microRNAs and Primary Familial Brain Calcification

Denis Arthur Pinheiro de Moura[1]

1 - Laboratório de Imunopatologia Keizo Asami, Universidade Federal de Pernambuco

This project aims to identify microRNAs that target simultaneously more than two PFBC-causing genes.
Our general hypothesis is that calcification process might be regulated by microRNAs.
Thus, our specific hypothesis is that identifying the potential microRNAs that regulate more than one PFBC-causing gene at the same time may lead to the understanding of one regulatory mechanism of PFBC.

In order to test these hypotheses, I have extracted data from the miRDB database (http://www.mirdb.org/index.html) (Wong and Wang, 2015; Liu and Wang, 2019) regarding microRNAs that bind to each of the six PFBC-causing genes (SLC20A2, PDGFB, PDGFRB, XPR1, JAM2 and MYORG).

I have combined each list of microRNAs with its reported Target Score in an one-by-one table. Then, I have created a microRNA selection criteria of an average Target Score between both genes of at least 80, to select potential microRNAs involved with the regulation of both genes.
In result, I have filtered 17 different microRNAs that may be considered for testing its role on regulating PFBC-causing genes and the calcification process.

Methods

```
In [1]: import pandas as pd
        import numpy as np
```

```
In [2]: slc20a2 = pd.read_html('miRDBslc20a2.html')[0]
```

```
In [3]: slc20a2.columns = slc20a2.iloc[0]
```

```
In [4]: slc20a2 = slc20a2[1:]
```

```
In [5]: slc20a2.head()
```

Out[5]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	99	hsa-miR-144-3p	SLC20A2	solute carrier family 20 member 2
2	Details	2	99	hsa-miR-3613-3p	SLC20A2	solute carrier family 20 member 2
3	Details	3	98	hsa-miR-3924	SLC20A2	solute carrier family 20 member 2
4	Details	4	97	hsa-miR-101-3p	SLC20A2	solute carrier family 20 member 2
5	Details	5	97	hsa-miR-12129	SLC20A2	solute carrier family 20 member 2

In [6]:
```python
pdgfb = pd.read_html('miRDBpdgfb.html')[0]
pdgfb.columns = pdgfb.iloc[0]
pdgfb = pdgfb[1:]
pdgfb.head()
```

Out[6]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	99	hsa-miR-6867-5p	PDGFB	platelet derived growth factor subunit B
2	Details	2	95	hsa-miR-4451	PDGFB	platelet derived growth factor subunit B
3	Details	3	94	hsa-miR-6851-5p	PDGFB	platelet derived growth factor subunit B
4	Details	4	94	hsa-miR-3689d	PDGFB	platelet derived growth factor subunit B
5	Details	5	93	hsa-miR-3120-3p	PDGFB	platelet derived growth factor subunit B

In [7]:
```python
pdgfrb = pd.read_html('miRDBpdgfrb.html')[0]
pdgfrb.columns = pdgfrb.iloc[0]
pdgfrb = pdgfrb[1:]
pdgfrb.head()
```

Out[7]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	96	hsa-miR-6764-5p	PDGFRB	platelet derived growth factor receptor beta
2	Details	2	95	hsa-miR-4456	PDGFRB	platelet derived growth factor receptor beta
3	Details	3	93	hsa-miR-1915-3p	PDGFRB	platelet derived growth factor receptor beta
4	Details	4	92	hsa-miR-9-5p	PDGFRB	platelet derived growth factor receptor beta
5	Details	5	91	hsa-miR-6804-5p	PDGFRB	platelet derived growth factor receptor beta

In [8]:
```python
xpr1 = pd.read_html('miRDBxpr1.html')[0]
xpr1.columns = xpr1.iloc[0]
xpr1 = xpr1[1:]
xpr1.head()
```

Out[8]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	99	hsa-miR-1252-5p	XPR1	xenotropic and polytropic retrovirus receptor 1
2	Details	2	98	hsa-miR-2054	XPR1	xenotropic and polytropic retrovirus receptor 1
3	Details	3	97	hsa-miR-5692a	XPR1	xenotropic and polytropic retrovirus receptor 1
4	Details	4	97	hsa-miR-548at-5p	XPR1	xenotropic and polytropic retrovirus receptor 1
5	Details	5	96	hsa-miR-30d-5p	XPR1	xenotropic and polytropic retrovirus receptor 1

In [9]:
```python
jam2 = pd.read_html('miRDBjam2.html')[0]
jam2.columns = jam2.iloc[0]
jam2 = jam2[1:]
jam2.head()
```

Out[9]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	95	hsa-miR-514a-3p	JAM2	junctional adhesion molecule 2
2	Details	2	95	hsa-miR-514b-3p	JAM2	junctional adhesion molecule 2
3	Details	3	93	hsa-miR-1205	JAM2	junctional adhesion molecule 2
4	Details	4	93	hsa-miR-7114-5p	JAM2	junctional adhesion molecule 2
5	Details	5	93	hsa-miR-10394-5p	JAM2	junctional adhesion molecule 2

In [10]:
```python
myorg = pd.read_html('miRDBmyorg.html')[0]
myorg.columns = myorg.iloc[0]
myorg = myorg[1:]
myorg.head()
```

Out[10]:

	Target Detail	Target Rank	Target Score	miRNA Name	Gene Symbol	Gene Description
1	Details	1	99	hsa-miR-7110-3p	MYORG	myogenesis regulating glycosidase (putative)
2	Details	2	99	hsa-miR-4269	MYORG	myogenesis regulating glycosidase (putative)
3	Details	3	99	hsa-miR-6715b-5p	MYORG	myogenesis regulating glycosidase (putative)
4	Details	4	96	hsa-miR-218-5p	MYORG	myogenesis regulating glycosidase (putative)
5	Details	5	95	hsa-miR-12127	MYORG	myogenesis regulating glycosidase (putative)

In [11]:
```python
slc20a2Xpr1 = slc20a2.merge(xpr1, how = 'inner', on = 'miRNA Name')
slc20a2Xpr1
```

Out[11]:

	Target Detail_x	Target Rank_x	Target Score_x	miRNA Name	Gene Symbol_x	Gene Description_x	Target Detail_y	Target Rank_y	Target Score_y	G Symb
0	Details	2	99	hsa-miR-3613-3p	SLC20A2	solute carrier family 20 member 2	Details	114	72	XI
1	Details	15	92	hsa-miR-16-5p	SLC20A2	solute carrier family 20 member 2	Details	211	59	XI
2	Details	16	92	hsa-miR-15b-5p	SLC20A2	solute carrier family 20 member 2	Details	208	59	XI
3	Details	17	92	hsa-miR-15a-5p	SLC20A2	solute carrier family 20 member 2	Details	202	59	XI
4	Details	18	92	hsa-miR-195-5p	SLC20A2	solute carrier family 20 member 2	Details	201	59	XI
5	Details	20	91	hsa-miR-5585-5p	SLC20A2	solute carrier family 20 member 2	Details	176	62	XI
6	Details	24	90	hsa-miR-6838-5p	SLC20A2	solute carrier family 20 member 2	Details	198	59	XI
7	Details	25	90	hsa-miR-497-5p	SLC20A2	solute carrier family 20 member 2	Details	205	59	XI
8	Details	27	90	hsa-miR-424-5p	SLC20A2	solute carrier family 20 member 2	Details	203	59	XI
9	Details	28	88	hsa-miR-6878-5p	SLC20A2	solute carrier family 20 member 2	Details	19	94	XI
10	Details	30	87	hsa-miR-484	SLC20A2	solute carrier family 20 member 2	Details	212	58	XI
11	Details	33	85	hsa-miR-3155a	SLC20A2	solute carrier family 20 member 2	Details	239	54	XI
12	Details	34	85	hsa-miR-3155b	SLC20A2	solute carrier family 20 member 2	Details	240	54	XI
13	Details	39	80	hsa-miR-12136	SLC20A2	solute carrier family 20 member 2	Details	9	96	XI
14	Details	56	75	hsa-miR-513c-3p	SLC20A2	solute carrier family 20 member 2	Details	150	68	XI
15	Details	58	75	hsa-miR-193a-3p	SLC20A2	solute carrier family 20	Details	260	52	XI

In [12]:
```
slc20a2Xpr1Myorg = slc20a2Xpr1.merge(myorg, how = 'inner', on = 'miRNA Name
')
slc20a2Xpr1Myorg
```

Out[12]:

	Target Detail_x	Target Rank_x	Target Score_x	miRNA Name	Gene Symbol_x	Gene Description_x	Target Detail_y	Target Rank_y	Target Score_y	Gen Symbol_
0	Details	28	88	hsa-miR-6878-5p	SLC20A2	solute carrier family 20 member 2	Details	19	94	XPR

In [13]:
```
slc20a2Myorg = slc20a2.merge(myorg, how = 'inner', on = 'miRNA Name')
slc20a2Myorg
```

Out[13]:

	Target Detail_x	Target Rank_x	Target Score_x	miRNA Name	Gene Symbol_x	Gene Description_x	Target Detail_y	Target Rank_y	Target Score_y	Gen Symbol_
0	Details	19	91	hsa-miR-340-5p	SLC20A2	solute carrier family 20 member 2	Details	57	74	MYOR
1	Details	28	88	hsa-miR-6878-5p	SLC20A2	solute carrier family 20 member 2	Details	171	51	MYOR
2	Details	103	60	hsa-miR-6132	SLC20A2	solute carrier family 20 member 2	Details	118	59	MYOR
3	Details	104	60	hsa-miR-548s	SLC20A2	solute carrier family 20 member 2	Details	131	56	MYOR
4	Details	111	58	hsa-miR-7157-5p	SLC20A2	solute carrier family 20 member 2	Details	13	92	MYOR
5	Details	116	57	hsa-miR-4310	SLC20A2	solute carrier family 20 member 2	Details	10	94	MYOR
6	Details	121	54	hsa-miR-4469	SLC20A2	solute carrier family 20 member 2	Details	80	69	MYOR

```
In [14]: pdgfbPdgfrb = pdgfb.merge(pdgfrb, how = 'inner', on = 'miRNA Name')
         pdgfbPdgfrb
```

Out[14]:

	Target Detail_x	Target Rank_x	Target Score_x	miRNA Name	Gene Symbol_x	Gene Description_x	Target Detail_y	Target Rank_y	Target Score_y	G Symbo
0	Details	20	83	hsa-miR-498-3p	PDGFB	platelet derived growth factor subunit B	Details	37	73	PDGI
1	Details	27	80	hsa-miR-4692	PDGFB	platelet derived growth factor subunit B	Details	98	55	PDGI
2	Details	64	63	hsa-miR-6780b-5p	PDGFB	platelet derived growth factor subunit B	Details	79	59	PDGI
3	Details	72	60	hsa-miR-6785-5p	PDGFB	platelet derived growth factor subunit B	Details	73	61	PDGI
4	Details	73	60	hsa-miR-4728-5p	PDGFB	platelet derived growth factor subunit B	Details	68	61	PDGI
5	Details	77	58	hsa-miR-4725-3p	PDGFB	platelet derived growth factor subunit B	Details	77	59	PDGI
6	Details	88	55	hsa-miR-6883-5p	PDGFB	platelet derived growth factor subunit B	Details	72	61	PDGI
7	Details	90	55	hsa-miR-363-5p	PDGFB	platelet derived growth factor subunit B	Details	44	70	PDGI
8	Details	92	55	hsa-miR-149-3p	PDGFB	platelet derived growth factor subunit B	Details	71	61	PDGI
9	Details	93	55	hsa-miR-6745	PDGFB	platelet derived growth factor subunit B	Details	46	69	PDGI
10	Details	94	55	hsa-miR-4441	PDGFB	platelet derived growth factor subunit B	Details	22	82	PDGI

In [15]:
```python
slc20a2Jam2 = slc20a2.merge(jam2, how = 'inner', on ='miRNA Name')
slc20a2Jam2
```

Out[15]:

	Target Detail_x	Target Rank_x	Target Score_x	miRNA Name	Gene Symbol_x	Gene Description_x	Target Detail_y	Target Rank_y	Target Score_y	Ge Symbol
0	Details	2	99	hsa-miR-3613-3p	SLC20A2	solute carrier family 20 member 2	Details	63	64	JAI
1	Details	28	88	hsa-miR-6878-5p	SLC20A2	solute carrier family 20 member 2	Details	112	54	JAI
2	Details	76	68	hsa-miR-548ao-5p	SLC20A2	solute carrier family 20 member 2	Details	119	53	JAI
3	Details	77	68	hsa-miR-548ax	SLC20A2	solute carrier family 20 member 2	Details	121	53	JAI
4	Details	85	65	hsa-miR-338-5p	SLC20A2	solute carrier family 20 member 2	Details	7	92	JAI
5	Details	98	62	hsa-miR-548c-3p	SLC20A2	solute carrier family 20 member 2	Details	46	70	JAI
6	Details	102	62	hsa-miR-6844	SLC20A2	solute carrier family 20 member 2	Details	19	82	JAI
7	Details	118	56	hsa-miR-150-5p	SLC20A2	solute carrier family 20 member 2	Details	89	57	JAI
8	Details	125	53	hsa-miR-197-3p	SLC20A2	solute carrier family 20 member 2	Details	60	65	JAI

In [16]:
```python
def sharedTarget(gene1, gene2):
    sharedmiRNAs = []
    geneOne = gene1['Gene Symbol'][1]
    geneTwo = gene2['Gene Symbol'][1]
    for miRNA in enumerate(gene1['miRNA Name']):
        if miRNA[1] in gene2['miRNA Name'].unique():
            targetScore1 = int(gene1['Target Score'].iloc[miRNA[0]])
            targetScore2 = int(gene2[gene2['miRNA Name'].str.contains(miRNA[1])]['Target Score'])
            aveScore = int((targetScore1 + targetScore2) / 2)
            sharedmiRNAs.append([miRNA[1], geneOne, targetScore1, geneTwo, targetScore2, aveScore])
    return sharedmiRNAs
```

In [17]:
```
sharedTarget(slc20a2,xpr1)
```

Out[17]:
```
[['hsa-miR-3613-3p', 'SLC20A2', 99, 'XPR1', 72, 85],
 ['hsa-miR-16-5p', 'SLC20A2', 92, 'XPR1', 59, 75],
 ['hsa-miR-15b-5p', 'SLC20A2', 92, 'XPR1', 59, 75],
 ['hsa-miR-15a-5p', 'SLC20A2', 92, 'XPR1', 59, 75],
 ['hsa-miR-195-5p', 'SLC20A2', 92, 'XPR1', 59, 75],
 ['hsa-miR-5585-5p', 'SLC20A2', 91, 'XPR1', 62, 76],
 ['hsa-miR-6838-5p', 'SLC20A2', 90, 'XPR1', 59, 74],
 ['hsa-miR-497-5p', 'SLC20A2', 90, 'XPR1', 59, 74],
 ['hsa-miR-424-5p', 'SLC20A2', 90, 'XPR1', 59, 74],
 ['hsa-miR-6878-5p', 'SLC20A2', 88, 'XPR1', 94, 91],
 ['hsa-miR-484', 'SLC20A2', 87, 'XPR1', 58, 72],
 ['hsa-miR-3155a', 'SLC20A2', 85, 'XPR1', 54, 69],
 ['hsa-miR-3155b', 'SLC20A2', 85, 'XPR1', 54, 69],
 ['hsa-miR-12136', 'SLC20A2', 80, 'XPR1', 96, 88],
 ['hsa-miR-513c-3p', 'SLC20A2', 75, 'XPR1', 68, 71],
 ['hsa-miR-193a-3p', 'SLC20A2', 75, 'XPR1', 52, 63],
 ['hsa-miR-193b-3p', 'SLC20A2', 75, 'XPR1', 52, 63],
 ['hsa-miR-513a-3p', 'SLC20A2', 75, 'XPR1', 68, 71],
 ['hsa-miR-3606-3p', 'SLC20A2', 74, 'XPR1', 68, 71],
 ['hsa-miR-6743-5p', 'SLC20A2', 70, 'XPR1', 63, 66],
 ['hsa-miR-4688', 'SLC20A2', 70, 'XPR1', 62, 66],
 ['hsa-miR-6810-3p', 'SLC20A2', 69, 'XPR1', 53, 61],
 ['hsa-miR-6131', 'SLC20A2', 69, 'XPR1', 59, 64],
 ['hsa-miR-548ao-5p', 'SLC20A2', 68, 'XPR1', 75, 71],
 ['hsa-miR-548ax', 'SLC20A2', 68, 'XPR1', 75, 71],
 ['hsa-miR-3163', 'SLC20A2', 65, 'XPR1', 74, 69],
 ['hsa-miR-4517', 'SLC20A2', 65, 'XPR1', 74, 69],
 ['hsa-miR-3148', 'SLC20A2', 58, 'XPR1', 93, 75],
 ['hsa-miR-200a-3p', 'SLC20A2', 53, 'XPR1', 92, 72],
 ['hsa-miR-141-3p', 'SLC20A2', 53, 'XPR1', 92, 72]]
```

In [18]:
```
geneList = [slc20a2, xpr1, pdgfb, pdgfrb, jam2, myorg]
miRPFBC = dict()

for i in range(len(geneList)-1):
    count = len(geneList)-1-i
    while count > 0:
        miRNAs = sharedTarget(geneList[i],geneList[count])
        geneOne = miRNAs[0][1]
        geneTwo = miRNAs[0][3]
        if geneOne == geneTwo:
            count -= 1
        else:
            key = str(str(geneOne) + str(geneTwo))
            miRPFBC[key] = miRNAs
            count -= 1
```

In [19]:
```
miRPFBC.keys()
```

Out[19]:
```
dict_keys(['SLC20A2MYORG', 'SLC20A2JAM2', 'SLC20A2PDGFRB', 'SLC20A2PDGFB', 'S
LC20A2XPR1', 'XPR1JAM2', 'XPR1PDGFRB', 'XPR1PDGFB', 'PDGFBPDGFRB', 'PDGFBXPR1
', 'PDGFRBPDGFB', 'PDGFRBXPR1', 'JAM2XPR1'])
```

In [20]:
```python
df = pd.DataFrame.from_dict(miRPFBC['SLC20A2MYORG'])
df.columns = ['miRNA', 'G1', 'G1 Target Score', 'G2', 'G2 Target Score', 'Av
erage']
df.sort_values(['Average'], ascending = False)
df
```

Out[20]:

	miRNA	G1	G1 Target Score	G2	G2 Target Score	Average
0	hsa-miR-340-5p	SLC20A2	91	MYORG	74	82
1	hsa-miR-6878-5p	SLC20A2	88	MYORG	51	69
2	hsa-miR-6132	SLC20A2	60	MYORG	59	59
3	hsa-miR-548s	SLC20A2	60	MYORG	56	58
4	hsa-miR-7157-5p	SLC20A2	58	MYORG	92	75
5	hsa-miR-4310	SLC20A2	57	MYORG	94	75
6	hsa-miR-4469	SLC20A2	54	MYORG	69	61

In [21]:
```python
for key in miRPFBC:
    df = pd.DataFrame.from_dict(miRPFBC[key])
    df.columns = ['miRNA', 'G1', 'G1 Target Score', 'G2', 'G2 Target Score',
'Average']
    df.sort_values(['Average'], ascending = False)
#     df.to_csv('%s.csv' % key)
    print(df)
```

	miRNA	G1	G1 Target Score	G2	G2 Target Score	Average
0	hsa-miR-340-5p	SLC20A2	91	MYORG	74	82
1	hsa-miR-6878-5p	SLC20A2	88	MYORG	51	69
2	hsa-miR-6132	SLC20A2	60	MYORG	59	59
3	hsa-miR-548s	SLC20A2	60	MYORG	56	58
4	hsa-miR-7157-5p	SLC20A2	58	MYORG	92	75
5	hsa-miR-4310	SLC20A2	57	MYORG	94	75
6	hsa-miR-4469	SLC20A2	54	MYORG	69	61

	miRNA	G1	G1 Target Score	G2	G2 Target Score	Average
0	hsa-miR-3613-3p	SLC20A2	99	JAM2	64	81
1	hsa-miR-6878-5p	SLC20A2	88	JAM2	54	71
2	hsa-miR-548ao-5p	SLC20A2	68	JAM2	53	60
3	hsa-miR-548ax	SLC20A2	68	JAM2	53	60
4	hsa-miR-338-5p	SLC20A2	65	JAM2	92	78
5	hsa-miR-548c-3p	SLC20A2	62	JAM2	70	66
6	hsa-miR-6844	SLC20A2	62	JAM2	82	72
7	hsa-miR-150-5p	SLC20A2	56	JAM2	57	56
8	hsa-miR-197-3p	SLC20A2	53	JAM2	65	59

	miRNA	G1	G1 Target Score	G2	G2 Target Score	\
0	hsa-miR-3184-5p	SLC20A2	93	PDGFRB	67	
1	hsa-miR-423-5p	SLC20A2	93	PDGFRB	67	
2	hsa-miR-9-5p	SLC20A2	90	PDGFRB	92	
3	hsa-miR-889-3p	SLC20A2	88	PDGFRB	52	
4	hsa-miR-12136	SLC20A2	80	PDGFRB	64	
5	hsa-miR-4441	SLC20A2	80	PDGFRB	82	
6	hsa-miR-6754-5p	SLC20A2	76	PDGFRB	67	
7	hsa-miR-4270	SLC20A2	76	PDGFRB	67	
8	hsa-miR-1263	SLC20A2	65	PDGFRB	90	
9	hsa-miR-150-3p	SLC20A2	65	PDGFRB	76	
10	hsa-miR-548n	SLC20A2	65	PDGFRB	75	
11	hsa-miR-4672	SLC20A2	63	PDGFRB	73	
12	hsa-miR-7157-5p	SLC20A2	58	PDGFRB	54	
13	hsa-miR-4310	SLC20A2	57	PDGFRB	67	
14	hsa-miR-2861	SLC20A2	51	PDGFRB	63	

	Average
0	80
1	80
2	91
3	70
4	72
5	81
6	71
7	71
8	77
9	70
10	70
11	68
12	56
13	62
14	57

	miRNA	G1	G1 Target Score	G2	G2 Target Score	Average
0	hsa-miR-4441	SLC20A2	80	PDGFB	55	67
1	hsa-miR-3202	SLC20A2	73	PDGFB	70	71
2	hsa-miR-5194	SLC20A2	63	PDGFB	50	56
3	hsa-miR-6738-5p	SLC20A2	62	PDGFB	50	56
4	hsa-miR-767-5p	SLC20A2	57	PDGFB	63	60

	miRNA	G1	G1 Target Score	G2	G2 Target Score	Average
0	hsa-miR-3613-3p	SLC20A2	99	XPR1	72	85
1	hsa-miR-16-5p	SLC20A2	92	XPR1	59	75
2	hsa-miR-15b-5p	SLC20A2	92	XPR1	59	75
3	hsa-miR-15a-5p	SLC20A2	92	XPR1	59	75
4	hsa-miR-195-5p	SLC20A2	92	XPR1	59	7

In [22]:
```python
listOfMiRs = []
for key in miRPFBC:
    for miR in miRPFBC[key]:
        if miR[5] > 80:
            listOfMiRs.append(miR[:5])

# with open('miRs.txt', 'w') as f:
#     for miR in listOfMiRs:
#         f.write("%s\n" % miR)
```

In [23]:
```python
isunique = []
for miR in listOfMiRs:
    if miR[0] in isunique:
        continue
    else:
        isunique.append(miR[0])
print(isunique)
print(len(isunique))
```

```
['hsa-miR-340-5p', 'hsa-miR-3613-3p', 'hsa-miR-9-5p', 'hsa-miR-4441', 'hsa-mi
R-6878-5p', 'hsa-miR-12136', 'hsa-miR-518a-5p', 'hsa-miR-527', 'hsa-miR-30d-5
p', 'hsa-miR-30a-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p', 'hsa-miR-30b-5p', '
hsa-miR-1252-5p', 'hsa-miR-5692a', 'hsa-miR-1289', 'hsa-miR-6880-5p']
17
```

In [24]:
```python
import matplotlib
from matplotlib import pyplot as plt
import venn
```

In [25]:
```python
def getMiRs(gene):
    miRList = []
    for miR in gene['miRNA Name']:
        miRList.append(miR)
    return miRList
```

In [26]:
```python
miRSLC = getMiRs(slc20a2)
miRMYO = getMiRs(myorg)
miRPDGFB = getMiRs(pdgfb)
miRPDGFRB = getMiRs(pdgfrb)
miRXPR1 = getMiRs(xpr1)
miRJAM = getMiRs(jam2)
```

In [96]:
```python
#Total miRs
allList = [miRSLC, miRMYO, miRPDGFB, miRPDGFRB, miRXPR1, miRJAM]
totalmiRs = []
print(len(miRSLC))
print(len(miRMYO))
print(len(miRPDGFB))
print(len(miRPDGFRB))
print(len(miRXPR1))
print(len(miRJAM))
for lista in allList:
    for miR in lista:
        if miR not in totalmiRs:
            totalmiRs.append(miR)
print(len(totalmiRs))
```

```
132
179
112
117
282
143
753
```

In [ ]:

In [27]:
```python
def getIntersect(list1,list2):
    intersect = []
    for i in list1:
        if i in list2:
            intersect.append(i)
    return intersect
```

In [98]:
```python
#2-Venn

miRSlcMyo = getIntersect(miRSLC, miRMYO)
print(miRSlcMyo)
miRSlcPdgfb = getIntersect(miRSLC, miRPDGFB)
print(miRSlcPdgfb)
miRSlcPdgfrb = getIntersect(miRSLC, miRPDGFRB)
print(miRSlcPdgfrb)
miRSlcXpr1 = getIntersect(miRSLC, miRXPR1)
print(miRSlcXpr1)
miRSlcJam2 = getIntersect(miRSLC, miRJAM)
print(miRSlcJam2)

miRMyoPdgfb = getIntersect(miRMYO, miRPDGFB)
print(miRMyoPdgfb)
miRMyoPdgfrb = getIntersect(miRMYO, miRPDGFRB)
print(miRMyoPdgfrb)
miRMyoXpr1 = getIntersect(miRMYO, miRXPR1)
print(miRMyoXpr1)
miRMyoJam2 = getIntersect(miRMYO, miRJAM)
print(miRMyoJam2)

miRPdgfbPdgfrb = getIntersect(miRPDGFB, miRPDGFRB)
print(miRPdgfbPdgfrb)
miRPdgfbXpr1 = getIntersect(miRPDGFB, miRXPR1)
print(miRPdgfbXpr1)
miRPdgfbJam2 = getIntersect(miRPDGFB, miRJAM)
print(miRPdgfbJam2)

miRPdgfrbXpr1 = getIntersect(miRPDGFRB, miRXPR1)
print(miRPdgfrbXpr1)
miRPdgfrbJam2 = getIntersect(miRPDGFRB, miRJAM)
print(miRPdgfrbJam2)

miRXpr1Jam2 = getIntersect(miRXPR1, miRJAM)
print(miRXpr1Jam2)
```

```
['hsa-miR-340-5p', 'hsa-miR-6878-5p', 'hsa-miR-6132', 'hsa-miR-548s', 'hsa-mi
R-7157-5p', 'hsa-miR-4310', 'hsa-miR-4469']
['hsa-miR-4441', 'hsa-miR-3202', 'hsa-miR-5194', 'hsa-miR-6738-5p', 'hsa-miR-
767-5p']
['hsa-miR-3184-5p', 'hsa-miR-423-5p', 'hsa-miR-9-5p', 'hsa-miR-889-3p', 'hsa-
miR-12136', 'hsa-miR-4441', 'hsa-miR-6754-5p', 'hsa-miR-4270', 'hsa-miR-1263
', 'hsa-miR-150-3p', 'hsa-miR-548n', 'hsa-miR-4672', 'hsa-miR-7157-5p', 'hsa-
miR-4310', 'hsa-miR-2861']
['hsa-miR-3613-3p', 'hsa-miR-16-5p', 'hsa-miR-15b-5p', 'hsa-miR-15a-5p', 'hsa
-miR-195-5p', 'hsa-miR-5585-5p', 'hsa-miR-6838-5p', 'hsa-miR-497-5p', 'hsa-mi
R-424-5p', 'hsa-miR-6878-5p', 'hsa-miR-484', 'hsa-miR-3155a', 'hsa-miR-3155b
', 'hsa-miR-12136', 'hsa-miR-513c-3p', 'hsa-miR-193a-3p', 'hsa-miR-193b-3p',
'hsa-miR-513a-3p', 'hsa-miR-3606-3p', 'hsa-miR-6743-5p', 'hsa-miR-4688', 'hsa
-miR-6810-3p', 'hsa-miR-6131', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', 'hsa-miR-
3163', 'hsa-miR-4517', 'hsa-miR-3148', 'hsa-miR-200a-3p', 'hsa-miR-141-3p']
['hsa-miR-3613-3p', 'hsa-miR-6878-5p', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', '
hsa-miR-338-5p', 'hsa-miR-548c-3p', 'hsa-miR-6844', 'hsa-miR-150-5p', 'hsa-mi
R-197-3p']
['hsa-miR-4269', 'hsa-miR-6715b-5p', 'hsa-miR-6846-5p', 'hsa-miR-6848-5p', 'h
sa-miR-4426', 'hsa-miR-4667-3p', 'hsa-miR-4451', 'hsa-miR-4742-5p', 'hsa-miR-
4692', 'hsa-miR-4500', 'hsa-let-7g-5p', 'hsa-let-7c-5p', 'hsa-let-7e-5p', 'hs
a-let-7b-5p', 'hsa-let-7f-5p', 'hsa-let-7d-5p', 'hsa-let-7a-5p', 'hsa-let-7i-
5p', 'hsa-miR-98-5p', 'hsa-miR-4458', 'hsa-miR-4514', 'hsa-miR-4728-5p', 'hsa
-miR-6785-5p', 'hsa-miR-149-3p', 'hsa-miR-6883-5p', 'hsa-miR-4488', 'hsa-miR-
1237-5p', 'hsa-miR-4697-5p', 'hsa-miR-5787', 'hsa-miR-4505', 'hsa-miR-4430',
'hsa-miR-3652', 'hsa-miR-6745', 'hsa-miR-6081']
['hsa-miR-4310', 'hsa-miR-7157-5p', 'hsa-miR-1207-3p', 'hsa-miR-4692', 'hsa-m
iR-10394-5p', 'hsa-miR-1205', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-
211-5p', 'hsa-miR-204-5p', 'hsa-miR-4292', 'hsa-miR-149-3p', 'hsa-miR-6791-5p
', 'hsa-miR-6883-5p', 'hsa-miR-874-5p', 'hsa-miR-6791-3p', 'hsa-miR-6829-3p',
'hsa-miR-6745']
['hsa-miR-4667-3p', 'hsa-miR-6852-3p', 'hsa-miR-583', 'hsa-miR-3909', 'hsa-mi
R-1207-3p', 'hsa-miR-188-3p', 'hsa-miR-6853-3p', 'hsa-miR-4446-5p', 'hsa-miR-
6737-3p', 'hsa-miR-7157-3p', 'hsa-miR-5008-3p', 'hsa-miR-6833-3p', 'hsa-miR-3
182', 'hsa-miR-509-3p', 'hsa-miR-6878-5p']
['hsa-miR-124-3p', 'hsa-miR-506-3p', 'hsa-miR-6799-5p', 'hsa-miR-6779-5p', 'h
sa-miR-1273h-5p', 'hsa-miR-6780a-5p', 'hsa-miR-30b-3p', 'hsa-miR-3689a-3p', '
hsa-miR-3689c', 'hsa-miR-3689b-3p', 'hsa-miR-10394-5p', 'hsa-miR-1205', 'hsa-
miR-4447', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-3140-3p', 'hsa-miR-
7106-5p', 'hsa-miR-149-3p', 'hsa-miR-6878-5p']
['hsa-miR-498-3p', 'hsa-miR-4692', 'hsa-miR-6780b-5p', 'hsa-miR-6785-5p', 'hs
a-miR-4728-5p', 'hsa-miR-4725-3p', 'hsa-miR-6883-5p', 'hsa-miR-363-5p', 'hsa-
miR-149-3p', 'hsa-miR-6745', 'hsa-miR-4441']
['hsa-miR-6880-5p', 'hsa-miR-1289', 'hsa-miR-5692a', 'hsa-miR-6847-5p', 'hsa-
miR-1252-5p', 'hsa-miR-3679-3p', 'hsa-miR-9500', 'hsa-miR-579-3p', 'hsa-miR-6
64b-3p', 'hsa-miR-4294', 'hsa-miR-4524a-3p', 'hsa-miR-450a-1-3p', 'hsa-miR-46
67-3p', 'hsa-miR-4261', 'hsa-miR-4533', 'hsa-miR-7854-3p', 'hsa-miR-6832-5p',
'hsa-miR-12115', 'hsa-miR-8071']
['hsa-miR-4524a-3p', 'hsa-miR-6785-5p', 'hsa-miR-4728-5p', 'hsa-miR-18a-3p',
'hsa-miR-149-3p']
['hsa-miR-30b-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p', 'hsa-miR-30d-5p', 'hsa
-miR-30a-5p', 'hsa-miR-548k', 'hsa-miR-548av-5p', 'hsa-miR-8054', 'hsa-miR-12
136', 'hsa-miR-637', 'hsa-miR-3165', 'hsa-miR-1207-3p', 'hsa-miR-4726-3p']
['hsa-miR-30b-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p', 'hsa-miR-30d-5p', 'hsa
-miR-30a-5p', 'hsa-miR-1205', 'hsa-miR-10394-5p', 'hsa-miR-6840-3p', 'hsa-miR
-4728-5p', 'hsa-miR-149-3p', 'hsa-miR-6785-5p', 'hsa-miR-4424']
['hsa-miR-30d-5p', 'hsa-miR-30a-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p', 'hsa
-miR-30b-5p', 'hsa-miR-6878-5p', 'hsa-miR-7154-5p', 'hsa-miR-548h-3p', 'hsa-m
iR-548d-3p', 'hsa-miR-548bb-3p', 'hsa-miR-548z', 'hsa-miR-548ac', 'hsa-miR-51
8a-5p', 'hsa-miR-3662', 'hsa-miR-527', 'hsa-miR-548ap-3p', 'hsa-miR-548t-3p',
'hsa-miR-548aa', 'hsa-miR-373-5p', 'hsa-miR-548ax', 'hsa-miR-616-5p', 'hsa-mi
R-371b-5p', 'hsa-miR-548ao-5p', 'hsa-miR-3613-3p', 'hsa-miR-382-5p', 'hsa-miR
-877-3p', 'hsa-miR-10393-5p', 'hsa-miR-7977', 'hsa-miR-4524a-3p', 'hsa-miR-68
24-5p', 'hsa-miR-3149', 'hsa-miR-12124']
184
['hsa-miR-340-5p', 'hsa-miR-6878-5p', 'hsa-miR-6132', 'hsa-miR-548s', 'hsa-mi
R-7157-5p', 'hsa-miR-4310', 'hsa-miR-4469', 'hsa-miR-4441', 'hsa-miR-3202', '
hsa-miR-5194', 'hsa-miR-6738-5p', 'hsa-miR-767-5p', 'hsa-miR-3184-5p', 'hsa-m
```

In [112]:
```python
targetsTwo = []
allTwoVenn = [miRSlcMyo, miRSlcPdgfb, miRSlcPdgfrb, miRSlcXpr1, miRSlcJam
2, miRMyoPdgfb, miRMyoPdgfrb,
              miRMyoXpr1, miRMyoJam2, miRPdgfbPdgfrb, miRPdgfbXpr1, miRPd
gfbJam2, miRPdgfrbXpr1,
              miRPdgfrbJam2, miRXpr1Jam2]

for lista in allTwoVenn:
    for miR in lista:
        if miR not in targetsTwo:
            targetsTwo.append(miR)
print(len(targetsTwo))
print(targetsTwo)
```

```
184
['hsa-miR-340-5p', 'hsa-miR-6878-5p', 'hsa-miR-6132', 'hsa-miR-548s', 'hsa-mi
R-7157-5p', 'hsa-miR-4310', 'hsa-miR-4469', 'hsa-miR-4441', 'hsa-miR-3202', '
hsa-miR-5194', 'hsa-miR-6738-5p', 'hsa-miR-767-5p', 'hsa-miR-3184-5p', 'hsa-m
iR-423-5p', 'hsa-miR-9-5p', 'hsa-miR-889-3p', 'hsa-miR-12136', 'hsa-miR-6754-
5p', 'hsa-miR-4270', 'hsa-miR-1263', 'hsa-miR-150-3p', 'hsa-miR-548n', 'hsa-m
iR-4672', 'hsa-miR-2861', 'hsa-miR-3613-3p', 'hsa-miR-16-5p', 'hsa-miR-15b-5p
', 'hsa-miR-15a-5p', 'hsa-miR-195-5p', 'hsa-miR-5585-5p', 'hsa-miR-6838-5p',
'hsa-miR-497-5p', 'hsa-miR-424-5p', 'hsa-miR-484', 'hsa-miR-3155a', 'hsa-miR-
3155b', 'hsa-miR-513c-3p', 'hsa-miR-193a-3p', 'hsa-miR-193b-3p', 'hsa-miR-513
a-3p', 'hsa-miR-3606-3p', 'hsa-miR-6743-5p', 'hsa-miR-4688', 'hsa-miR-6810-3p
', 'hsa-miR-6131', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', 'hsa-miR-3163', 'hsa-
miR-4517', 'hsa-miR-3148', 'hsa-miR-200a-3p', 'hsa-miR-141-3p', 'hsa-miR-338-
5p', 'hsa-miR-548c-3p', 'hsa-miR-6844', 'hsa-miR-150-5p', 'hsa-miR-197-3p', '
hsa-miR-4269', 'hsa-miR-6715b-5p', 'hsa-miR-6846-5p', 'hsa-miR-6848-5p', 'hsa
-miR-4426', 'hsa-miR-4667-3p', 'hsa-miR-4451', 'hsa-miR-4742-5p', 'hsa-miR-46
92', 'hsa-miR-4500', 'hsa-let-7g-5p', 'hsa-let-7c-5p', 'hsa-let-7e-5p', 'hsa-
let-7b-5p', 'hsa-let-7f-5p', 'hsa-let-7d-5p', 'hsa-let-7a-5p', 'hsa-let-7i-5p
', 'hsa-miR-98-5p', 'hsa-miR-4458', 'hsa-miR-4514', 'hsa-miR-4728-5p', 'hsa-m
iR-6785-5p', 'hsa-miR-149-3p', 'hsa-miR-6883-5p', 'hsa-miR-4488', 'hsa-miR-12
37-5p', 'hsa-miR-4697-5p', 'hsa-miR-5787', 'hsa-miR-4505', 'hsa-miR-4430', 'h
sa-miR-3652', 'hsa-miR-6745', 'hsa-miR-6081', 'hsa-miR-1207-3p', 'hsa-miR-103
94-5p', 'hsa-miR-1205', 'hsa-miR-211-5p', 'hsa-miR-204-5p', 'hsa-miR-4292', '
hsa-miR-6791-5p', 'hsa-miR-874-5p', 'hsa-miR-6791-3p', 'hsa-miR-6829-3p', 'hs
a-miR-6852-3p', 'hsa-miR-583', 'hsa-miR-3909', 'hsa-miR-188-3p', 'hsa-miR-685
3-3p', 'hsa-miR-4446-5p', 'hsa-miR-6737-3p', 'hsa-miR-7157-3p', 'hsa-miR-5008
-3p', 'hsa-miR-6833-3p', 'hsa-miR-3182', 'hsa-miR-509-3p', 'hsa-miR-124-3p',
'hsa-miR-506-3p', 'hsa-miR-6799-5p', 'hsa-miR-6779-5p', 'hsa-miR-1273h-5p', '
hsa-miR-6780a-5p', 'hsa-miR-30b-3p', 'hsa-miR-3689a-3p', 'hsa-miR-3689c', 'hs
a-miR-3689b-3p', 'hsa-miR-4447', 'hsa-miR-3140-3p', 'hsa-miR-7106-5p', 'hsa-m
iR-498-3p', 'hsa-miR-6780b-5p', 'hsa-miR-4725-3p', 'hsa-miR-363-5p', 'hsa-miR
-6880-5p', 'hsa-miR-1289', 'hsa-miR-5692a', 'hsa-miR-6847-5p', 'hsa-miR-1252-
5p', 'hsa-miR-3679-3p', 'hsa-miR-9500', 'hsa-miR-579-3p', 'hsa-miR-664b-3p',
'hsa-miR-4294', 'hsa-miR-4524a-3p', 'hsa-miR-450a-1-3p', 'hsa-miR-4261', 'hsa
-miR-4533', 'hsa-miR-7854-3p', 'hsa-miR-6832-5p', 'hsa-miR-12115', 'hsa-miR-8
071', 'hsa-miR-18a-3p', 'hsa-miR-30b-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p',
'hsa-miR-30d-5p', 'hsa-miR-30a-5p', 'hsa-miR-548k', 'hsa-miR-548av-5p', 'hsa-
miR-8054', 'hsa-miR-637', 'hsa-miR-3165', 'hsa-miR-4726-3p', 'hsa-miR-6840-3p
', 'hsa-miR-4424', 'hsa-miR-7154-5p', 'hsa-miR-548h-3p', 'hsa-miR-548d-3p', '
hsa-miR-548bb-3p', 'hsa-miR-548z', 'hsa-miR-548ac', 'hsa-miR-518a-5p', 'hsa-m
iR-3662', 'hsa-miR-527', 'hsa-miR-548ap-3p', 'hsa-miR-548t-3p', 'hsa-miR-548a
a', 'hsa-miR-373-5p', 'hsa-miR-616-5p', 'hsa-miR-371b-5p', 'hsa-miR-382-5p',
'hsa-miR-877-3p', 'hsa-miR-10393-5p', 'hsa-miR-7977', 'hsa-miR-6824-5p', 'hsa
-miR-3149', 'hsa-miR-12124']
```

In [77]:
```python
def show2Venn(list1, list2, name1, name2):
    labels = venn.get_labels([set(list1), set(list2)], fill=['number'])
    fig, ax = venn.venn2(labels, names=[name1, name2])
    plt.figure(figsize=(30,20))
    plt.show()
    figname = str(name1) + '-' + str(name2)
    plt.savefig('%s.png' %figname)
    print(getIntersect(list1, list2))
```

In [76]:
```python
show2Venn(miRSLC, miRMYO, 'SLC20A2', 'MYORG')
```



```
<Figure size 2160x1440 with 0 Axes>
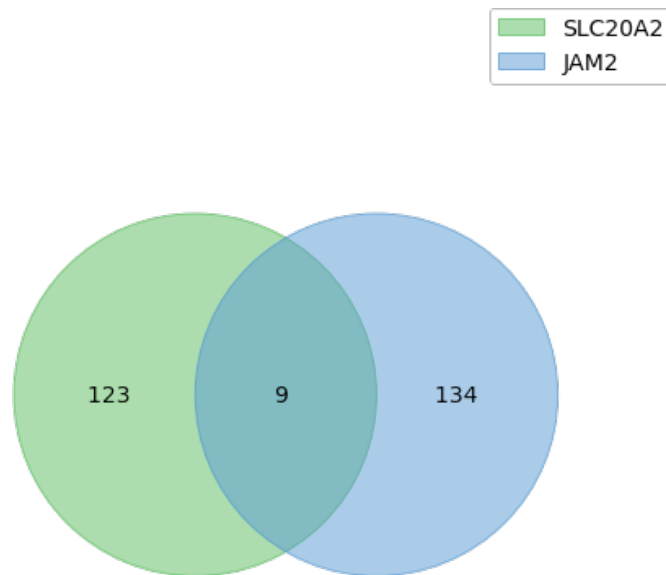```
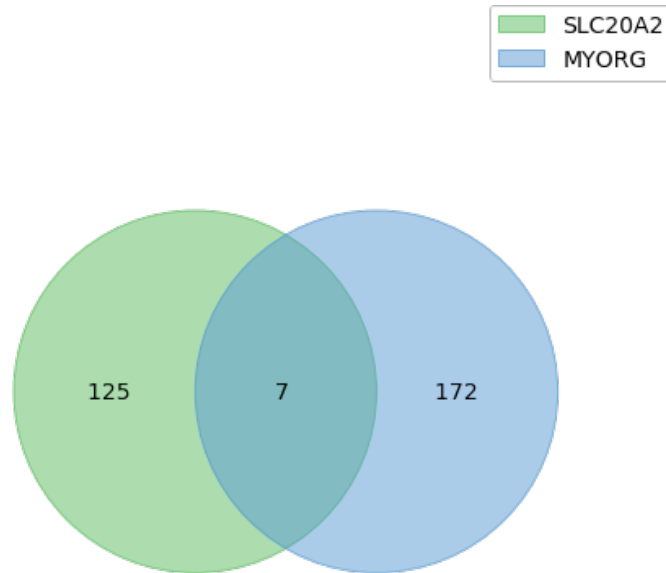
```
['hsa-miR-340-5p', 'hsa-miR-6878-5p', 'hsa-miR-6132', 'hsa-miR-548s', 'hsa-mi
R-7157-5p', 'hsa-miR-4310', 'hsa-miR-4469']
```

```
<Figure size 432x288 with 0 Axes>
```

In [78]: show2Venn(miRSLC, miRJAM, 'SLC20A2', 'JAM2')
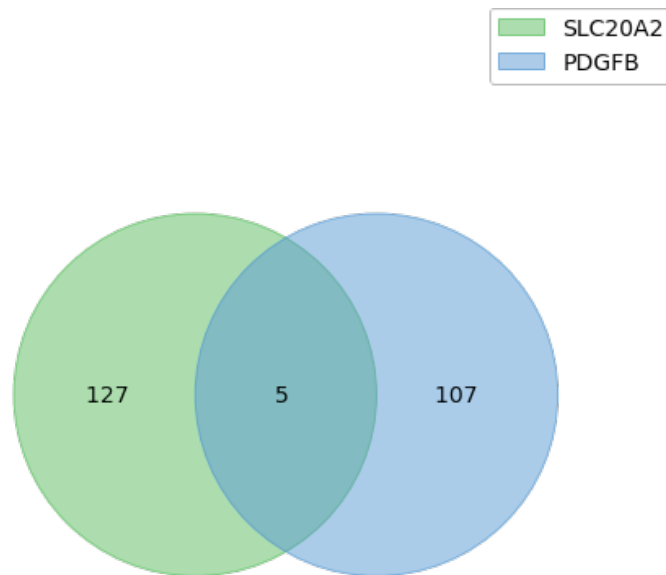

<Figure size 2160x1440 with 0 Axes>

['hsa-miR-3613-3p', 'hsa-miR-6878-5p', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', '
hsa-miR-338-5p', 'hsa-miR-548c-3p', 'hsa-miR-6844', 'hsa-miR-150-5p', 'hsa-mi
R-197-3p']

<Figure size 432x288 with 0 Axes>

In [79]: `show2Venn(miRSLC, miRPDGFB, 'SLC20A2', 'PDGFB')`

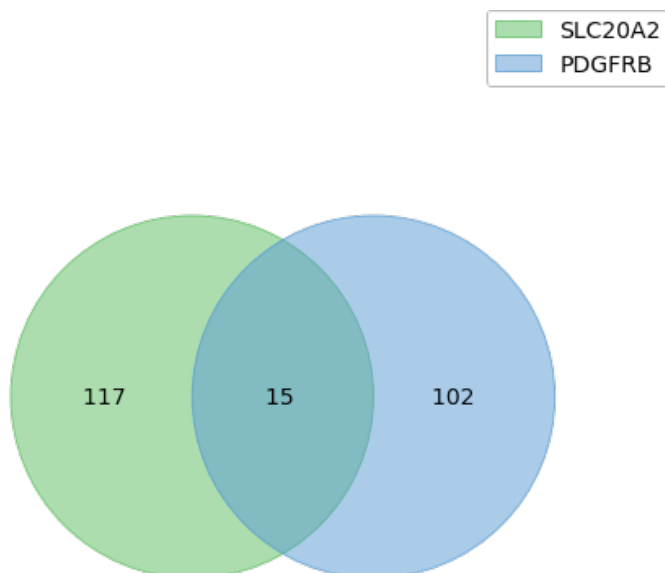<Figure size 2160x1440 with 0 Axes>

['hsa-miR-4441', 'hsa-miR-3202', 'hsa-miR-5194', 'hsa-miR-6738-5p', 'hsa-miR-767-5p']

<Figure size 432x288 with 0 Axes>

In [80]: `show2Venn(miRSLC, miRPDGFRB, 'SLC20A2', 'PDGFRB')`
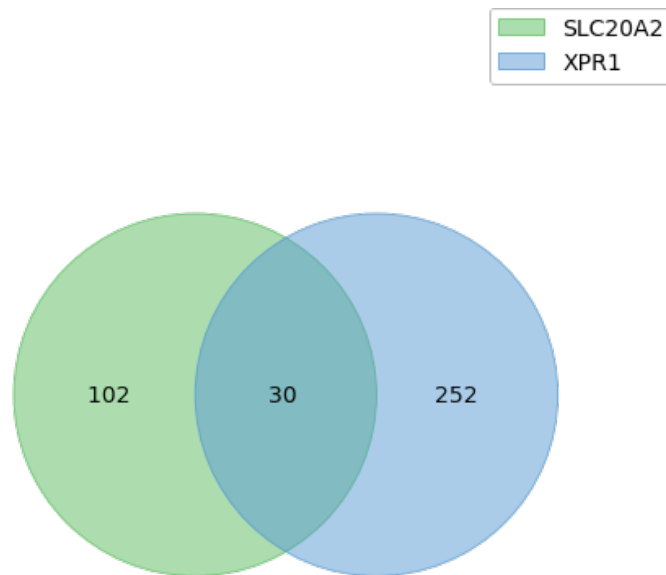

<Figure size 2160x1440 with 0 Axes>

['hsa-miR-3184-5p', 'hsa-miR-423-5p', 'hsa-miR-9-5p', 'hsa-miR-889-3p', 'hsa-miR-12136', 'hsa-miR-4441', 'hsa-miR-6754-5p', 'hsa-miR-4270', 'hsa-miR-1263', 'hsa-miR-150-3p', 'hsa-miR-548n', 'hsa-miR-4672', 'hsa-miR-7157-5p', 'hsa-miR-4310', 'hsa-miR-2861']

<Figure size 432x288 with 0 Axes>

In [81]: show2Venn(miRSLC, miRXPR1, 'SLC20A2', 'XPR1')


```
<Figure size 2160x1440 with 0 Axes>

['hsa-miR-3613-3p', 'hsa-miR-16-5p', 'hsa-miR-15b-5p', 'hsa-miR-15a-5p', 'hsa
-miR-195-5p', 'hsa-miR-5585-5p', 'hsa-miR-6838-5p', 'hsa-miR-497-5p', 'hsa-mi
R-424-5p', 'hsa-miR-6878-5p', 'hsa-miR-484', 'hsa-miR-3155a', 'hsa-miR-3155b
', 'hsa-miR-12136', 'hsa-miR-513c-3p', 'hsa-miR-193a-3p', 'hsa-miR-193b-3p',
'hsa-miR-513a-3p', 'hsa-miR-3606-3p', 'hsa-miR-6743-5p', 'hsa-miR-4688', 'hsa
-miR-6810-3p', 'hsa-miR-6131', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', 'hsa-miR-
3163', 'hsa-miR-4517', 'hsa-miR-3148', 'hsa-miR-200a-3p', 'hsa-miR-141-3p']

<Figure size 432x288 with 0 Axes>
```

```
In [110]:   #3-Venn intersect
            miRSlcMyoPdgfb = getIntersect(miRSlcMyo, miRPDGFB)
            print(miRSlcMyoPdgfb)
            miRSlcMyoPdgfrb = getIntersect(miRSlcMyo, miRPDGFRB)
            print(miRSlcMyoPdgfrb)
            miRSlcMyoXpr1 = getIntersect(miRSlcMyo, miRXPR1)
            print(miRSlcMyoXpr1)
            miRSlcMyoJam2 = getIntersect(miRSlcMyo, miRJAM)
            print(miRSlcMyoJam2)

            miRSlcPdgfbPdgfrb = getIntersect(miRSlcPdgfb, miRPDGFRB)
            print(miRSlcPdgfbPdgfrb)
            miRSlcPdgfbXpr1 = getIntersect(miRSlcPdgfb, miRXPR1)
            print(miRSlcPdgfbXpr1)
            miRSlcPdgfbJam2 = getIntersect(miRSlcPdgfb, miRJAM)
            print(miRSlcPdgfbJam2)

            miRSlcPdgfrbXpr1 = getIntersect(miRSlcPdgfrb, miRXPR1)
            print(miRSlcPdgfrbXpr1)
            miRSlcPdgfrbJam2 = getIntersect(miRSlcPdgfrb, miRJAM)
            print(miRSlcPdgfrbJam2)

            miRSlcXpr1Jam2 = getIntersect(miRSlcXpr1, miRJAM)
            print(miRSlcXpr1Jam2)

            miRMyoPdgfbPdgfrb = getIntersect(miRMyoPdgfb, miRPDGFRB)
            print(miRMyoPdgfbPdgfrb)
            miRMyoPdgfbXpr1 = getIntersect(miRMyoPdgfb, miRXPR1)
            print(miRMyoPdgfbXpr1)
            miRMyoPdgfbJam2 = getIntersect(miRMyoPdgfb, miRJAM)
            print(miRMyoPdgfbJam2)

            miRMyoPdgfrbXpr1 = getIntersect(miRMyoPdgfrb, miRXPR1)
            print(miRMyoPdgfrbXpr1)
            miRMyoPdgfrbJam2 = getIntersect(miRMyoPdgfrb, miRJAM)
            print(miRMyoPdgfrbJam2)

            miRMyoXpr1Jam2 = getIntersect(miRMyoXpr1, miRJAM)
            print(miRMyoXpr1Jam2)

            miRPdgfbPdgfrbXpr1 = getIntersect(miRPdgfbPdgfrb, miRXPR1)
            print(miRPdgfbPdgfrbXpr1)
            miRPdgfbPdgfrbJam2 = getIntersect(miRPdgfbPdgfrb, miRJAM)
            print(miRPdgfbPdgfrbJam2)
            miRPdgfbXpr1Jam2 = getIntersect(miRPdgfbXpr1, miRJAM)
            print(miRPdgfbPdgfrbXpr1)

            miRPdgfrbXpr1Jam2 = getIntersect(miRPdgfrbXpr1, miRJAM)
            print(miRPdgfrbXpr1Jam2)
```

```
[]
['hsa-miR-7157-5p', 'hsa-miR-4310']
['hsa-miR-6878-5p']
['hsa-miR-6878-5p']
['hsa-miR-4441']
[]
[]
['hsa-miR-12136']
[]
['hsa-miR-3613-3p', 'hsa-miR-6878-5p', 'hsa-miR-548ao-5p', 'hsa-miR-548ax']
['hsa-miR-4692', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-149-3p', 'hsa
-miR-6883-5p', 'hsa-miR-6745']
['hsa-miR-4667-3p']
['hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-149-3p']
['hsa-miR-1207-3p']
['hsa-miR-10394-5p', 'hsa-miR-1205', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'h
sa-miR-149-3p']
['hsa-miR-6878-5p']
[]
['hsa-miR-6785-5p', 'hsa-miR-4728-5p', 'hsa-miR-149-3p']
[]
['hsa-miR-30b-5p', 'hsa-miR-30c-5p', 'hsa-miR-30e-5p', 'hsa-miR-30d-5p', 'hsa
-miR-30a-5p']
```

In [113]:
```python
targetsThree = []
allThreeVenn = [
    miRSlcMyoPdgfb, miRSlcMyoPdgfrb, miRSlcMyoXpr1, miRSlcMyoJam2,
    miRSlcPdgfbPdgfrb, miRSlcPdgfbXpr1, miRSlcPdgfbJam2, miRSlcPdgfrbXpr1,
    miRSlcPdgfrbJam2, miRSlcXpr1Jam2, miRMyoPdgfbPdgfrb, miRMyoPdgfbXpr1,
    miRMyoPdgfbJam2, miRMyoPdgfrbXpr1, miRMyoPdgfrbJam2, miRMyoXpr1Jam2,
    miRPdgfbPdgfrbXpr1, miRPdgfbPdgfrbJam2, miRPdgfbXpr1Jam2, miRPdgfrbXpr1J
am2
                ]

for lista in allThreeVenn:
    for miR in lista:
        if miR not in targetsThree:
            targetsThree.append(miR)
print(len(targetsThree))
print(targetsThree)
```

```
24
['hsa-miR-7157-5p', 'hsa-miR-4310', 'hsa-miR-6878-5p', 'hsa-miR-4441', 'hsa-m
iR-12136', 'hsa-miR-3613-3p', 'hsa-miR-548ao-5p', 'hsa-miR-548ax', 'hsa-miR-4
692', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-149-3p', 'hsa-miR-6883-5
p', 'hsa-miR-6745', 'hsa-miR-4667-3p', 'hsa-miR-1207-3p', 'hsa-miR-10394-5p',
'hsa-miR-1205', 'hsa-miR-4524a-3p', 'hsa-miR-30b-5p', 'hsa-miR-30c-5p', 'hsa-
miR-30e-5p', 'hsa-miR-30d-5p', 'hsa-miR-30a-5p']
```

In [ ]:
```python
#3-Venn Show
```

In [114]:
```python
#4-Venn intersect

miRSlcMyoPdgfbPdgfrb = getIntersect(miRSlcMyoPdgfb, miRPDGFRB)
print(miRSlcMyoPdgfbPdgfrb)
miRSlcMyoPdgfbXpr1 = getIntersect(miRSlcMyoPdgfb, miRXPR1)
print(miRSlcMyoPdgfbXpr1)
miRSlcMyoPdgfbJam2 = getIntersect(miRSlcMyoPdgfb, miRJAM)
print(miRSlcMyoPdgfbJam2)

miRSlcMyoPdgfrbXpr1 = getIntersect(miRSlcMyoPdgfrb, miRXPR1)
print(miRSlcMyoPdgfrbXpr1)
miRSlcMyoPdgfrbJam2 = getIntersect(miRSlcMyoPdgfrb, miRJAM)
print(miRSlcMyoPdgfrbJam2)

miRSlcMyoXpr1Jam2 = getIntersect(miRSlcMyoXpr1, miRJAM)
print(miRSlcMyoXpr1Jam2)

miRMyoPdgfbPdgfrbXpr1 = getIntersect(miRMyoPdgfbPdgfrb, miRXPR1)
print(miRMyoPdgfbPdgfrbXpr1)
miRMyoPdgfbPdgfrbJam2 = getIntersect(miRMyoPdgfbPdgfrb, miRJAM)
print(miRMyoPdgfbPdgfrbJam2)
miRMyoPdgfbXpr1Jam2 = getIntersect(miRMyoPdgfbXpr1, miRJAM)
print(miRMyoPdgfbXpr1Jam2)
miRMyoPdgfrbXpr1Jam2 = getIntersect(miRMyoPdgfrbXpr1, miRJAM)
print(miRMyoPdgfrbXpr1Jam2)

miRPdgfbPdgfrbXpr1Jam2 = getIntersect(miRPdgfbPdgfrbXpr1, miRJAM)
print(miRPdgfbPdgfrbXpr1Jam2)
```

```
[]
[]
[]
[]
[]
['hsa-miR-6878-5p']
[]
['hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-149-3p']
[]
[]
[]
```

In [116]:
```python
targetsFour = []
allFourVenn = [
    miRSlcMyoPdgfbPdgfrb, miRSlcMyoPdgfbXpr1, miRSlcMyoPdgfbJam2,
    miRSlcMyoPdgfrbXpr1, miRSlcMyoPdgfrbJam2, miRSlcMyoXpr1Jam2,
    miRMyoPdgfbPdgfrbXpr1, miRMyoPdgfbPdgfrbJam2, miRMyoPdgfbXpr1Jam2,
    miRMyoPdgfrbXpr1Jam2, miRPdgfbPdgfrbXpr1Jam2
]

for lista in allFourVenn:
    for miR in lista:
        if miR not in targetsFour:
            targetsFour.append(miR)
print(len(targetsFour))
print(targetsFour)
```

```
4
['hsa-miR-6878-5p', 'hsa-miR-4728-5p', 'hsa-miR-6785-5p', 'hsa-miR-149-3p']
```

In [ ]:
```python
#4-Venn Show
```

In [84]:
```
#5-Venn Intersect

miRSlcMyoPdgfbPdgfrbXpr1 = getIntersect(miRSlcMyoPdgfbPdgfrb, miRXPR1)
print(miRSlcMyoPdgfbPdgfrbXpr1)
miRSlcMyoPdgfbPdgfrbJam2 = getIntersect(miRSlcMyoPdgfbPdgfrb, miRJAM)
print(miRSlcMyoPdgfbPdgfrbJam2)

miRMyoPdgfbPdgfrbXpr1Jam2 = getIntersect(miRMyoPdgfbPdgfrbXpr1, miRJAM)
print(miRMyoPdgfbPdgfrbXpr1Jam2)
```

```
[]
[]
[]
```

In [ ]:
```
#5-Venn Show
```

In [85]:
```
#6-Venn Intersect
miRSlcMyoPdgfbPdgfrbXpr1Jam2 = getIntersect(miRSlcMyoPdgfbPdgfrbXpr1, miRJAM)
print(miRSlcMyoPdgfbPdgfrbXpr1Jam2)
```
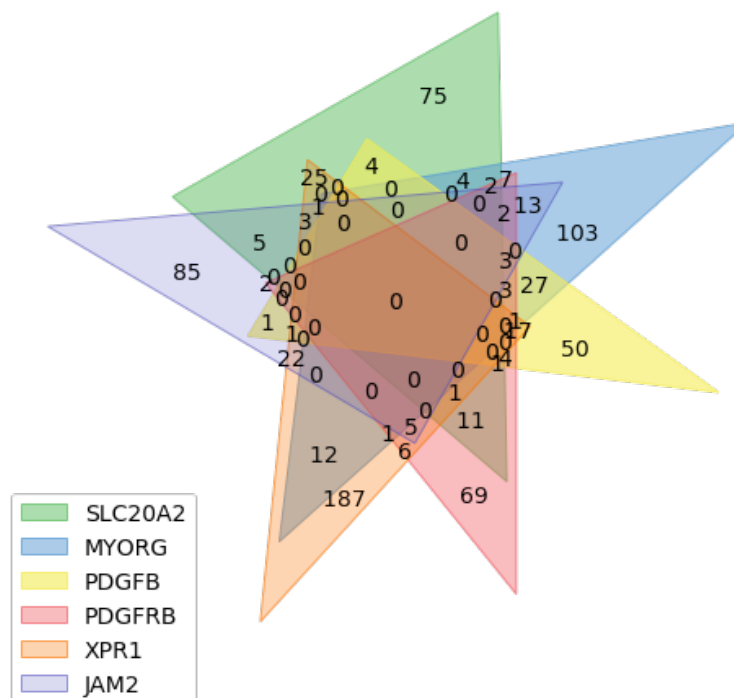
```
[]
```

In [63]:
```
#6-Venn
%matplotlib inline
labels = venn.get_labels([set(miRSLC), set(miRMYO), set(miRPDGFB), set(miRPDGFRB), set(miRXPR1), set(miRJAM)], fill=['number']
                         )
fig, ax = venn.venn6(labels, names=['SLC20A2', 'MYORG', 'PDGFB', 'PDGFRB', 'XPR1', 'JAM2'])
plt.figure(figsize=(30,20))
plt.savefig('miRVenn.png', bbox_inches='tight')
plt.show()
```



```
<Figure size 2160x1440 with 0 Axes>
```
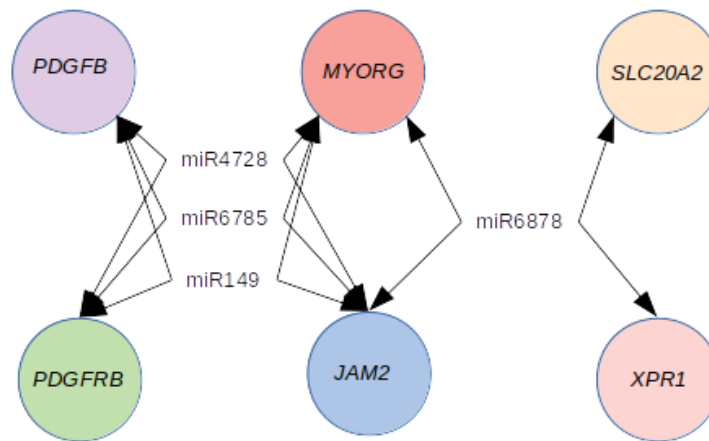
Figure Legend:

6-Venn Diagram of microRNAs that target each PFBC-causing gene. The intersection points and values represent the number of microRNAs shared by the intersecting genes. No microRNA targets all six or five of six genes simultaneously. Only four microRNAs are present in a four-gene intersection. 3 in one four-gene intersection of PDGFB, PDGFRB, XPR1 and JAM2, and 1 microRNA in the four-gene intersection of SLC20A2, XPR1, JAM2 and MYORG.

```python
for miR in targetsFour:
    if miR in slc20a2['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and SLC20A2: ' + str(int(slc20a2[slc20a2['miRNA Name'].str.contains(miR)]['Target Score'].values)))
    if miR in xpr1['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and XPR1: ' + str(int(xpr1[xpr1['miRNA Name'].str.contains(miR)]['Target Score'].values)))
    if miR in myorg['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and MYORG: ' + str(int(myorg[myorg['miRNA Name'].str.contains(miR)]['Target Score'].values)))
    if miR in pdgfb['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and PDGFB: ' + str(int(pdgfb[pdgfb['miRNA Name'].str.contains(miR)]['Target Score'].values)))
    if miR in pdgfrb['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and PDGFRB: ' + str(int(pdgfrb[pdgfrb['miRNA Name'].str.contains(miR)]['Target Score'].values)))
    if miR in jam2['miRNA Name'].values:
        print('Target Score between ' + str(miR) + ' and JAM2: ' + str(int(jam2[jam2['miRNA Name'].str.contains(miR)]['Target Score'].values)))
```

```
Target Score between hsa-miR-6878-5p and SLC20A2: 88
Target Score between hsa-miR-6878-5p and XPR1: 94
Target Score between hsa-miR-6878-5p and MYORG: 51
Target Score between hsa-miR-6878-5p and JAM2: 54
Target Score between hsa-miR-4728-5p and MYORG: 60
Target Score between hsa-miR-4728-5p and PDGFB: 60
Target Score between hsa-miR-4728-5p and PDGFRB: 61
Target Score between hsa-miR-4728-5p and JAM2: 62
Target Score between hsa-miR-6785-5p and MYORG: 60
Target Score between hsa-miR-6785-5p and PDGFB: 60
Target Score between hsa-miR-6785-5p and PDGFRB: 61
Target Score between hsa-miR-6785-5p and JAM2: 54
Target Score between hsa-miR-149-3p and MYORG: 56
Target Score between hsa-miR-149-3p and PDGFB: 55
Target Score between hsa-miR-149-3p and PDGFRB: 61
Target Score between hsa-miR-149-3p and JAM2: 55
```

Figure: Molecular Network of microRNAs and PFBC-genes

Figure Legend:
A representation of a putative molecular network binding all PFBC-genes by their interaction (regulation) with microRNAs. miR4728, miR6785, and miR149 links PFBC genes by targeting simultaneously PDGFB, PDGFRB, MYORG and JAM2, while miR6878 does the same to SLC20A2, MYORG, JAM2 and XPR1.

Discussion

We have found microRNAs that target more than one PFBC-causing gene simultaneously. Of a total of 753 microRNAs, 184 target at least two PFBC-causing genes at the same time, 24 target three genes simultaneously, and 4 target four of the six genes.

Although no microRNA targets all six genes, we have found that miR4728, miR6785, miR149 all target simultaneously PDGFB, PDGFRB, MYORG, JAM2 genes. Little is known about these microRNAs, and currently they are not linked to any specific pathway or disease. miR4728 and miR149 were reported in breast and cervical cancer studies (Lui, Pourmand, Patterson and Fire 2007; Persson et al, 2011), while no specific function or role was described for these molecules. miR6878 targets SLC20A2, XPR1, JAM2 and MYORG simultaneously, though no functional study was reported for this microRNA. Even though no specific role is confirmed for these microRNAs, they link the PFBC-causing genes together through potentially shared regulatory processes,.

This study identifies potential microRNAs that may participate in the progression of PFBC through the regulation of several PFBC-causing genes at the same time. Experimental in vitro studies are necessary to confirm the microRNAs regulatory process of PFBC genes, and further in vivo studies may be needed to confirm their role in the pathological phenotype of the disease.

Conclusion

This project successfully identified microRNAs that target simultaneously more than two PFBC-causing genes. miR4728, miR6785, miR149 and miR6878 through their regulatory potential of PFBC-causing genes, are important candidates for the development of PFBC phenotypes. Their specific function in regulating such genes is still unknown. Experimental in vitro and in vivo analysis are necessary to confirm these associations and the understand their function on PFBC.