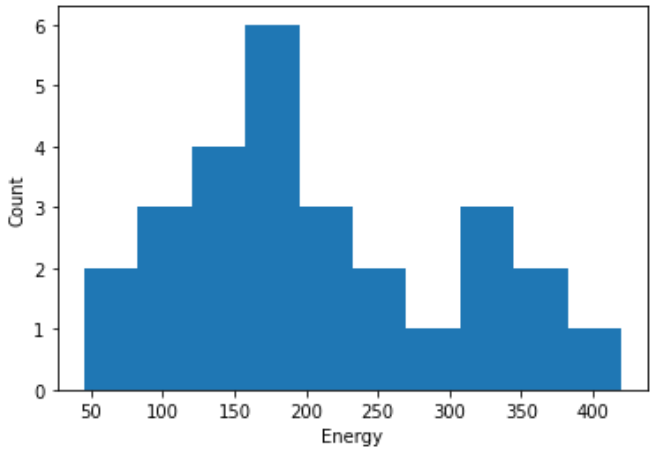
In [16]:
```
import numpy as np
import pandas as pd

import matplotlib.pyplot as plt
import seaborn as sns

from scipy.cluster.hierarchy import dendrogram, linkage
from sklearn.preprocessing import StandardScaler, normalize

from scipy.cluster.hierarchy import single, cophenet
from scipy.spatial.distance import pdist, squareform

from sklearn.cluster import AgglomerativeClustering
from sklearn.metrics import silhouette_score

from sklearn.cluster import KMeans
```

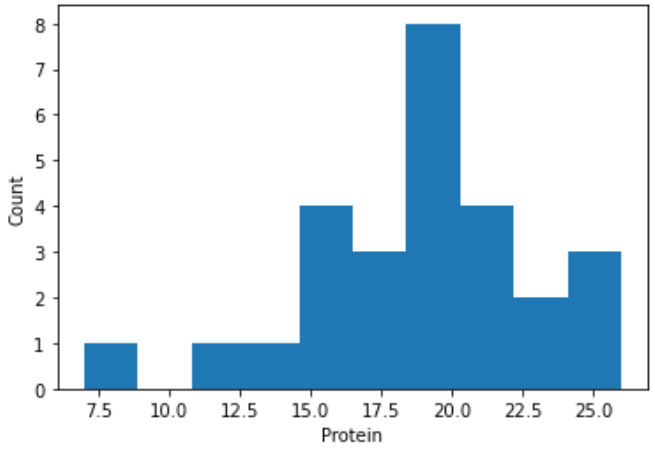
In [2]:
```
df = pd.read_csv('data.csv', names=['Name', 'Energy', 'Protein', 'Fat', 'Calcium', 'Iron'])
df
```

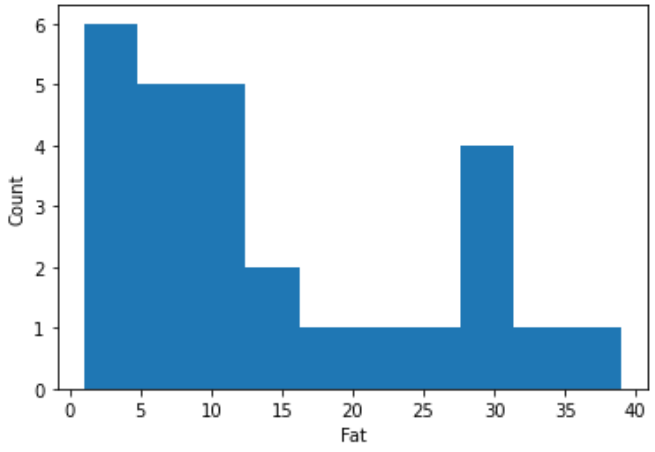
Out[2]:

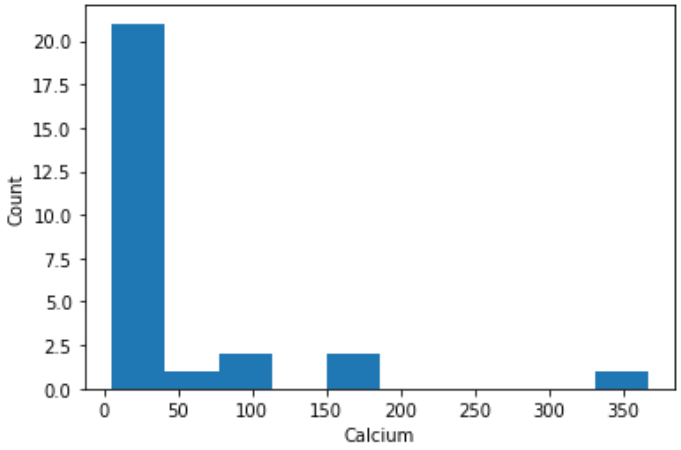
	Name	Energy	Protein	Fat	Calcium	Iron
0	Braised beef	340	20	28	9	2.6
1	Hamburger	245	21	17	9	2.7
2	Roast beef	420	15	39	7	2.0
3	Beefsteak	375	19	32	9	2.6
4	Canned beef	180	22	10	17	3.7
5	Broiled chicken	115	20	3	8	1.4
6	Canned chicken	170	25	7	12	1.5
7	Beef heart	160	26	5	14	5.9
8	Roast lamb leg	265	20	20	9	2.6
9	Roast lamb shoulder	300	18	25	9	2.3
10	Smoked ham	340	20	28	9	2.5
11	Pork roast	340	19	29	9	2.5
12	Pork simmered	355	19	30	9	2.4
13	Beef tongue	205	18	14	7	2.5
14	Veal cutlet	185	23	9	9	2.7
15	Baked bluefish	135	22	4	25	0.6
16	Raw clams	70	11	1	82	6.0
17	Canned clams	45	7	1	74	5.4
18	Canned crabmeat	90	14	2	38	0.8
19	Fried haddock	135	16	5	15	0.5
20	Broiled mackerel	200	19	13	5	1.0
21	Canned mackerel	155	16	9	157	1.8
22	Fried perch	195	16	11	14	1.3
23	Canned salmon	120	17	5	159	0.7
24	Canned sardines	180	22	9	367	2.5
25	Canned tuna	170	25	7	7	1.2
26	Canned shrimp	110	23	1	98	2.6

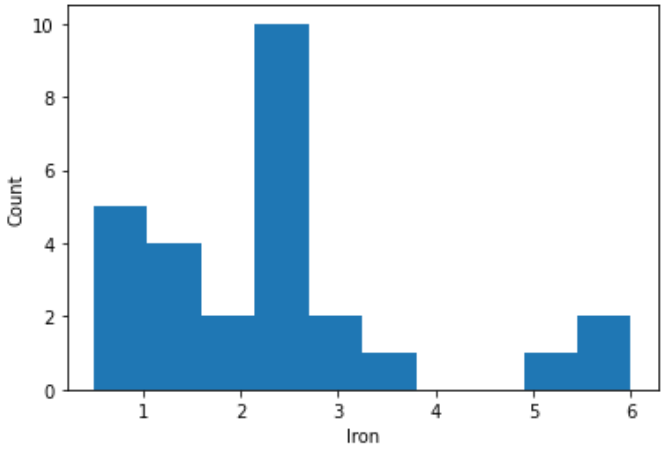
In [3]:
```
for i in range(1,6):
    plt.figure(figsize=(6,4))
    plt.hist(df.iloc[:,i].values)
    plt.xlabel(df.columns.values[i])
    plt.ylabel('Count')
    plt.show()
```



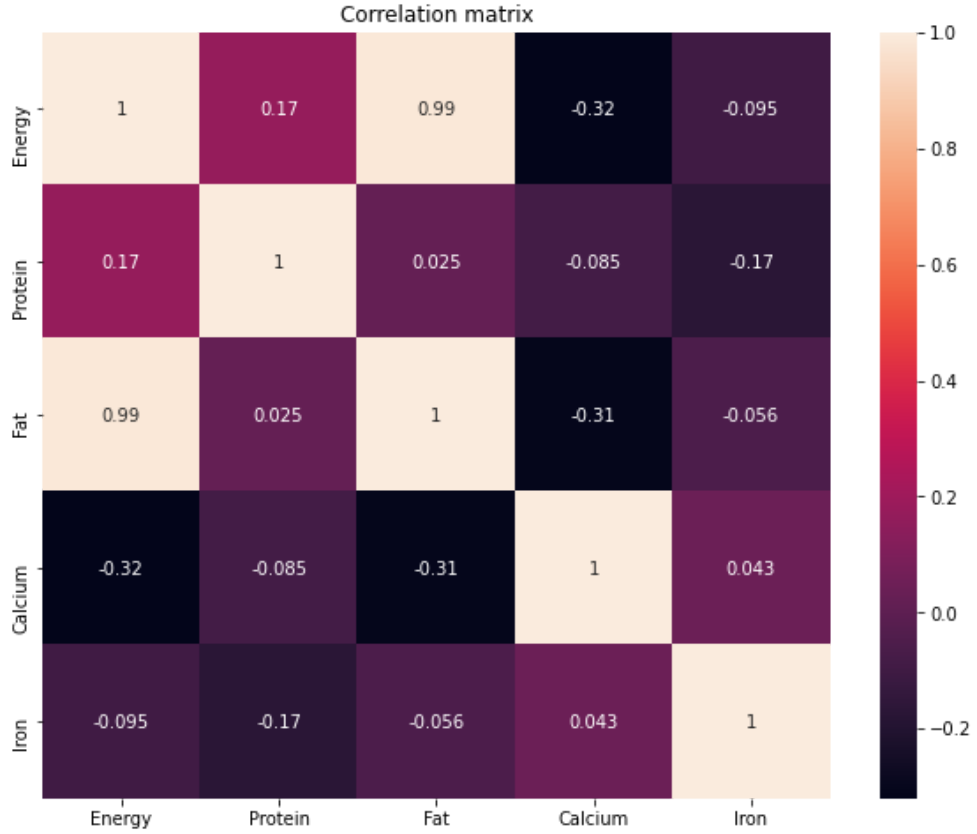





Count
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0
50
100
150
200
250
300
350
Calcium


Count
10
8
6
4
2
0
1
2
3
4
5
6
Iron

In [4]:
```
plt.figure(figsize=(10,8))
g = sns.heatmap(df.corr(), annot=True)
g.set(title='Correlation matrix')
plt.show()
```



In [5]:
```
df2 = df.copy()
df = normalize(df.iloc[:,1:])
df
```

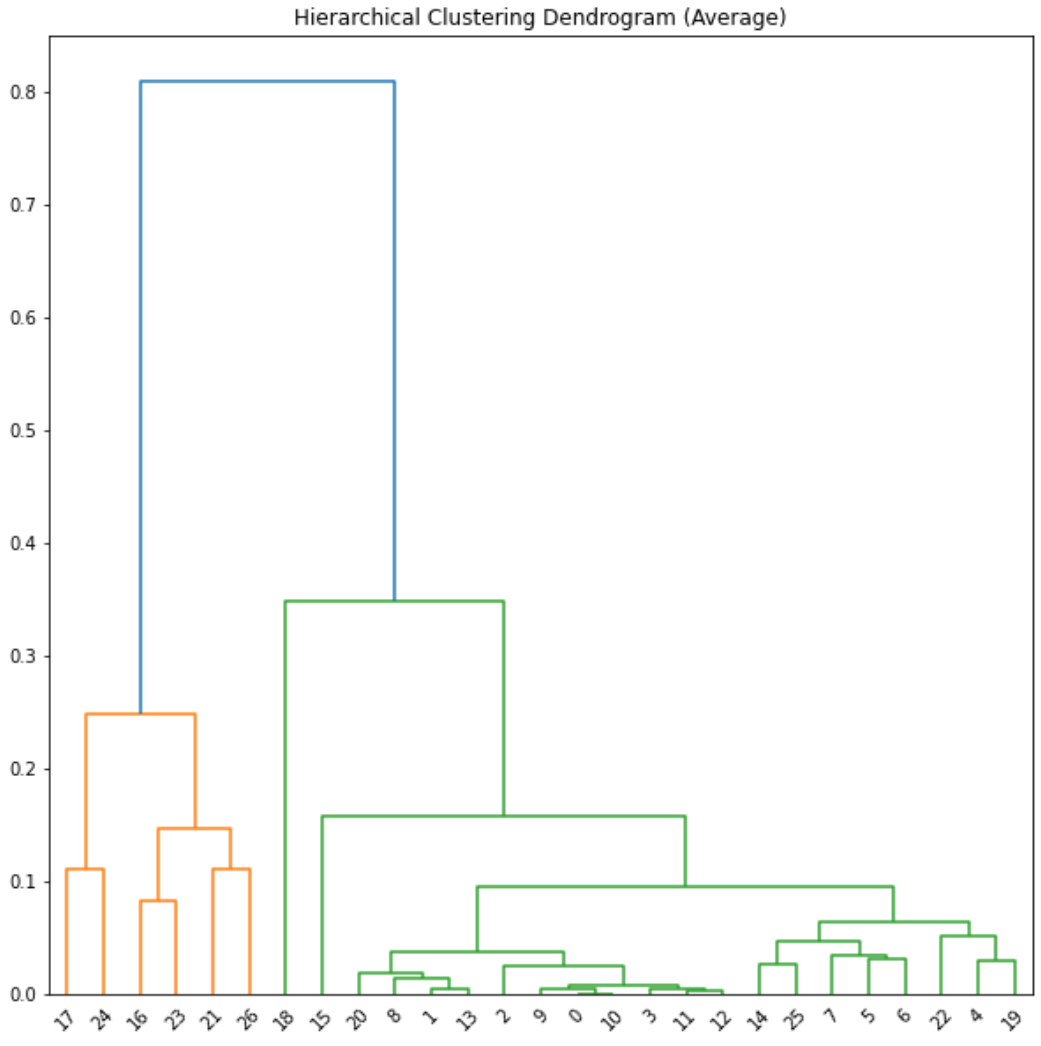
Out[5]:
```
array([[0.99454428, 0.0585026 , 0.08190365, 0.02632617, 0.00760534],
       [0.99325267, 0.08513594, 0.06891957, 0.03648683, 0.01094605],
       [0.99493947, 0.03553355, 0.09238724, 0.01658232, 0.00473781],
       [0.9948043 , 0.05040342, 0.08488997, 0.0238753 , 0.00689731],
       [0.98659111, 0.12058336, 0.05481062, 0.09317805, 0.02027993],
       [0.98251274, 0.17087178, 0.02563077, 0.06834871, 0.01196102],
       [0.98610394, 0.14501528, 0.04060428, 0.06960734, 0.00870092],
       [0.98228281, 0.15962096, 0.03069634, 0.08594975, 0.03622168],
       [0.99373848, 0.07499913, 0.07499913, 0.03374961, 0.00974989],
       [0.99429754, 0.05965785, 0.08285813, 0.02982893, 0.00762295],
       [0.99454645, 0.05850273, 0.08190383, 0.02632623, 0.00731284],
       [0.99446987, 0.05557332, 0.08482243, 0.0263242 , 0.00731228],
       [0.99469532, 0.05323721, 0.08405876, 0.02521763, 0.0067247 ],
       [0.99322533, 0.08721003, 0.06783002, 0.03391501, 0.0121125 ],
       [0.98995204, 0.12307512, 0.04815983, 0.04815983, 0.01444795],
       [0.97048593, 0.15815326, 0.02875514, 0.17971962, 0.00431327],
       [0.64489429, 0.10134053, 0.00921278, 0.7554476 , 0.05527665],
       [0.51686048, 0.08040052, 0.01148579, 0.84994835, 0.06202326],
       [0.91171607, 0.1418225 , 0.02026036, 0.38494679, 0.00810414],
       [0.98639392, 0.11690595, 0.03653311, 0.10959932, 0.00365331],
       [0.99312162, 0.09434655, 0.06455291, 0.02482804, 0.00496561],
       [0.7001169 , 0.07227013, 0.04065195, 0.70915067, 0.00813039],
       [0.99252785, 0.08143818, 0.05598875, 0.07125841, 0.00661685],
       [0.60003383, 0.08500479, 0.02500141, 0.79504482, 0.0035002 ],
       [0.43959976, 0.05372886, 0.02197999, 0.89629507, 0.00610555],
       [0.98769725, 0.1452496 , 0.04066989, 0.04066989, 0.00697198],
       [0.73759485, 0.15422438, 0.00670541, 0.65712995, 0.01743406]])
```

In [6]:
```
c1,coph=cophenet(linkage(df, 'single'),pdist(df))
c2,coph=cophenet(linkage(df, 'complete'),pdist(df))
c3,coph=cophenet(linkage(df, 'average'),pdist(df))
c4,coph=cophenet(linkage(df, 'weighted'),pdist(df))
c5,coph=cophenet(linkage(df, 'centroid'),pdist(df))
linkage=pd.DataFrame({"Linkage":['Single','Complete','Average','Weighted','Centroid'],
                      "Cophenet Coeff":[c1,c2,c3,c4,c5]})
linkage
```

Out[6]:

	Linkage	Cophenet Coeff
0	Single	0.959796
1	Complete	0.964865
2	Average	0.968280
3	Weighted	0.967990
4	Centroid	0.968274

In [15]:
```
plt.figure(figsize=(10, 10))
dendrogram(linkage(df, 'average'))
plt.title('Hierarchical Clustering Dendrogram (Average)')
plt.show()
```



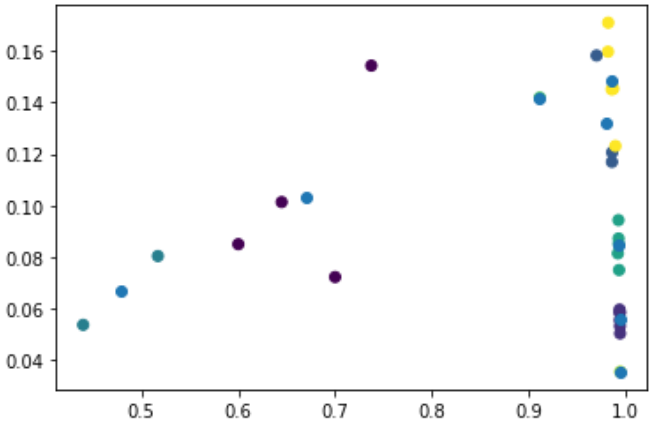
In [23]:
```
db_index=[]
for i in range(2,11):
    db_index.append(silhouette_score(df, AgglomerativeClustering(n_clusters=i,linkage='aver
db_index = pd.DataFrame({'K Values':['2','3','4','5','6','7','8','9','10'],
                         'Silhouette index':db_index})
pd.DataFrame(db_index)
```

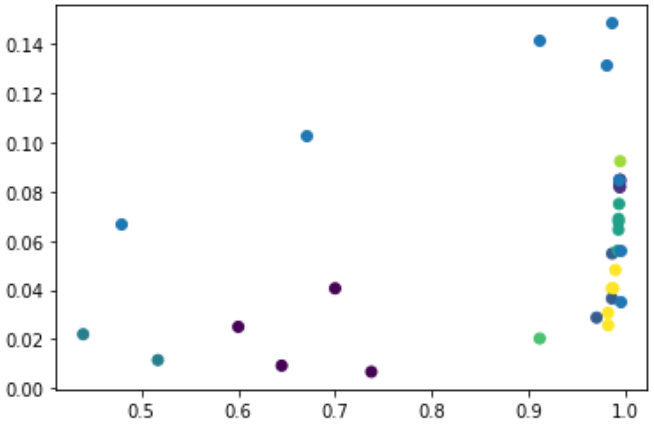
Out[23]:

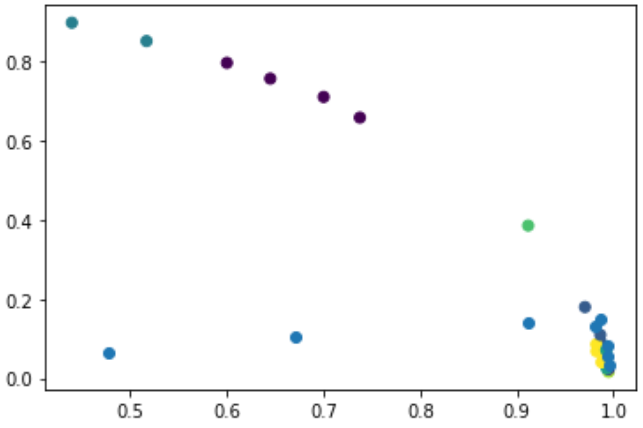
	K Values	Silhouette index
0	2	0.840039
1	3	0.702438
2	4	0.673562
3	5	0.472026
4	6	0.441687
5	7	0.415750
6	8	0.385742
7	9	0.418950
8	10	0.402763

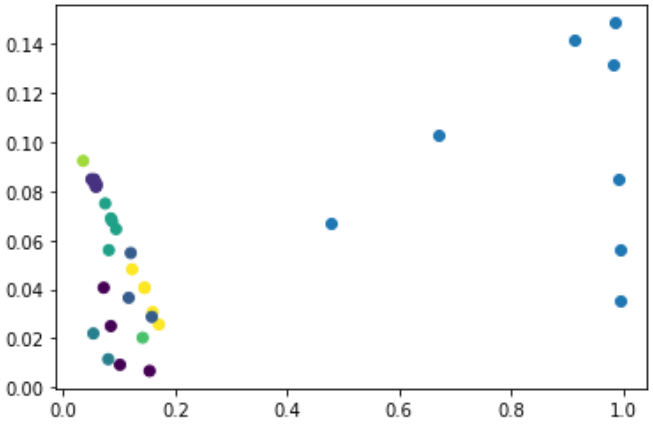
In [27]:
```
from sklearn.cluster import KMeans
kmeans = KMeans(init="random", n_clusters=8)
kmeans.fit(df)
y_kmeans = kmeans.predict(df)
```

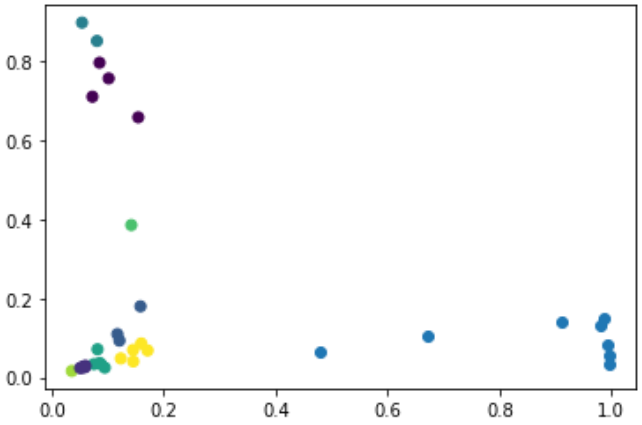
In [34]:
```
for i in range(4):
    for j in range(i+1, 4):
        plt.figure(figsize=(6, 4))
        plt.scatter(df[:, i], df[:, j], c=y_kmeans)

        centers = kmeans.cluster_centers_
        plt.scatter(centers[:, 0], centers[:, 1])
        plt.show()
```

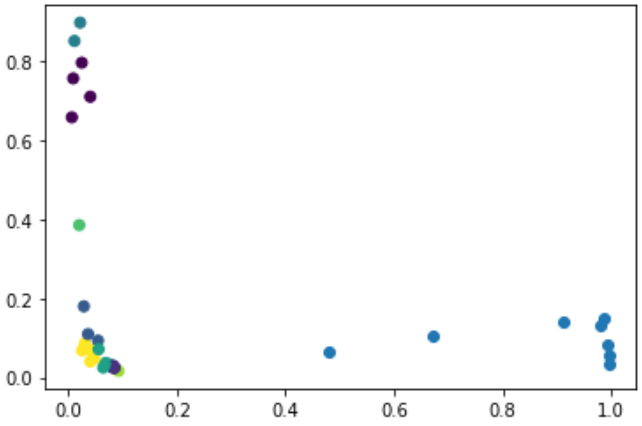







0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.0
0.2
0.4
0.6
0.8
1.0


0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0