonawrites · dec unknown diseas...	theona layne\r\ntheonawrites\r\n·\r\ndec \r\nu...	Celiac_Disease

	LemmatizedTweets	StemmedTweets	AutoImmuneDisorder
3	bob simonoff simonoffbob · dec there be eviden...	bob simonoff\r\nsimonoffbob\r\n·\r\ndec \r\nth...	Celiac_Disease
4	gfdenver gfdenver · nov hm interest research n...	gfdenver\r\ngfdenver\r\n·\r\nnov \r\nhm intere...	Celiac_Disease

In [6]:

```
reviews.tail()
```

Out[6]:

	LemmatizedTweets	StemmedTweets	AutoImmuneDisorder
502	pharmabot thepharmabot · nov codessly effectiv...	pharmabot\r\nthepharmabot\r\n·\r\nnov \r\ncode...	Leukemia_Disease
503	wcm lymphoma wcmclymphoma · dec select initial...	wcm lymphoma\r\nwcmclymphoma\r\n·\r\ndec \r\ns...	Leukemia_Disease
504	medivizor medivizor · dec cope with cml check ...	medivizor\r\nmedivizor\r\n·\r\ndec \r\ncoping ...	Leukemia_Disease
505	abi brokenleadheart · dec reply to rickyspurs ...	abi\r\nbrokenleadheart\r\n·\r\ndec \r\nreplyin...	Leukemia_Disease
506	brooke xbrooke · dec reply to itsjojosiwa dear...	brooke\r\n\r\n\r\nxbrooke\r\n·\r\ndec \r\nrepl...	Leukemia_Disease

In [7]:

```
reviews.shape
```

Out[7]:

```
(507, 3)
```

In [8]:

```
reviews = reviews.reindex(np.random.permutation(reviews.index))


print(reviews.head())
print(reviews.tail())
```

```
                                  LemmatizedTweets  \
407  medivizor medivizor · nov cope with cml check ...
196  medical news bulletin mednewsbulletin · jun a ...
359  drtharanga kumari wickramasooriya drtharanga ·...
39   nola unknown unknowndiary · sep reply to nolan...
245  christine blome blomechristine · jan our new t...

                                    StemmedTweets AutoImmuneDisorder
407  medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ...   Leukemia_Disease
196  medical news bulletin\r\nmednewsbulletin\r\n·\...       Fibromyalgia
359  drtharanga kumari wickramasooriya\r\ndrtharang...     Kidney_Disease
39   nola unknown\r\nunknowndiary\r\n·\r\nsep  \r\n...     Celiac_Disease
245  christine blome\r\nblomechristine\r\n·\r\njan ...         MS_Disease
                                  LemmatizedTweets  \
72   r unknownunknown runknownunknown · h chronic o...
264  lorilynn lorilynn · nov multiple unknown be a ...
327  unknown guild theunknownguild · nov fridayfin...
390  drug topic drugtopics · dec the fda have appro...
```

```
135  fms news bot fmsbot · nov unknown treatment ma...

                                          StemmedTweets AutoImmuneDisorder
72   r unknownunknown\r\nrunknownunknown\r\n·\r\nh\...  Hashimoto_Disease
264  lorilynn\r\nlorilynn\r\n·\r\nnov \r\nmultiple ...         MS_Disease
327  unknown guild□\r\ntheunknownguild\r\n·\r\nnov ...         MS_Disease
390  drug topics\r\ndrugtopics\r\n·\r\ndec \r\nthe ...   Leukemia_Disease
135  fms news bot\r\nfmsbot\r\n·\r\nnov \r\nunknown...       Fibromyalgia
```

In [9]:

```
reviews.groupby('AutoImmuneDisorder').describe()
```

Out[9]:

	LemmatizedTweets				StemmedTweets				
	count	unique	top	freq	count	unique	top		freq
AutoImmuneDisorder									
Celiac_Disease	50	50	erin smith gfreefun · nov unknown disease trea...	1	50	50	cari a\r\ncariknits\r\n·\r\nnov \r\ntoday i ha...		1
Chron_Disease	19	19	matthew johnson maerial · feb submission for d...	1	19	19	purpose \r\nhappybelieber\r\n·\r\njan \r\nnig...		1
Fibromyalgia	99	95	woman in pain forgrace · nov for grace be prou...	2	99	95	chronic disease coalition\r\nchronicrights\r\n...		2
Hashimoto_Disease	30	29	colorado natural med drgravesco · dec naturopa...	2	30	29	colorado natural med\r\ndrgravesco\r\n·\r\ndec...		2
Kidney_Disease	43	43	coffeemeetscarnivore cofemtscarnivor · dec rep...	1	43	43	marketsticker\r\nmarketsticker\r\n·\r\ndec \r\...		1
Leukemia_Disease	119	116	medivizor medivizor · nov cope with cml check ...	3	119	116	medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ...		3
MS_Disease	119	119	erectile dysfunction news research erectiledys...	1	119	119	amesh adalja\r\nameshaa\r\n·\r\ndec \r\n“ they ...		1
RA_Disease	28	28	dr john cush unknownnow · oct the committee fo...	1	28	28	gse health blog\r\ngsehealth\r\n·\r\nsep \r\nw...		1

In [10]:

```
reviews['length'] = reviews['StemmedTweets'].map(lambda text: len(text))
print(reviews.head())
```

```
                                    LemmatizedTweets  \
407  medivizor medivizor · nov cope with cml check ...
196  medical news bulletin mednewsbulletin · jun a ...
359  drtharanga kumari wickramasooriya drtharanga ·...
39   nola unknown unknowndiary · sep reply to nolan...
245  christine blome blomechristine · jan our new t...

                                    StemmedTweets AutoImmuneDisorder  \
407  medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ...   Leukemia_Disease
196  medical news bulletin\r\nmednewsbulletin\r\n·\...       Fibromyalgia
```

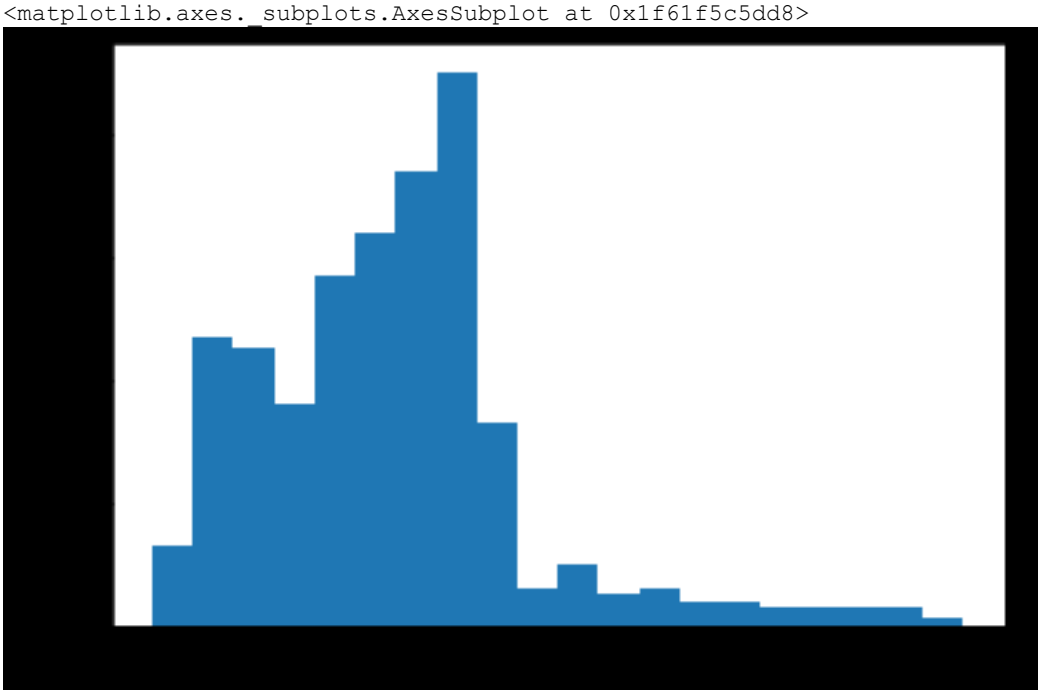
```
359  drtharanga kumari wickramasooriya\r\ndrtharang...     Kidney_Disease
39   nola unknown\r\nunknowndiary\r\n·\r\nsep  \r\n...     Celiac_Disease
245  christine blome\r\nblomechristine\r\n·\r\njan ...         MS_Disease

     length
407     140
196     256
359     328
39      337
245     203
```

In [11]:

```
reviews.length.plot(bins=20, kind='hist')
```

Out[11]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1f61f5c5dd8>
```



In [12]:

```
reviews.length.describe()
```

Out[12]:

```
count    507.000000
mean     258.960552
std       97.788402
min       83.000000
25%      188.000000
50%      258.000000
75%      304.000000
max      678.000000
Name: length, dtype: float64
```

In [13]:

```
print(list(reviews.StemmedTweets[reviews.length > 500].index)) #near the max for lengt
h of LemmatizedTweets
```

```
print(list(reviews.AutoImmuneDisorder[reviews.length > 500]))
```

```
[75, 432, 105, 104, 176, 58, 129, 174, 145, 193, 26, 82, 109, 111, 99, 167, 149]
['Hashimoto_Disease', 'Leukemia_Disease', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgi
a', 'Hashimoto_Disease', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia
', 'Celiac_Disease', 'Chron_Disease', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia',
'Fibromyalgia', 'Fibromyalgia']
```

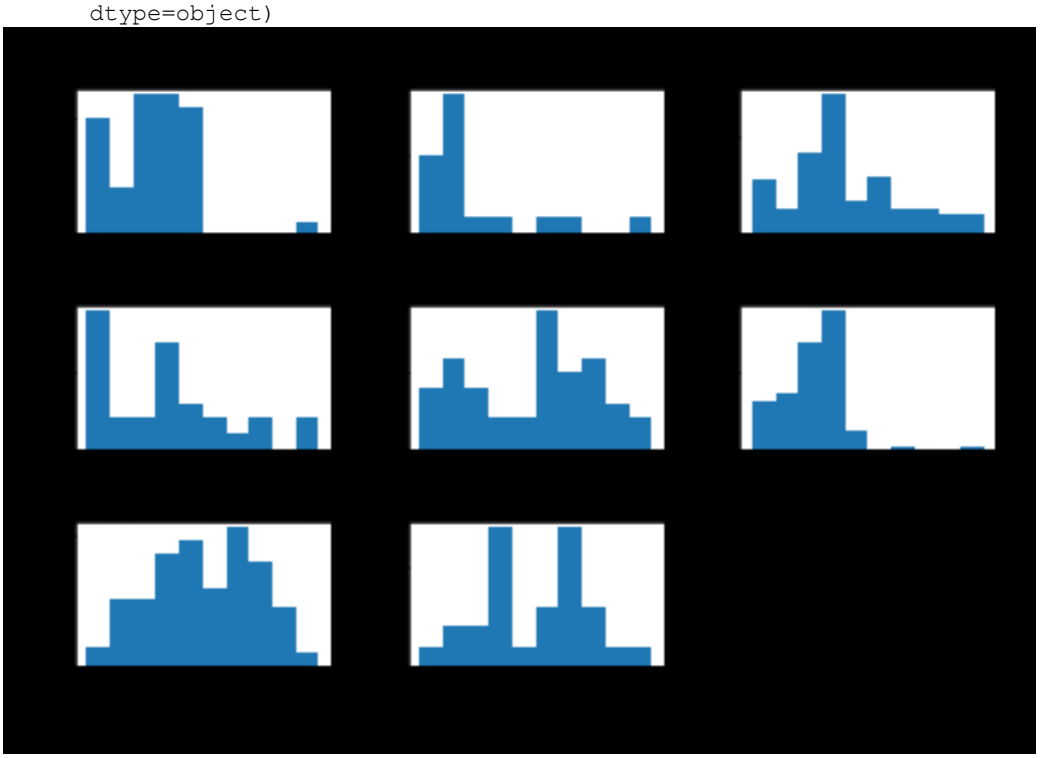
In [14]:

```
%%time

reviews.hist(column='length', by='AutoImmuneDisorder', bins=10)
```

```
Wall time: 484 ms
```

Out[14]:

```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F5E5240>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F625278>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F651828>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F684DD8>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F6C13C8>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F6F1978>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F723F28>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F75E550>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x000001F61F75E588>]],
      dtype=object)
```



In [15]:

```
def split_into_tokens(review):


    #review = unicode(review, 'iso-8859-1')# in python 3 the default of str() previous
ly python2 as unicode() is utf-8
```

```
    return TextBlob(review).words
```

In [16]:

```
reviews.StemmedTweets.head().apply(split_into_tokens)
```

Out[16]:

```
407    [medivizor, medivizor, ·, nov, coping, with, c...
196    [medical, news, bulletin, mednewsbulletin, ·, ...
359    [drtharanga, kumari, wickramasooriya, drtharan...
39     [nola, unknown, unknowndiary, ·, sep, replying...
245    [christine, blome, blomechristine, ·, jan, our...
Name: StemmedTweets, dtype: object
```

In [17]:

```
TextBlob("hello world, how is it going?").tags
```

Out[17]:

```
[('hello', 'JJ'),
 ('world', 'NN'),
 ('how', 'WRB'),
 ('is', 'VBZ'),
 ('it', 'PRP'),
 ('going', 'VBG')]
```

In [18]:

```
import nltk

nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\m\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Out[18]:

```
True
```

In [19]:

```
from nltk.corpus import stopwords


stop = stopwords.words('english')

stop = stop + [u'a',u'b',u'c',u'd',u'e',u'f',u'g',u'h',u'i',u'j',u'k',u'l',u'm',u'n',u
'o',u'p',u'q',u'r',u's',u't',u'v',u'w',u'x',u'y',u'z']
```

In [20]:

```
def split_into_lemmas(review):

    #review = unicode(review, 'iso-8859-1')

    review = review.lower()

    #review = unicode(review, 'utf8').lower()

    #review = str(review).lower()
```

```
    words = TextBlob(review).words
    # for each word, take its "base form" = lemma
    return [word.lemma for word in words if word not in stop]

reviews.StemmedTweets.head().apply(split_into_lemmas)
```

Out[20]:

```
407    [medivizor, medivizor, ·, nov, coping, cml, ch...
196    [medical, news, bulletin, mednewsbulletin, ·, ...
359    [drtharanga, kumari, wickramasooriya, drtharan...
39     [nola, unknown, unknowndiary, ·, sep, replying...
245    [christine, blome, blomechristine, ·, jan, new...
Name: StemmedTweets, dtype: object
```

In [21]:

```
%%time
bow_transformer = CountVectorizer(analyzer=split_into_lemmas).fit(reviews['StemmedTwee
ts'])
print(len(bow_transformer.vocabulary_))
```

```
4585
Wall time: 859 ms
```

In [22]:

```
review4 = reviews['StemmedTweets'][42]
print(review4)
```

```
purna
purnamusic
·
jun
gluten shouldn□t be so painful no sleep night two advice tried antihistamines ginger t
ea ibuprofen and activated charcoal over the last  hours unknown treatment
```

In [23]:

```
bow4 = bow_transformer.transform([review4])
print(bow4)
```

```
  (0, 48)        1
  (0, 83)        1
  (0, 224)       1
  (0, 678)       1
  (0, 1602)      1
  (0, 1622)      1
  (0, 1827)      1
  (0, 2034)      1
  (0, 2298)      1
  (0, 2385)      1
  (0, 2942)      1
  (0, 3086)      1
  (0, 3387)      1
  (0, 3388)      1
```

```
  (0, 3732)      1
  (0, 3770)      1
  (0, 4025)      1
  (0, 4183)      1
  (0, 4196)      1
  (0, 4231)      1
  (0, 4290)      1
  (0, 4583)      1
```

In [24]:

```
%%time

reviews_bow = bow_transformer.transform(reviews['StemmedTweets'])

print('sparse matrix shape:', reviews_bow.shape)

print('number of non-zeros:', reviews_bow.nnz)

print('sparsity: %.2f%%' % (100.0 * reviews_bow.nnz / (reviews_bow.shape[0] * reviews_
bow.shape[1])))
```

```
sparse matrix shape: (507, 4585)
number of non-zeros: 11905
sparsity: 0.51%
Wall time: 734 ms
```

In [25]:

```
# Split/splice into training ~ 80% and testing ~ 20%

reviews_bow_train = reviews_bow[:400]

reviews_bow_test = reviews_bow[400:]

reviews_sentiment_train = reviews['AutoImmuneDisorder'][:400]

reviews_sentiment_test = reviews['AutoImmuneDisorder'][400:]


print(reviews_bow_train.shape)

print(reviews_bow_test.shape)
```

```
(400, 4585)
(107, 4585)
```

In [26]:

```
%time review_sentiment = MultinomialNB().fit(reviews_bow_train, reviews_sentiment_trai
n)
```

```
Wall time: 15.6 ms
```

In [27]:

```
print('predicted:', review_sentiment.predict(bow4)[0])

print('expected:', reviews.AutoImmuneDisorder[42])
```

```
predicted: Celiac_Disease
expected: Celiac_Disease
```

In [28]:

```
predictions = review_sentiment.predict(reviews_bow_test)
print(predictions)
```

```
['Fibromyalgia' 'Fibromyalgia' 'MS_Disease' 'Leukemia_Disease'
 'MS_Disease' 'Fibromyalgia' 'Leukemia_Disease' 'Kidney_Disease'
 'Hashimoto_Disease' 'Fibromyalgia' 'Fibromyalgia' 'Leukemia_Disease'
 'Fibromyalgia' 'Fibromyalgia' 'MS_Disease' 'MS_Disease' 'MS_Disease'
 'Fibromyalgia' 'Fibromyalgia' 'Leukemia_Disease' 'Leukemia_Disease'
 'Fibromyalgia' 'Fibromyalgia' 'Leukemia_Disease' 'Fibromyalgia'
 'Celiac_Disease' 'Leukemia_Disease' 'Fibromyalgia' 'Leukemia_Disease'
 'Leukemia_Disease' 'Fibromyalgia' 'Leukemia_Disease' 'Leukemia_Disease'
 'MS_Disease' 'MS_Disease' 'Fibromyalgia' 'Leukemia_Disease' 'MS_Disease'
 'MS_Disease' 'Fibromyalgia' 'Hashimoto_Disease' 'MS_Disease' 'MS_Disease'
 'MS_Disease' 'MS_Disease' 'Leukemia_Disease' 'MS_Disease' 'Fibromyalgia'
 'Fibromyalgia' 'Fibromyalgia' 'Fibromyalgia' 'Fibromyalgia' 'MS_Disease'
 'Leukemia_Disease' 'Fibromyalgia' 'MS_Disease' 'Leukemia_Disease'
 'MS_Disease' 'Leukemia_Disease' 'Fibromyalgia' 'MS_Disease' 'MS_Disease'
 'Fibromyalgia' 'MS_Disease' 'Leukemia_Disease' 'Leukemia_Disease'
 'Fibromyalgia' 'MS_Disease' 'Leukemia_Disease' 'Fibromyalgia'
 'Celiac_Disease' 'MS_Disease' 'Fibromyalgia' 'MS_Disease' 'Fibromyalgia'
 'Leukemia_Disease' 'MS_Disease' 'MS_Disease' 'Celiac_Disease'
 'Fibromyalgia' 'Fibromyalgia' 'MS_Disease' 'MS_Disease' 'Fibromyalgia'
 'Leukemia_Disease' 'Leukemia_Disease' 'MS_Disease' 'RA_Disease'
 'Hashimoto_Disease' 'Celiac_Disease' 'MS_Disease' 'Hashimoto_Disease'
 'Celiac_Disease' 'Fibromyalgia' 'Fibromyalgia' 'Celiac_Disease'
 'MS_Disease' 'Fibromyalgia' 'Hashimoto_Disease' 'Celiac_Disease'
 'MS_Disease' 'Fibromyalgia' 'Fibromyalgia' 'MS_Disease' 'MS_Disease'
 'Leukemia_Disease' 'Fibromyalgia']
```

In [29]:

```
print('accuracy', accuracy_score(reviews_sentiment_test, predictions))
print('confusion matrix\n', confusion_matrix(reviews_sentiment_test, predictions))
print('(row=expected, col=predicted)')
```

```
accuracy 0.6261682242990654
confusion matrix
 [[ 2  0  3  0  0  0  2  0]
 [ 1  0  1  0  0  0  2  1]
 [ 0  0 21  0  0  0  4  0]
 [ 2  0  4  5  0  0  0  0]
 [ 1  0  0  0  1  1  1  0]
 [ 0  0  0  0  0 21  1  0]
 [ 1  0  3  0  0  1 17  0]
 [ 0  0  5  0  0  0  6  0]]
(row=expected, col=predicted)
```

In [30]:

```
print(classification_report(reviews_sentiment_test, predictions))
#The F1 score can be interpreted as a weighted average of the precision and recall,
#where an F1 score reaches its best value at 1 and worst score at 0.
```

```
                  precision    recall  f1-score   support

   Celiac_Disease       0.29      0.29      0.29         7
    Chron_Disease       0.00      0.00      0.00         5
     Fibromyalgia       0.57      0.84      0.68        25
```

```
Hashimoto_Disease       1.00      0.45      0.62        11
   Kidney_Disease       1.00      0.25      0.40         4
 Leukemia_Disease       0.91      0.95      0.93        22
       MS_Disease       0.52      0.77      0.62        22
       RA_Disease       0.00      0.00      0.00        11

         accuracy                           0.63       107
        macro avg       0.54      0.44      0.44       107
     weighted avg       0.59      0.63      0.58       107

c:\users\m\anaconda2\envs\python36\lib\site-packages\sklearn\metrics\classification.py
:1437: UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples.
  'precision', 'predicted', average, warn_for)
```

In [31]:

```
def predict_review(new_review):
    new_sample = bow_transformer.transform([new_review])
    p = np.around(review_sentiment.predict_proba(new_sample), decimals=2)
    print(new_review, p,'\tMax: ', np.max(p), '\n')
```

The respective probabilities correspond to those diseases alphebatized as
[[1-Celiac Disease, 2-Chron's Disease, 3-Fibromyalgia, 4-Hashimoto, 5-Kidney Disease, 6-Leukemia, 7-Multiple Sclerosis, 8-Rheumatoid Arthritis]]

In [32]:

```
predict_review('sick. pain. sleepless. anxious.')


predict_review('digestive. hungry.')


predict_review('bruising. sleepy. tired. headache.')
predict_review('energy. crazy. manic. depressed. angry.')
```

```
sick. pain. sleepless. anxious. [[0.01 0.   0.89 0.01 0.01 0.01 0.05 0.01]] Max:  0.89

digestive. hungry. [[0.11 0.03 0.19 0.05 0.1  0.24 0.24 0.04]]      Max:  0.24

bruising. sleepy. tired. headache. [[0.09 0.08 0.39 0.05 0.08 0.13 0.14 0.04]]      M
ax:  0.39

energy. crazy. manic. depressed. angry. [[0.1  0.05 0.17 0.06 0.1  0.23 0.25 0.05]]  M
ax:  0.25
```

In [ ]:

```

```