In [76]:
```
import pandas as pd

df = pd.read_csv('Pima.csv', names=['Pregnancies', 'Glucose', 'BloodPressure
assert df.shape[0] == 768
assert len(df.columns) == 9
print('Successfully verified 768 rows and 9 columns!')
df
```

```
Successfully verified 768 rows and 9 columns!
```

Out[76]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFu
0	6	148	72	35	0	33.6	
1	1	85	66	29	0	26.6	
2	8	183	64	0	0	23.3	
3	1	89	66	23	94	28.1	
4	0	137	40	35	168	43.1	
...	...	...	...	...	...	...	
763	10	101	76	48	180	32.9	
764	2	122	70	27	0	36.8	
765	5	121	72	23	112	26.2	
766	1	126	60	0	0	30.1	
767	1	93	70	31	0	30.4	

768 rows × 9 columns

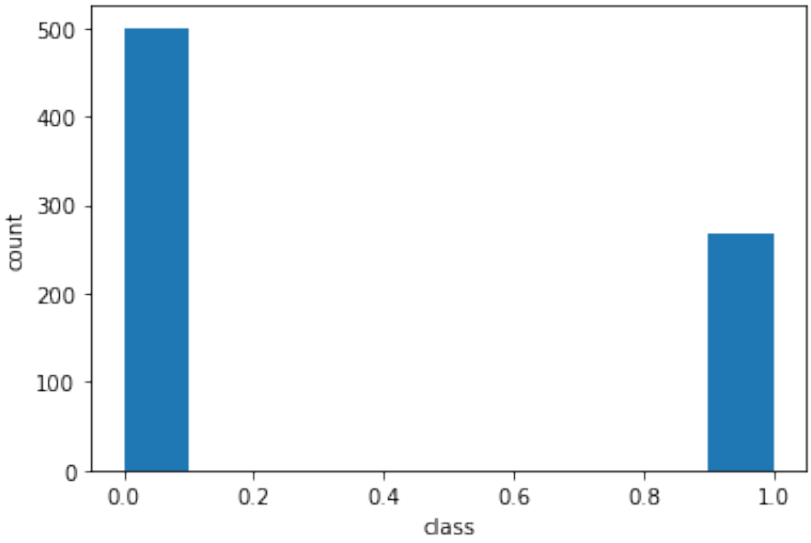
In [77]:
```
df.describe()
```

Out[77]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	Di
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	

In [78]:
```
import numpy as np
import matplotlib.pyplot as plt

%matplotlib inline

plt.xlabel('class')
plt.ylabel('count')
plt.hist(df['Label'])
# val_counts = np.unique(df['Label'], return_counts=True)
# x = val_counts[0]
# y = val_counts[1]

# counts, bins = np.histogram(df['Label'])
# print(counts, bins)
#
# # plt.hist(x=counts, bins=bins)
# plt.stairs(counts, bins)
```

Out[78]:
```
(array([500.,   0.,   0.,   0.,   0.,   0.,   0.,   0.,   0., 268.]),
 array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. ]),
 <BarContainer object of 10 artists>)
```



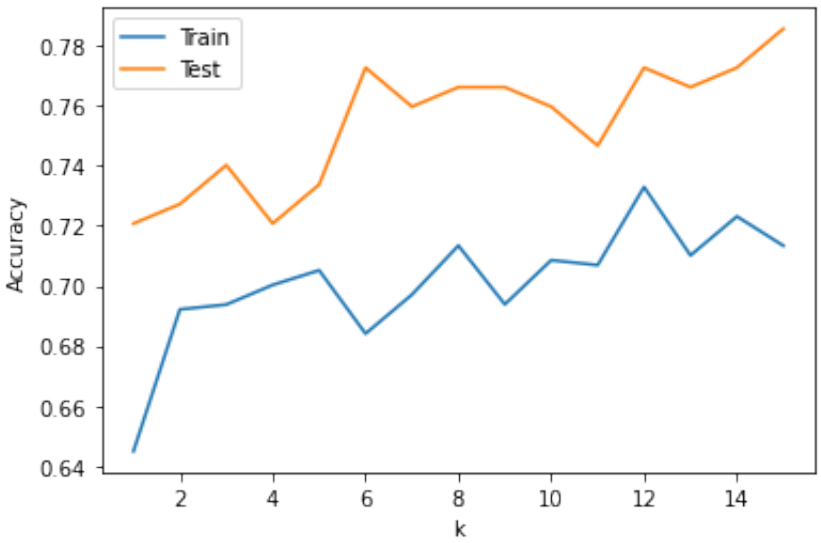
Question 3

In [79]:
```
from sklearn.model_selection import train_test_split

y = df['Label']
X = df.drop(columns=['Label'])
np.random.seed(1)
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.8)
```

In [80]:
```
from sklearn.model_selection import cross_val_score
from sklearn.neighbors import KNeighborsClassifier

avg_scores = []
test_scores = []
for k in range(1, 16):
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(estimator=knn, X=X_train, y=y_train)
    avg_score = np.mean(scores)
    avg_scores.append(avg_score)
    print(f'k={k} score={avg_score}')

    # check
    knn.fit(X_train, y_train)
    score = knn.score(X_test, y_test)
    test_scores.append(score)
    # print(f'=====> k={k} test_score={score}')
    # end check

print(avg_scores)
best_k = np.argmax(avg_scores) + 1
print(f'best k={best_k}')

best_test_k = np.argmax(test_scores) + 1
print(f'best test k={best_test_k}')

x = range(1, 16)
y = avg_scores
plt.xlabel('k')
plt.ylabel('Accuracy')
plt.plot(x, y)

y = test_scores
plt.plot(x, y)
plt.legend(['Train', 'Test'])
```

```
k=1 score=0.6449020391843263
k=2 score=0.6921764627482341
k=3 score=0.6937758230041318
k=4 score=0.7003198720511795
k=5 score=0.7051979208316673
k=6 score=0.6840863654538184
k=7 score=0.6971078235372518
k=8 score=0.7134346261495401
k=9 score=0.6938557910169265
k=10 score=0.7085699053711847
k=11 score=0.7069305611088896
k=12 score=0.7329734772757563
k=13 score=0.7101692656270825
k=14 score=0.7231640677062509
k=15 score=0.7133946421431427
[0.6449020391843263, 0.6921764627482341, 0.6937758230041318, 0.7003198720511
795, 0.7051979208316673, 0.6840863654538184, 0.6971078235372518, 0.713434626
1495401, 0.6938557910169265, 0.7085699053711847, 0.7069305611088896, 0.73297
34772757563, 0.7101692656270825, 0.7231640677062509, 0.7133946421431427]
best k=12
best test k=15
```

Out[80]: <matplotlib.legend.Legend at 0x1536cbca0>



In [81]:
```
knn = KNeighborsClassifier(n_neighbors=best_k)
knn.fit(X_train, y_train)
score = knn.score(X_test, y_test)
print(f'k={best_k} test_error={1-score}')
```

```
k=12 test_error=0.2272727272727273
```

In [82]:
```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
print(X_train.shape, X_test.shape)
X_train_norm = scaler.fit_transform(X_train)
X_test_norm = scaler.transform(X_test)

knn.fit(X_train_norm, y_train)
score = knn.score(X_test_norm, y_test)
print(f'k={best_k} standardized test_error={1-score}')
```

```
(614, 8) (154, 8)
k=12 standardized test_error=0.20779220779220775
```

Q4

- Yes, centralization and standardization affects the data.
- This is because KNN uses raw feature values, hence if some value is much larger than the others, it would dominate the outcome. We can clearly see values of the feature "Insulin" is much higher than "DPF", thus without normalization "Insulin" would have higher weightage. If such scale difference is not desirable, normalization would give better results.