# Coronavirus Liver and Blood Capillary Samples

Janis Corona

2/8/2020

These samples are the headers added from three Gene Expression Omnibus studies at

- ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE89166
- ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE89160
- ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE100509

The first two studies are part of the same study that used human liver tumor samples in vitro to compare the effects of the coronavirus over time. The third study used human microvascular blood capillaries in vitro to study the effects of the coronavirus over time.

In the first two studies that used the liver tumor samples to examine the effects of the coronavirus in vitro, there were four groups inoculated or treated with the active coronavirus and four groups not inoculated with the active coranavirus, and two samples that were treated with heat inactivated coronavirus, and two samples that were treated with active coronavirus and IL-1alpha to see the gene expression changes over one hour's time.

In the the third study that used blood capillaries, there were five samples followed over a 0,12,24,36, and 48 hour time intervals in groups A,B,C,D, and E that compared the time interval values of screening for changes in microarray analysis with a mock group of the same.

This following data is the data of all genes in common between these three studies, cleaned to remove missing values and with the attached gene symbols from the GEO platform for the probe IDs.

```
both <- read.csv('both_clean_liver_capillary_CoV.csv', sep=',', header=TRUE,
                 na.strings=c('',' '))

dim(both)

## [1] 21754    63

colnames(both)

##  [1] "GENE_SYMBOL"
##  [2] "LiverTumorSamples.GSM2359851_CoV1"
##  [3] "LiverTumorSamples.GSM2359853_CoV2"
##  [4] "LiverTumorSamples.GSM2359910_CoV3"
##  [5] "LiverTumorSamples.GSM2359913_CoV4"
##  [6] "LiverTumorSamples.GSM2359850_ctrl1"
##  [7] "LiverTumorSamples.GSM2359852_ctrl2"
```

```
##  [8] "LiverTumorSamples.GSM2359911_ctrl3"
##  [9] "LiverTumorSamples.GSM2359914_ctrl4"
## [10] "LiverTumorSamples.GSM2359912_Il1"
## [11] "LiverTumorSamples.GSM2359917_IL2"
## [12] "LiverTumorSamples.GSM2359915_inactiveHeatCoV1"
## [13] "LiverTumorSamples.GSM2359916_inactiveHeatCoV2"
## [14] "capillarySamples.GSM2685693_MERS_CoV_0hr_A"
## [15] "capillarySamples.GSM2685694_MERS_CoV_0hr_B"
## [16] "capillarySamples.GSM2685695_MERS_CoV_0hr_C"
## [17] "capillarySamples.GSM2685696_MERS_CoV_0hr_D"
## [18] "capillarySamples.GSM2685697_MERS_CoV_0hr_E"
## [19] "capillarySamples.GSM2685698_ctrl_0hr_A"
## [20] "capillarySamples.GSM2685699_ctrl_0hr_B"
## [21] "capillarySamples.GSM2685700_ctrl_0hr_C"
## [22] "capillarySamples.GSM2685701_ctrl_0hr_D"
## [23] "capillarySamples.GSM2685702_ctrl_0hr_E"
## [24] "capillarySamples.GSM2685703_MERS_CoV_12hr_A"
## [25] "capillarySamples.GSM2685704_MERS_CoV_12hr_B"
## [26] "capillarySamples.GSM2685705_MERS_CoV_12hr_C"
## [27] "capillarySamples.GSM2685706_MERS_CoV_12hr_D"
## [28] "capillarySamples.GSM2685707_MERS_CoV_12hr_E"
## [29] "capillarySamples.GSM2685708_ctrl_12hr_A"
## [30] "capillarySamples.GSM2685709_ctrl_12hr_B"
## [31] "capillarySamples.GSM2685710_ctrl_12hr_C"
## [32] "capillarySamples.GSM2685711_ctrl_12hr_D"
## [33] "capillarySamples.GSM2685712_ctrl_12hr_E"
## [34] "capillarySamples.GSM2685713_MERS_CoV_24hr_A"
## [35] "capillarySamples.GSM2685714_MERS_CoV_24hr_B"
## [36] "capillarySamples.GSM2685715_MERS_CoV_24hr_C"
## [37] "capillarySamples.GSM2685716_MERS_CoV_24hr_D"
## [38] "capillarySamples.GSM2685717_MERS_CoV_24hr_E"
## [39] "capillarySamples.GSM2685718_ctrl_24hr_A"
## [40] "capillarySamples.GSM2685719_ctrl_24hr_B"
## [41] "capillarySamples.GSM2685720_ctrl_24hr_C"
## [42] "capillarySamples.GSM2685721_ctrl_24hr_D"
## [43] "capillarySamples.GSM2685722_ctrl_24hr_E"
## [44] "capillarySamples.GSM2685723_MERS_CoV_36hr_A"
## [45] "capillarySamples.GSM2685724_MERS_CoV_36hr_B"
## [46] "capillarySamples.GSM2685725_MERS_CoV_36hr_C"
## [47] "capillarySamples.GSM2685726_MERS_CoV_36hr_D"
## [48] "capillarySamples.GSM2685727_MERS_CoV_36hr_E"
## [49] "capillarySamples.GSM2685728_ctrl_36hr_A"
## [50] "capillarySamples.GSM2685729_ctrl_36hr_B"
## [51] "capillarySamples.GSM2685730_ctrl_36hr_C"
## [52] "capillarySamples.GSM2685731_ctrl_36hr_D"
## [53] "capillarySamples.GSM2685732_ctrl_36hr_E"
## [54] "capillarySamples.GSM2685733_MERS_CoV_48hr_A"
## [55] "capillarySamples.GSM2685734_MERS_CoV_48hr_B"
## [56] "capillarySamples.GSM2685735_MERS_CoV_48hr_C"
## [57] "capillarySamples.GSM2685736_MERS_CoV_48hr_D"
```

```
## [58] "capillarySamples.GSM2685737_MERS_CoV_48hr_E"
## [59] "capillarySamples.GSM2685738_ctrl_48hr_A"
## [60] "capillarySamples.GSM2685739_ctrl_48hr_B"
## [61] "capillarySamples.GSM2685740_ctrl_48hr_C"
## [62] "capillarySamples.GSM2685741_ctrl_48hr_D"
## [63] "capillarySamples.GSM2685742_ctrl_48hr_E"
```

---

---

Lets group the samples that are our columns with descriptive and GEO ID names into their respective groups, get the fold change between the controls from those groups, attach to the original data table, both, as a different names, then order by the genes that have the most fold change then the least fold change. Take the first 100 genes from both lists, combine into one table of 200 genes and the samples with their fold change values ordered, make into a transposed data frame so that the samples are the rows, the stats removed, and the 200 genes are the header columns to save as a machine learning ready file.

---

---

Liver tumor study control and CoV treated. Also, the IL-alpha treated and the inactive CoV treated tables are in this code block.

```
names <- both$GENE_SYMBOL

liverCtrl <- both[,c(6:9)]
row.names(liverCtrl) <- names

liverCoV <- both[,c(2:5)]
row.names(liverCoV) <- names

liverIL <- both[,10:11]
row.names(liverIL) <- names

liverIACoV <- both[,12:13]
row.names(liverIACoV) <- names
```

Get the row means of those liver samples groups each.

```
liverCtrl$CtrlMeanLvr <- rowMeans(liverCtrl)
liverCoV$CoVMeanLvr <- rowMeans(liverCoV)
liverIL$ILMeanLvr <- rowMeans(liverIL)
liverIACoV$IACoVMeanLvr <- rowMeans(liverIACoV)
```

Get the fold change values of those states as a ratio to the control group values.

```
fold1 <-
as.data.frame(cbind(liverCtrl$CtrlMeanLvr,liverCoV$CoVMeanLvr,liverIL$ILMeanL
```

```
vr,
                liverIACoV$IACoVMeanLvr))
row.names(fold1) <- names
colnames(fold1) <- c('CtrlMeanLvr','CoVMeanLvr','ILMeanLvr','IACoVMeanLvr')

fold1$FC_CoV <- fold1$CoVMeanLvr/fold1$CtrlMeanLvr
fold1$FC_IL <- fold1$ILMeanLvr/fold1$CtrlMeanLvr
fold1$FC_IACov <- fold1$IACoVMeanLvr/fold1$CtrlMeanLvr
```

Most expressed in liver samples by fold change of the Coronavirus, inactive CoronaVirus, and the IL-alpha treated Coronavirus as tables.

```
mostCoV <- fold1[order(fold1$FC_CoV, decreasing = TRUE)[0:100],]
mostIL <- fold1[order(fold1$FC_IL, decreasing = TRUE)[0:100],]
mostIACoV <- fold1[order(fold1$FC_IACov, decreasing = TRUE)[0:100],]
```

Least expressed in liver samples by fold change of the Coronavirus, inactive CoronaVirus, and the IL-alpha treated Coronavirus as tables.

```
leastCoV <- fold1[order(fold1$FC_CoV, decreasing = FALSE)[0:100],]
leastIL <- fold1[order(fold1$FC_IL, decreasing = FALSE)[0:100],]
leastIACoV <- fold1[order(fold1$FC_IACov, decreasing = FALSE)[0:100],]
```

Gene Expressions with most changes in the liver samples.

```
changes <- rbind(mostCoV,mostIL,mostIACoV,leastCoV,leastIL,leastIACoV)
Changes <- changes[!duplicated(row.names(changes)),]
length(unique(row.names(Changes)))

## [1] 600
```

Get the magnitude of the fold change genes' row means.

```
Changes$MagnitudeFCs <- abs(rowMeans(Changes[,5:7]))
```

Combine this to the samples data for the liver tumor group.

```
Changes$Gene <- row.names(Changes)
combined1 <- merge(both, Changes, by.x='GENE_SYMBOL', by.y='Gene')

combined2 <- combined1[order(combined1$MagnitudeFCs, decreasing=TRUE),]

CombinedLiver <- combined2[c(0:100,354:453),]
```

Machine Learning data for liver samples with 200 genes in the group of most gene expression changes.

```
names1 <- CombinedLiver$GENE_SYMBOL
names2 <- colnames(CombinedLiver)
row.names(CombinedLiver) <- names1

Combo_lvr_ML <- as.data.frame(t(CombinedLiver))
```

```
colnames(Combo_lvr_ML) <- gsub('-','_',colnames(Combo_lvr_ML))
Combo1 <- Combo_lvr_ML[c(2:63),] #remove stats of fold change values and gene symbol row
```

Lets add a class field called Class_Type to use machine learning on predicting class with these 200 genes and 62 mixed samples of capillary and liver tumor both inoculated with Coronavirus.

```
a <- rep('liver_CoV', 4)
b <- rep('liver_Ctrl',4)
c <- rep('liver_CoV_IL',2)
d <- rep('liver_IA_CoV',2)
e <- rep('capillary_CoV_0hr',5)
f <- rep('capillary_Ctrl_0hr',5)
g <- rep('capillary_Cov_12hr',5)
h <- rep('capillary_Ctrl_12hr',5)
i <- rep('capillary_Cov_24hr',5)
j <- rep('capillary_Ctrl_24hr',5)
k <- rep('capillary_Cov_36hr',5)
l <- rep('capillary_Ctrl_36hr',5)
m <- rep('capillary_Cov_48hr',5)
n <- rep('capillary_Ctrl_48hr',5)

type <- as.data.frame(c(a,b,c,d,e,f,g,h,i,j,k,l,m,n))
colnames(type) <- 'Class_Type'
row.names(type) <- row.names(Combo1)
type
```

```
##                                                  Class_Type
## LiverTumorSamples.GSM2359851_CoV1                 liver_CoV
## LiverTumorSamples.GSM2359853_CoV2                 liver_CoV
## LiverTumorSamples.GSM2359910_CoV3                 liver_CoV
## LiverTumorSamples.GSM2359913_CoV4                 liver_CoV
## LiverTumorSamples.GSM2359850_ctrl1               liver_Ctrl
## LiverTumorSamples.GSM2359852_ctrl2               liver_Ctrl
## LiverTumorSamples.GSM2359911_ctrl3               liver_Ctrl
## LiverTumorSamples.GSM2359914_ctrl4               liver_Ctrl
## LiverTumorSamples.GSM2359912_Il1                liver_CoV_IL
## LiverTumorSamples.GSM2359917_IL2                liver_CoV_IL
## LiverTumorSamples.GSM2359915_inactiveHeatCoV1    liver_IA_CoV
## LiverTumorSamples.GSM2359916_inactiveHeatCoV2    liver_IA_CoV
## capillarySamples.GSM2685693_MERS_CoV_0hr_A     capillary_CoV_0hr
## capillarySamples.GSM2685694_MERS_CoV_0hr_B     capillary_CoV_0hr
## capillarySamples.GSM2685695_MERS_CoV_0hr_C     capillary_CoV_0hr
## capillarySamples.GSM2685696_MERS_CoV_0hr_D     capillary_CoV_0hr
## capillarySamples.GSM2685697_MERS_CoV_0hr_E     capillary_CoV_0hr
## capillarySamples.GSM2685698_ctrl_0hr_A        capillary_Ctrl_0hr
## capillarySamples.GSM2685699_ctrl_0hr_B        capillary_Ctrl_0hr
## capillarySamples.GSM2685700_ctrl_0hr_C        capillary_Ctrl_0hr
```

```
## capillarySamples.GSM2685701_ctrl_0hr_D         capillary_Ctrl_0hr
## capillarySamples.GSM2685702_ctrl_0hr_E         capillary_Ctrl_0hr
## capillarySamples.GSM2685703_MERS_CoV_12hr_A    capillary_Cov_12hr
## capillarySamples.GSM2685704_MERS_CoV_12hr_B    capillary_Cov_12hr
## capillarySamples.GSM2685705_MERS_CoV_12hr_C    capillary_Cov_12hr
## capillarySamples.GSM2685706_MERS_CoV_12hr_D    capillary_Cov_12hr
## capillarySamples.GSM2685707_MERS_CoV_12hr_E    capillary_Cov_12hr
## capillarySamples.GSM2685708_ctrl_12hr_A       capillary_Ctrl_12hr
## capillarySamples.GSM2685709_ctrl_12hr_B       capillary_Ctrl_12hr
## capillarySamples.GSM2685710_ctrl_12hr_C       capillary_Ctrl_12hr
## capillarySamples.GSM2685711_ctrl_12hr_D       capillary_Ctrl_12hr
## capillarySamples.GSM2685712_ctrl_12hr_E       capillary_Ctrl_12hr
## capillarySamples.GSM2685713_MERS_CoV_24hr_A    capillary_Cov_24hr
## capillarySamples.GSM2685714_MERS_CoV_24hr_B    capillary_Cov_24hr
## capillarySamples.GSM2685715_MERS_CoV_24hr_C    capillary_Cov_24hr
## capillarySamples.GSM2685716_MERS_CoV_24hr_D    capillary_Cov_24hr
## capillarySamples.GSM2685717_MERS_CoV_24hr_E    capillary_Cov_24hr
## capillarySamples.GSM2685718_ctrl_24hr_A       capillary_Ctrl_24hr
## capillarySamples.GSM2685719_ctrl_24hr_B       capillary_Ctrl_24hr
## capillarySamples.GSM2685720_ctrl_24hr_C       capillary_Ctrl_24hr
## capillarySamples.GSM2685721_ctrl_24hr_D       capillary_Ctrl_24hr
## capillarySamples.GSM2685722_ctrl_24hr_E       capillary_Ctrl_24hr
## capillarySamples.GSM2685723_MERS_CoV_36hr_A    capillary_Cov_36hr
## capillarySamples.GSM2685724_MERS_CoV_36hr_B    capillary_Cov_36hr
## capillarySamples.GSM2685725_MERS_CoV_36hr_C    capillary_Cov_36hr
## capillarySamples.GSM2685726_MERS_CoV_36hr_D    capillary_Cov_36hr
## capillarySamples.GSM2685727_MERS_CoV_36hr_E    capillary_Cov_36hr
## capillarySamples.GSM2685728_ctrl_36hr_A       capillary_Ctrl_36hr
## capillarySamples.GSM2685729_ctrl_36hr_B       capillary_Ctrl_36hr
## capillarySamples.GSM2685730_ctrl_36hr_C       capillary_Ctrl_36hr
## capillarySamples.GSM2685731_ctrl_36hr_D       capillary_Ctrl_36hr
## capillarySamples.GSM2685732_ctrl_36hr_E       capillary_Ctrl_36hr
## capillarySamples.GSM2685733_MERS_CoV_48hr_A    capillary_Cov_48hr
## capillarySamples.GSM2685734_MERS_CoV_48hr_B    capillary_Cov_48hr
## capillarySamples.GSM2685735_MERS_CoV_48hr_C    capillary_Cov_48hr
## capillarySamples.GSM2685736_MERS_CoV_48hr_D    capillary_Cov_48hr
## capillarySamples.GSM2685737_MERS_CoV_48hr_E    capillary_Cov_48hr
## capillarySamples.GSM2685738_ctrl_48hr_A       capillary_Ctrl_48hr
## capillarySamples.GSM2685739_ctrl_48hr_B       capillary_Ctrl_48hr
## capillarySamples.GSM2685740_ctrl_48hr_C       capillary_Ctrl_48hr
## capillarySamples.GSM2685741_ctrl_48hr_D       capillary_Ctrl_48hr
## capillarySamples.GSM2685742_ctrl_48hr_E       capillary_Ctrl_48hr

Combo2 <- cbind(type,Combo1)
Combo2[1:10,1:5]

##                                    Class_Type      NEURL3       DUSP1
## LiverTumorSamples.GSM2359851_CoV1     liver_CoV  1429.61750  8491.40875
## LiverTumorSamples.GSM2359853_CoV2     liver_CoV   190.21750  2219.85650
## LiverTumorSamples.GSM2359910_CoV3     liver_CoV   10.004148   11.494585
```

```
## LiverTumorSamples.GSM2359913_CoV4     liver_CoV   11.245589   12.898250
## LiverTumorSamples.GSM2359850_ctrl1   liver_Ctrl    34.57000   228.18775
## LiverTumorSamples.GSM2359852_ctrl2   liver_Ctrl    17.25750   216.08550
## LiverTumorSamples.GSM2359911_ctrl3   liver_Ctrl    3.708157    7.184185
## LiverTumorSamples.GSM2359914_ctrl4   liver_Ctrl    4.757780    7.113854
## LiverTumorSamples.GSM2359912_Il1   liver_CoV_IL    4.879242    9.576161
## LiverTumorSamples.GSM2359917_IL2   liver_CoV_IL   5.1138565   9.5527540
##                                             ATF3        PCLO
## LiverTumorSamples.GSM2359851_CoV1   3608.28250    17.74792
## LiverTumorSamples.GSM2359853_CoV2    974.76937   613.28583
## LiverTumorSamples.GSM2359910_CoV3     8.337322    3.355859
## LiverTumorSamples.GSM2359913_CoV4     9.441972    2.741117
## LiverTumorSamples.GSM2359850_ctrl1   108.52250    13.80667
## LiverTumorSamples.GSM2359852_ctrl2    97.05125    12.88750
## LiverTumorSamples.GSM2359911_ctrl3    5.373051    3.904719
## LiverTumorSamples.GSM2359914_ctrl4    5.513552    3.621765
## LiverTumorSamples.GSM2359912_Il1      6.500059    3.653289
## LiverTumorSamples.GSM2359917_IL2     6.6111744   3.7909157
```

Write this ML ready file to csv.

```
write.csv(Combo2, 'ML_ready_CoV_14_classes.csv', row.names=TRUE)
```

Make a separate ML ready file with a smaller set of classes to classify by liver or capillary and control or CoronaVirus

```
a <- rep('liver', 4)
b <- rep('liver',4)
c <- rep('liver',2)
d <- rep('liver',2)
e <- rep('capillary',5)
f <- rep('capillary',5)
g <- rep('capillary',5)
h <- rep('capillary',5)
i <- rep('capillary',5)
j <- rep('capillary',5)
k <- rep('capillary',5)
l <- rep('capillary',5)
m <- rep('capillary',5)
n <- rep('capillary',5)

type <- as.data.frame(c(a,b,c,d,e,f,g,h,i,j,k,l,m,n))
colnames(type) <- 'Class_Type'
row.names(type) <- row.names(Combo1)

Combo3 <- cbind(type,Combo1)

Combo3[1:10,1:5]
```

```
##                                  Class_Type      NEURL3       DUSP1
## LiverTumorSamples.GSM2359851_CoV1      liver  1429.61750  8491.40875
```

```
## LiverTumorSamples.GSM2359853_CoV2       liver   190.21750  2219.85650
## LiverTumorSamples.GSM2359910_CoV3       liver   10.004148   11.494585
## LiverTumorSamples.GSM2359913_CoV4       liver   11.245589   12.898250
## LiverTumorSamples.GSM2359850_ctrl1      liver    34.57000   228.18775
## LiverTumorSamples.GSM2359852_ctrl2      liver    17.25750   216.08550
## LiverTumorSamples.GSM2359911_ctrl3      liver    3.708157    7.184185
## LiverTumorSamples.GSM2359914_ctrl4      liver    4.757780    7.113854
## LiverTumorSamples.GSM2359912_Il1        liver    4.879242    9.576161
## LiverTumorSamples.GSM2359917_IL2        liver   5.1138565   9.5527540
##                                           ATF3        PCLO
## LiverTumorSamples.GSM2359851_CoV1   3608.28250    17.74792
## LiverTumorSamples.GSM2359853_CoV2    974.76937   613.28583
## LiverTumorSamples.GSM2359910_CoV3     8.337322    3.355859
## LiverTumorSamples.GSM2359913_CoV4     9.441972    2.741117
## LiverTumorSamples.GSM2359850_ctrl1   108.52250    13.80667
## LiverTumorSamples.GSM2359852_ctrl2    97.05125    12.88750
## LiverTumorSamples.GSM2359911_ctrl3    5.373051    3.904719
## LiverTumorSamples.GSM2359914_ctrl4    5.513552    3.621765
## LiverTumorSamples.GSM2359912_Il1      6.500059    3.653289
## LiverTumorSamples.GSM2359917_IL2     6.6111744   3.7909157
```

```
write.csv(Combo3, 'ML_ready_CoV_2_classes.csv', row.names=TRUE)
```

```
a <- rep('CoV', 4)
b <- rep('Ctrl',4)
c <- rep('CoV_IL',2)
d <- rep('IA_CoV',2)
e <- rep('CoV',5)
f <- rep('Ctrl',5)
g <- rep('Cov',5)
h <- rep('Ctrl',5)
i <- rep('Cov',5)
j <- rep('Ctrl',5)
k <- rep('Cov',5)
l <- rep('Ctrl',5)
m <- rep('Cov',5)
n <- rep('Ctrl',5)
```

```
type <- as.data.frame(c(a,b,c,d,e,f,g,h,i,j,k,l,m,n))
colnames(type) <- 'Class_Type'
row.names(type) <- row.names(Combo1)
```

```
Combo4 <- cbind(type,Combo1)
```

```
Combo4[1:10,1:5]
```

```
##                                  Class_Type      NEURL3       DUSP1
## LiverTumorSamples.GSM2359851_CoV1        CoV  1429.61750  8491.40875
## LiverTumorSamples.GSM2359853_CoV2        CoV   190.21750  2219.85650
## LiverTumorSamples.GSM2359910_CoV3        CoV   10.004148   11.494585
```

```
## LiverTumorSamples.GSM2359913_CoV4         CoV   11.245589   12.898250
## LiverTumorSamples.GSM2359850_ctrl1       Ctrl    34.57000   228.18775
## LiverTumorSamples.GSM2359852_ctrl2       Ctrl    17.25750   216.08550
## LiverTumorSamples.GSM2359911_ctrl3       Ctrl    3.708157    7.184185
## LiverTumorSamples.GSM2359914_ctrl4       Ctrl    4.757780    7.113854
## LiverTumorSamples.GSM2359912_Il1       CoV_IL    4.879242    9.576161
## LiverTumorSamples.GSM2359917_IL2       CoV_IL   5.1138565   9.5527540
##                                           ATF3        PCLO
## LiverTumorSamples.GSM2359851_CoV1   3608.28250    17.74792
## LiverTumorSamples.GSM2359853_CoV2    974.76937   613.28583
## LiverTumorSamples.GSM2359910_CoV3     8.337322    3.355859
## LiverTumorSamples.GSM2359913_CoV4     9.441972    2.741117
## LiverTumorSamples.GSM2359850_ctrl1   108.52250    13.80667
## LiverTumorSamples.GSM2359852_ctrl2    97.05125    12.88750
## LiverTumorSamples.GSM2359911_ctrl3    5.373051    3.904719
## LiverTumorSamples.GSM2359914_ctrl4    5.513552    3.621765
## LiverTumorSamples.GSM2359912_Il1      6.500059    3.653289
## LiverTumorSamples.GSM2359917_IL2     6.6111744   3.7909157
```

```
write.csv(Combo4, 'ML_ready_CoV_4_classes.csv', row.names=TRUE)
```

---

---

We didn't do any fold change or stat measures on the capillary samples, but we can plot them by using ggplot2 and group the sets by timed intervals for each group A through E and picking a handful of genes to compare over the 0,12,24,36, and 48 hour time intervals for the control group and the Coronavirus inoculated groups.

---

When the values are a ratio like this, it is easier to see the larger changes as in 9 compared to a low change like 0.0005, but this just means that compared to the control samples the inoculated Coronavirus had 9 times the gene expression values or had downregulated or suppressed gene expression values to 1/5000th the amount of the normal range of gene expression values respectively. ***

It makes sense to use some genes we already know have a higher magnitude of change, and we have a column for that in the CombinedLiver table called MagnitudeFCs that was already sorted from largest to smallest when made. We'll just select the first five of those genes to compare in these capillary samples over time.

```
mostChanged <- CombinedLiver[1:5,c(1,71)]
mostSuppressed <- CombinedLiver[196:200,c(1,71)]
row.names(mostChanged)
```

```
## [1] "NEURL3" "DUSP1"  "ATF3"   "PCLO"   "LHB"
```

```
row.names(mostSuppressed)
```

```
## [1] "RASSF7"       "LOC100335030" "C2orf78"      "DEFB1"        "ZNF610"

capillary <- merge(mostChanged, CombinedLiver, by.x='GENE_SYMBOL',
by.y='GENE_SYMBOL')
capillary1 <- merge(mostSuppressed, CombinedLiver, by.x='GENE_SYMBOL',
by.y='GENE_SYMBOL')
capillaries <- rbind(capillary,capillary1)
Capillaries <- capillaries[,c(1,15:64)]
row.names(Capillaries) <- Capillaries$GENE_SYMBOL

Capillaries2 <- as.data.frame(t(Capillaries))
Capillaries2 <- Capillaries2[-1,]
row.names(Capillaries2) <-
gsub('capillarySamples.','',row.names(Capillaries2))
row.names(Capillaries2) <- gsub('GSM[0-9][0-9][0-9][0-9][0-9][0-9][0-
9]_','',row.names(Capillaries2))
row.names(Capillaries2) <- gsub('MERS_','', row.names(Capillaries2))

CoV <- grep('CoV', row.names(Capillaries2))
ctrl <- grep('ctrl', row.names(Capillaries2))

Capillaries2$Class <- 'CoV or ctrl'

Capillaries2[CoV,11] <- 'Coronavirus'
Capillaries2[ctrl,11] <- 'control'

A <- grep('_A', row.names(Capillaries2))
B <- grep('_B', row.names(Capillaries2))
C <- grep('_C', row.names(Capillaries2))
D <- grep('_D', row.names(Capillaries2))
E <- grep('_E', row.names(Capillaries2))

Capillaries2$Group <- 'group'

Capillaries2[A,12] <- 'A'
Capillaries2[B,12] <- 'B'
Capillaries2[C,12] <- 'C'
Capillaries2[D,12] <- 'D'
Capillaries2[E,12] <- 'E'

hr0 <- grep('0hr', row.names(Capillaries2))
hr12 <- grep('12hr', row.names(Capillaries2))
hr24 <- grep('24hr', row.names(Capillaries2))
hr36 <- grep('36hr', row.names(Capillaries2))
hr48 <- grep('48hr', row.names(Capillaries2))

Capillaries2$TimeInterval <- 'time'

Capillaries2[hr0,13] <- '0 hr'
```

```
Capillaries2[hr12,13] <- '12 hr'
Capillaries2[hr24,13] <- '24 hr'
Capillaries2[hr36,13] <- '36 hr'
Capillaries2[hr48,13] <- '48 hr'

Capillaries2
```

```
##                  ATF3     DUSP1       LHB    NEURL3      PCLO   C2orf78
## CoV_0hr_A   10.290996 13.901505  9.093671  7.498965  6.468670  5.936451
## CoV_0hr_B    9.780412 13.852933  9.128886  7.446590  6.476326  6.023280
## CoV_0hr_C    9.574148 13.740905  8.662565  7.495092  6.463702  5.909934
## CoV_0hr_D    9.848204 13.863910  8.729845  7.364854  6.572579  5.986079
## CoV_0hr_E   10.114265 13.968982  8.738079  7.436675  6.625125  5.862801
## ctrl_0hr_A  10.173291 14.398733  8.776979  7.267773  6.410249  6.016610
## ctrl_0hr_B  10.132629 14.237192  9.610252  7.015544  6.467982  5.931786
## ctrl_0hr_C  10.308477 14.382699  9.557514  7.440873  6.478339  5.853411
## ctrl_0hr_D   9.888505 14.404923  9.602914  7.102155  6.489396  5.855096
## ctrl_0hr_E   9.892730 14.120833  9.577233  6.936543  6.417981  5.942510
## CoV_12hr_A   9.819186 11.303627 10.795022 12.768140  6.256646  5.865277
## CoV_12hr_B  10.011539 11.577456 11.006393 12.402078  6.327304  5.922540
## CoV_12hr_C   9.783105 11.626722 11.000187 12.532051  6.322820  5.988353
## CoV_12hr_D   9.849858 11.692725 10.938022 12.668202  6.261566  5.901327
## CoV_12hr_E   9.617070 12.220997 10.553798 12.273302  6.333485  5.898912
## ctrl_12hr_A  7.825226 11.488735  9.286872  6.829080  6.528833  5.954890
## ctrl_12hr_B  7.872041 11.710908  8.845744  6.784278  6.532492  5.862801
## ctrl_12hr_C  7.989155 11.468072  9.267328  6.908973  6.489589  5.973506
## ctrl_12hr_D  8.028735 11.407001  9.820556  6.615987  6.412667  5.928711
## ctrl_12hr_E  8.154875 11.042038  9.741747  6.833504  6.431864  5.862305
## CoV_24hr_A  12.356029 14.922819 10.081784 13.713997  6.330955  5.981748
## CoV_24hr_B  12.393863 14.762759 10.125434 13.516154  6.376025  5.938335
## CoV_24hr_C  12.347139 15.286795  9.988253 13.718699  6.398037  6.047165
## CoV_24hr_D  12.280955 15.019195  9.580647 13.576554  6.441270  6.099102
## CoV_24hr_E  12.187980 14.989084  9.508540 13.545156  6.428447  6.044217
## ctrl_24hr_A  7.914153 12.020454  8.926344  6.410178  6.709108  6.033401
## ctrl_24hr_B  8.179651 11.901618  9.159004  6.560892  6.642224  5.909934
## ctrl_24hr_C  8.062523 11.831523  9.275883  6.568645  6.626875  5.938570
## ctrl_24hr_D  8.045721 11.806023  9.273915  6.631753  6.618130  5.997365
## ctrl_24hr_E  8.204591 11.942950  9.125971  6.562419  6.697083  5.919444
## CoV_36hr_A  12.318180 14.508819  9.861903 13.561144  6.548994  6.087523
## CoV_36hr_B  12.173687 14.540567  9.802688 13.549071  6.644295  5.999396
## CoV_36hr_C  12.163530 14.579001  9.872176 13.449660  6.515321  5.933150
## CoV_36hr_D  12.142847 14.514722  9.982218 13.712803  6.671993  6.001650
## CoV_36hr_E  12.297080 14.374295 10.201176 13.521456  6.372439  6.051522
## ctrl_36hr_A  7.940682 11.742312  9.321322  6.730998  6.678982  6.220477
## ctrl_36hr_B  7.783378 11.751105  9.056790  6.621403  6.643658  6.125131
## ctrl_36hr_C  7.810544 11.798201  9.151894  6.822530  6.618794  6.092605
## ctrl_36hr_D  7.731982 11.876269  9.024215  6.685524  6.629717  6.098892
## ctrl_36hr_E  7.734450 11.888111  8.922796  6.630443  6.673160  6.028326
## CoV_48hr_A  11.205349 13.523040  9.679922 12.333937  6.529574  6.049019
## CoV_48hr_B  11.253111 13.511350  9.912659 12.481150  6.549794  5.980606
```

```
## CoV_48hr_C  10.944238 13.316529  9.850259 12.260608  6.708351  6.203350
## CoV_48hr_D  10.983900 13.358680  9.899124 11.961065  6.599227  6.142515
## CoV_48hr_E  11.255318 13.367467 10.184716 12.498831  6.679909  6.017946
## ctrl_48hr_A  7.932607 12.174103  9.024090  6.757483  6.552106  6.016387
## ctrl_48hr_B  7.668012 12.449589  8.985262  6.882334  6.700790  5.961156
## ctrl_48hr_C  7.755264 12.365436  9.031925  6.844960  6.455577  6.003225
## ctrl_48hr_D  7.725891 12.415529  8.940948  6.872043  6.533961  5.986534
## ctrl_48hr_E  7.656200 12.455840  8.994880  6.868035  6.479109  6.091125
##                 DEFB1 LOC100335030    RASSF7    ZNF610       Class Group
## CoV_0hr_A    7.622403     8.114815  6.822339  7.227249 Coronavirus     A
## CoV_0hr_B    7.778352     8.270884  6.700971  7.428115 Coronavirus     B
## CoV_0hr_C    7.352772     8.308822  6.966246  7.481717 Coronavirus     C
## CoV_0hr_D    7.118591     8.246936  6.875601  7.426565 Coronavirus     D
## CoV_0hr_E    7.179596     8.214737  6.952108  7.420473 Coronavirus     E
## ctrl_0hr_A   7.331124     8.187333  6.964110  7.403619     control     A
## ctrl_0hr_B   7.872561     8.288294  6.910892  7.464914     control     B
## ctrl_0hr_C   7.584274     8.147007  6.994899  7.269174     control     C
## ctrl_0hr_D   7.650353     8.185575  7.033153  7.359418     control     D
## ctrl_0hr_E   7.847725     8.156999  7.056144  7.447995     control     E
## CoV_12hr_A   8.059324     7.868801  6.594891  8.147592 Coronavirus     A
## CoV_12hr_B   7.843962     7.735502  6.692292  8.178197 Coronavirus     B
## CoV_12hr_C   7.985707     7.820541  6.586602  8.121462 Coronavirus     C
## CoV_12hr_D   7.995350     7.717794  6.571151  8.224417 Coronavirus     D
## CoV_12hr_E   7.418830     7.832236  6.801301  8.247149 Coronavirus     E
## ctrl_12hr_A  8.009080     8.069778  6.880927  7.524340     control     A
## ctrl_12hr_B  8.055858     7.986788  6.895230  7.537055     control     B
## ctrl_12hr_C  7.952662     7.941232  6.903801  7.575149     control     C
## ctrl_12hr_D  8.277781     8.181431  6.745836  7.641494     control     D
## ctrl_12hr_E  8.235038     8.169354  6.554766  7.782781     control     E
## CoV_24hr_A   7.571666     8.536174  6.747448  8.938377 Coronavirus     A
## CoV_24hr_B   7.629778     8.509799  6.697222  8.733307 Coronavirus     B
## CoV_24hr_C   7.260831     8.425157  6.692222  9.019246 Coronavirus     C
## CoV_24hr_D   7.080690     8.584440  6.757083  9.012278 Coronavirus     D
## CoV_24hr_E   7.058040     8.736338  6.698612  9.092390 Coronavirus     E
## ctrl_24hr_A  7.563681     8.155811  6.789623  7.914991     control     A
## ctrl_24hr_B  7.729397     8.138252  6.704019  7.747434     control     B
## ctrl_24hr_C  7.946592     8.095640  6.643618  7.788730     control     C
## ctrl_24hr_D  7.625182     8.078397  6.716886  7.876311     control     D
## ctrl_24hr_E  7.486914     8.005603  6.680610  7.754600     control     E
## CoV_36hr_A   8.078504     8.482066  6.721733  8.534288 Coronavirus     A
## CoV_36hr_B   7.874253     8.583444  6.770072  8.659518 Coronavirus     B
## CoV_36hr_C   7.801655     8.552423  6.862404  8.572155 Coronavirus     C
## CoV_36hr_D   7.980233     8.606779  6.846841  8.654873 Coronavirus     D
## CoV_36hr_E   7.610937     8.589262  6.822339  8.589262 Coronavirus     E
## ctrl_36hr_A  7.737160     8.018402  6.849095  7.846848     control     A
## ctrl_36hr_B  7.704646     8.042240  6.771987  7.839025     control     B
## ctrl_36hr_C  7.652111     8.124825  6.842196  7.974192     control     C
## ctrl_36hr_D  7.564977     8.045657  6.925022  7.847725     control     D
## ctrl_36hr_E  7.592967     8.041310  6.908012  7.860321     control     E
## CoV_48hr_A   7.328972     8.062943  6.505043  7.678934 Coronavirus     A
```

```
## CoV_48hr_B   7.354622     8.098275  6.544158  7.742997 Coronavirus     B
## CoV_48hr_C   7.478970     8.024786  6.488793  7.725653 Coronavirus     C
## CoV_48hr_D   7.584650     7.979318  6.643906  7.822518 Coronavirus     D
## CoV_48hr_E   7.345740     8.128902  6.493502  9.374216 Coronavirus     E
## ctrl_48hr_A  7.551584     8.234894  6.812821  7.882805     control     A
## ctrl_48hr_B  7.634577     8.221036  6.918835  8.076742     control     B
## ctrl_48hr_C  7.580736     8.234032  6.851086  8.033925     control     C
## ctrl_48hr_D  7.753263     8.230602  6.913527  7.983884     control     D
## ctrl_48hr_E  7.731435     8.270651  6.878047  7.998738     control     E
##              TimeInterval
## CoV_0hr_A           0 hr
## CoV_0hr_B           0 hr
## CoV_0hr_C           0 hr
## CoV_0hr_D           0 hr
## CoV_0hr_E           0 hr
## ctrl_0hr_A          0 hr
## ctrl_0hr_B          0 hr
## ctrl_0hr_C          0 hr
## ctrl_0hr_D          0 hr
## ctrl_0hr_E          0 hr
## CoV_12hr_A         12 hr
## CoV_12hr_B         12 hr
## CoV_12hr_C         12 hr
## CoV_12hr_D         12 hr
## CoV_12hr_E         12 hr
## ctrl_12hr_A        12 hr
## ctrl_12hr_B        12 hr
## ctrl_12hr_C        12 hr
## ctrl_12hr_D        12 hr
## ctrl_12hr_E        12 hr
## CoV_24hr_A         24 hr
## CoV_24hr_B         24 hr
## CoV_24hr_C         24 hr
## CoV_24hr_D         24 hr
## CoV_24hr_E         24 hr
## ctrl_24hr_A        24 hr
## ctrl_24hr_B        24 hr
## ctrl_24hr_C        24 hr
## ctrl_24hr_D        24 hr
## ctrl_24hr_E        24 hr
## CoV_36hr_A         36 hr
## CoV_36hr_B         36 hr
## CoV_36hr_C         36 hr
## CoV_36hr_D         36 hr
## CoV_36hr_E         36 hr
## ctrl_36hr_A        36 hr
## ctrl_36hr_B        36 hr
## ctrl_36hr_C        36 hr
## ctrl_36hr_D        36 hr
## ctrl_36hr_E        36 hr
```

```
## CoV_48hr_A         48 hr
## CoV_48hr_B         48 hr
## CoV_48hr_C         48 hr
## CoV_48hr_D         48 hr
## CoV_48hr_E         48 hr
## ctrl_48hr_A        48 hr
## ctrl_48hr_B        48 hr
## ctrl_48hr_C        48 hr
## ctrl_48hr_D        48 hr
## ctrl_48hr_E        48 hr

write.csv(Capillaries2,'FC_10_capillaries_CoV.csv', row.names=TRUE)
```

---

The above table has 10 genes as the columns with the added Class (Coronavirus or control), Group (A,B,C,D,E), and TimeInterval (0,12,24,36,48 hours) fields to filter by and plot.

Lets make these group tables for the corona virus and see how they compare over time.

```
library(dplyr)

A_group <- filter(Capillaries2, Group=='A' & Class == 'Coronavirus')
B_group <- filter(Capillaries2, Group=='B' & Class == 'Coronavirus')
C_group <- filter(Capillaries2, Group=='C' & Class == 'Coronavirus')
D_group <- filter(Capillaries2, Group=='D' & Class == 'Coronavirus')
E_group <- filter(Capillaries2, Group=='E' & Class == 'Coronavirus')
```

Lets use the tidyr package to put the 10 genes into one Gene field.

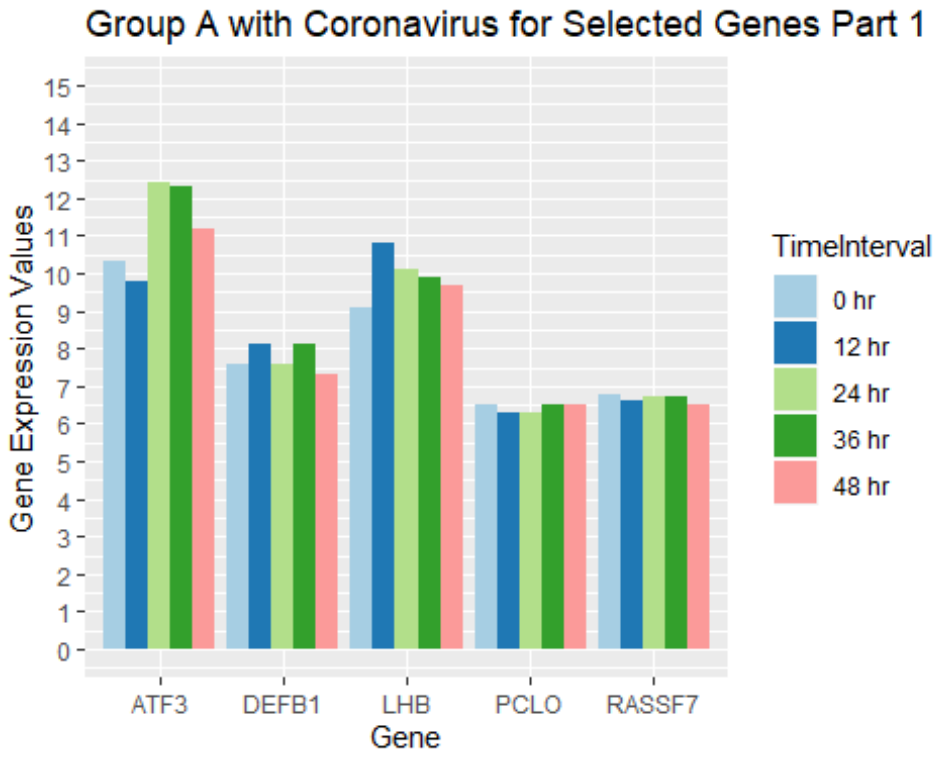
```
library(tidyr)
```

We will do this for the A_group table and ignore the Group and Class fields, because we made it only the A group of the Coronavirus class.

```
A_group2 <- A_group[,c(1,3,5,7,9,11:13)]
A_tidy <- gather(A_group2, 'Gene','GeneExpression',1:5)

## Warning: attributes are not identical across measure variables;
## they will be dropped

A_tidy$GeneExpression <- round(as.numeric(A_tidy$GeneExpression),1)
A_tidy$TimeInterval <- as.factor(A_tidy$TimeInterval)
A_tidy$Gene <- as.factor(A_tidy$Gene)
A_tidy

##          Class Group TimeInterval   Gene GeneExpression
## 1  Coronavirus     A         0 hr   ATF3           10.3
## 2  Coronavirus     A        12 hr   ATF3            9.8
## 3  Coronavirus     A        24 hr   ATF3           12.4
## 4  Coronavirus     A        36 hr   ATF3           12.3
## 5  Coronavirus     A        48 hr   ATF3           11.2
```

```
## 6  Coronavirus     A         0 hr    LHB            9.1
## 7  Coronavirus     A        12 hr    LHB           10.8
## 8  Coronavirus     A        24 hr    LHB           10.1
## 9  Coronavirus     A        36 hr    LHB            9.9
## 10 Coronavirus     A        48 hr    LHB            9.7
## 11 Coronavirus     A         0 hr   PCLO            6.5
## 12 Coronavirus     A        12 hr   PCLO            6.3
## 13 Coronavirus     A        24 hr   PCLO            6.3
## 14 Coronavirus     A        36 hr   PCLO            6.5
## 15 Coronavirus     A        48 hr   PCLO            6.5
## 16 Coronavirus     A         0 hr  DEFB1            7.6
## 17 Coronavirus     A        12 hr  DEFB1            8.1
## 18 Coronavirus     A        24 hr  DEFB1            7.6
## 19 Coronavirus     A        36 hr  DEFB1            8.1
## 20 Coronavirus     A        48 hr  DEFB1            7.3
## 21 Coronavirus     A         0 hr RASSF7            6.8
## 22 Coronavirus     A        12 hr RASSF7            6.6
## 23 Coronavirus     A        24 hr RASSF7            6.7
## 24 Coronavirus     A        36 hr RASSF7            6.7
## 25 Coronavirus     A        48 hr RASSF7            6.5
```

```r
library(ggplot2)

ggplot(data = A_tidy, aes(x=Gene, y=GeneExpression, fill=TimeInterval)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Group A with Coronavirus for Selected Genes Part 1')+
  xlab('Gene')+
  ylab('Gene Expression Values')
```




---

The genes above for Part 1 of the group A samples of coronavirus in blood capillaries show some variation in gene expression values for some of these genes that had the most change in the liver tumor samples. Starting at the initial hour up to 48 hours after being inoculated in vitro, there is an increase then decrease for ATF3 and LHB genes, while a decrease then increase close to initial value with PCLO and slightly with RASSF7. For DEFB1, it has a cyclical increase, decrease, increase, then decrease to stabilize closer to the initial gene expressio value.

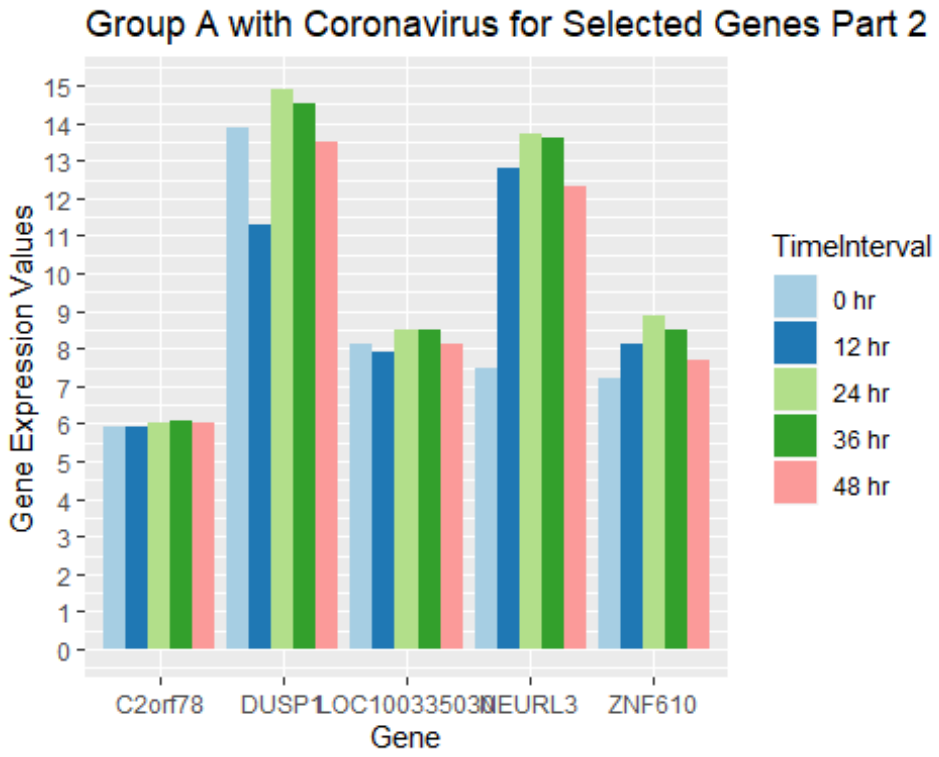
---

Now lets find the other five genes in the group A set of ten genes found to have the most change in the liver tumor samples, and examined here in the blood capillary samples.

```
A_group3 <- A_group[,c(2,4,6,8,10,11:13)]
A_tidy1 <- gather(A_group3, 'Gene','GeneExpression',1:5)

## Warning: attributes are not identical across measure variables;
## they will be dropped

A_tidy1$GeneExpression <- round(as.numeric(A_tidy1$GeneExpression),1)
A_tidy1$TimeInterval <- as.factor(A_tidy1$TimeInterval)
A_tidy1$Gene <- as.factor(A_tidy1$Gene)
A_tidy1
```

```
##          Class Group TimeInterval         Gene GeneExpression
## 1  Coronavirus     A         0 hr        DUSP1           13.9
## 2  Coronavirus     A        12 hr        DUSP1           11.3
## 3  Coronavirus     A        24 hr        DUSP1           14.9
## 4  Coronavirus     A        36 hr        DUSP1           14.5
## 5  Coronavirus     A        48 hr        DUSP1           13.5
## 6  Coronavirus     A         0 hr       NEURL3            7.5
## 7  Coronavirus     A        12 hr       NEURL3           12.8
## 8  Coronavirus     A        24 hr       NEURL3           13.7
## 9  Coronavirus     A        36 hr       NEURL3           13.6
## 10 Coronavirus     A        48 hr       NEURL3           12.3
## 11 Coronavirus     A         0 hr      C2orf78            5.9
## 12 Coronavirus     A        12 hr      C2orf78            5.9
## 13 Coronavirus     A        24 hr      C2orf78            6.0
## 14 Coronavirus     A        36 hr      C2orf78            6.1
## 15 Coronavirus     A        48 hr      C2orf78            6.0
## 16 Coronavirus     A         0 hr LOC100335030            8.1
## 17 Coronavirus     A        12 hr LOC100335030            7.9
## 18 Coronavirus     A        24 hr LOC100335030            8.5
## 19 Coronavirus     A        36 hr LOC100335030            8.5
## 20 Coronavirus     A        48 hr LOC100335030            8.1
## 21 Coronavirus     A         0 hr       ZNF610            7.2
## 22 Coronavirus     A        12 hr       ZNF610            8.1
## 23 Coronavirus     A        24 hr       ZNF610            8.9
## 24 Coronavirus     A        36 hr       ZNF610            8.5
## 25 Coronavirus     A        48 hr       ZNF610            7.7
```

```r
ggplot(data = A_tidy1, aes(x=Gene, y=GeneExpression, fill=TimeInterval)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Group A with Coronavirus for Selected Genes Part 2')+
  xlab('Gene')+
  ylab('Gene Expression Values')
```




---

The above genes in part 2 of the group A Coronavirus samples over 48 hours, shows that the gene expression values increase up to 24 hours then decrease to 48 hours for most of the genes above.

---

---

Lets look back at the platforms and the features removed. The sequence field is an interesting field because it can show copy number variants of genes by the genes that are duplicates at other probes from the samples.

```
Platform13497 <- read.csv('GPL13497-9755-forSequenceFeature-GSE100509.csv',
sep=',',
                  na.strings=c('',' '), header=TRUE)
Platform16699 <- read.csv('GPL16699-forSequenceFeatureGSE89166_GSE89160.csv',
sep=',',
                          na.strings=c('',' '), header=TRUE)
```

The features in Platform13497 and the first five listed ID values for this platform:

```
colnames(Platform13497)

##  [1] "ID"                    "SPOT_ID"               "CONTROL_TYPE"
##  [4] "REFSEQ"                "GB_ACC"                "GENE"
##  [7] "GENE_SYMBOL"           "GENE_NAME"             "UNIGENE_ID"
```

```
## [10] "ENSEMBL_ID"           "TIGR_ID"              "ACCESSION_STRING"
## [13] "CHROMOSOMAL_LOCATION" "CYTOBAND"             "DESCRIPTION"
## [16] "GO_ID"                "SEQUENCE"

head(Platform13497$SPOT_ID)[1:5]

## [1] (+)E1A_r60_1    (+)E1A_r60_3    (+)E1A_r60_a104 (+)E1A_r60_a107
## [5] (+)E1A_r60_a135
## 34184 Levels: (-)3xSLv1 (+)E1A_r60_1 (+)E1A_r60_3 ... NA
```

The features in Platform16699 and the first five listed ID values of that platform:

```
colnames(Platform16699)

##  [1] "ID"                   "COL"                  "ROW"
##  [4] "NAME"                 "SPOT_ID"              "CONTROL_TYPE"
##  [7] "REFSEQ"               "GB_ACC"               "LOCUSLINK_ID"
## [10] "GENE_SYMBOL"          "GENE_NAME"            "UNIGENE_ID"
## [13] "ENSEMBL_ID"           "ACCESSION_STRING"     "CHROMOSOMAL_LOCATION"
## [16] "CYTOBAND"             "DESCRIPTION"          "GO_ID"
## [19] "SEQUENCE"

head(Platform16699$SPOT_ID)[1:5]

## [1] CONTROL       CONTROL       CONTROL       A_23_P117082  A_33_P3246448
## 50491 Levels: A_19_P00315452 A_19_P00315459 A_19_P00315482 ...
tc|THC2788944
```

Lets keep only the ID (Platform16699) or SPOT_ID (Platform13497), GENE_SYMBOL, DESCRIPTION, and SEQUENCE features of both platforms.

```
P16699 <- Platform16699[,c(1,10,17,19)]
P13497 <- Platform13497[,c(2,7,15,17)]
```

Lets also remove the incomplete cases in both platforms.

```
work16699 <- P16699[complete.cases(P16699),]
work13497 <- P13497[complete.cases(P13497),]
```

Now merge these data sets to their corresponding samples by SPOT_ID.First read in the samples data for each platform and series.

```
GSE89166_89160 <- read.csv('GSE89166_GSE89160.csv',sep=',', na.strings=c('','
'),
                           header=TRUE)
GSE100509 <- read.csv('GSE100509.csv', sep=',', header=TRUE,
                      na.strings=c('',' '))
```

Now merge the series data sets to their respective platforms of gene informational meta features.

```
Series100509 <- merge(work13497,GSE100509,by.x='SPOT_ID', by.y='ID_REF')
Series89166_89160 <- merge(work16699,GSE89166_89160,by.x='ID', by.y='ID_REF')
```

Rename the columns of the Series100509 to the 5 groups for each of CoV and Ctrl over 0,12,24,36, and 48 hours.

```
colnames(Series100509)
```

```
##  [1] "SPOT_ID"                   "GENE_SYMBOL"
##  [3] "DESCRIPTION"               "SEQUENCE"
##  [5] "GSM2685693_MERS_CoV_0hr"   "GSM2685694_MERS_CoV_0hr"
##  [7] "GSM2685695_MERS_CoV_0hr"   "GSM2685696_MERS_CoV_0hr"
##  [9] "GSM2685697_MERS_CoV_0hr"   "GSM2685698_ctrl_0hr"
## [11] "GSM2685699_ctrl_0hr"       "GSM2685700_ctrl_0hr"
## [13] "GSM2685701_ctrl_0hr"       "GSM2685702_ctrl_0hr"
## [15] "GSM2685703_MERS_CoV_12hr" "GSM2685704_MERS_CoV_12hr"
## [17] "GSM2685705_MERS_CoV_12hr" "GSM2685706_MERS_CoV_12hr"
## [19] "GSM2685707_MERS_CoV_12hr" "GSM2685708_ctrl_12hr"
## [21] "GSM2685709_ctrl_12hr"      "GSM2685710_ctrl_12hr"
## [23] "GSM2685711_ctrl_12hr"      "GSM2685712_ctrl_12hr"
## [25] "GSM2685713_MERS_CoV_24hr" "GSM2685714_MERS_CoV_24hr"
## [27] "GSM2685715_MERS_CoV_24hr" "GSM2685716_MERS_CoV_24hr"
## [29] "GSM2685717_MERS_CoV_24hr" "GSM2685718_ctrl_24hr"
## [31] "GSM2685719_ctrl_24hr"      "GSM2685720_ctrl_24hr"
## [33] "GSM2685721_ctrl_24hr"      "GSM2685722_ctrl_24hr"
## [35] "GSM2685723_MERS_CoV_36hr" "GSM2685724_MERS_CoV_36hr"
## [37] "GSM2685725_MERS_CoV_36hr" "GSM2685726_MERS_CoV_36hr"
## [39] "GSM2685727_MERS_CoV_36hr" "GSM2685728_ctrl_36hr"
## [41] "GSM2685729_ctrl_36hr"      "GSM2685730_ctrl_36hr"
## [43] "GSM2685731_ctrl_36hr"      "GSM2685732_ctrl_36hr"
## [45] "GSM2685733_MERS_CoV_48hr" "GSM2685734_MERS_CoV_48hr"
## [47] "GSM2685735_MERS_CoV_48hr" "GSM2685736_MERS_CoV_48hr"
## [49] "GSM2685737_MERS_CoV_48hr" "GSM2685738_ctrl_48hr"
## [51] "GSM2685739_ctrl_48hr"      "GSM2685740_ctrl_48hr"
## [53] "GSM2685741_ctrl_48hr"      "GSM2685742_ctrl_48hr"
```

```
group <- rep(1:5,10)
Group <- gsub('1','Group_A',group)
Group <- gsub('2','Group_B',Group)
Group <- gsub('3','Group_C',Group)
Group <- gsub('4','Group_D',Group)
Group <- gsub('5','Group_E',Group)

names <- colnames(Series100509)[5:54]

Names <- paste(names,Group,sep='_')

newNames <- gsub('_MERS','', Names)
newNames
```

```
##  [1] "GSM2685693_CoV_0hr_Group_A"   "GSM2685694_CoV_0hr_Group_B"
##  [3] "GSM2685695_CoV_0hr_Group_C"   "GSM2685696_CoV_0hr_Group_D"
##  [5] "GSM2685697_CoV_0hr_Group_E"   "GSM2685698_ctrl_0hr_Group_A"
```

```
##  [7] "GSM2685699_ctrl_0hr_Group_B"  "GSM2685700_ctrl_0hr_Group_C"
##  [9] "GSM2685701_ctrl_0hr_Group_D"  "GSM2685702_ctrl_0hr_Group_E"
## [11] "GSM2685703_CoV_12hr_Group_A"  "GSM2685704_CoV_12hr_Group_B"
## [13] "GSM2685705_CoV_12hr_Group_C"  "GSM2685706_CoV_12hr_Group_D"
## [15] "GSM2685707_CoV_12hr_Group_E"  "GSM2685708_ctrl_12hr_Group_A"
## [17] "GSM2685709_ctrl_12hr_Group_B" "GSM2685710_ctrl_12hr_Group_C"
## [19] "GSM2685711_ctrl_12hr_Group_D" "GSM2685712_ctrl_12hr_Group_E"
## [21] "GSM2685713_CoV_24hr_Group_A"  "GSM2685714_CoV_24hr_Group_B"
## [23] "GSM2685715_CoV_24hr_Group_C"  "GSM2685716_CoV_24hr_Group_D"
## [25] "GSM2685717_CoV_24hr_Group_E"  "GSM2685718_ctrl_24hr_Group_A"
## [27] "GSM2685719_ctrl_24hr_Group_B" "GSM2685720_ctrl_24hr_Group_C"
## [29] "GSM2685721_ctrl_24hr_Group_D" "GSM2685722_ctrl_24hr_Group_E"
## [31] "GSM2685723_CoV_36hr_Group_A"  "GSM2685724_CoV_36hr_Group_B"
## [33] "GSM2685725_CoV_36hr_Group_C"  "GSM2685726_CoV_36hr_Group_D"
## [35] "GSM2685727_CoV_36hr_Group_E"  "GSM2685728_ctrl_36hr_Group_A"
## [37] "GSM2685729_ctrl_36hr_Group_B" "GSM2685730_ctrl_36hr_Group_C"
## [39] "GSM2685731_ctrl_36hr_Group_D" "GSM2685732_ctrl_36hr_Group_E"
## [41] "GSM2685733_CoV_48hr_Group_A"  "GSM2685734_CoV_48hr_Group_B"
## [43] "GSM2685735_CoV_48hr_Group_C"  "GSM2685736_CoV_48hr_Group_D"
## [45] "GSM2685737_CoV_48hr_Group_E"  "GSM2685738_ctrl_48hr_Group_A"
## [47] "GSM2685739_ctrl_48hr_Group_B" "GSM2685740_ctrl_48hr_Group_C"
## [49] "GSM2685741_ctrl_48hr_Group_D" "GSM2685742_ctrl_48hr_Group_E"
```

Change the column names in Series100509 to the new column names identifying which group the samples is from in A:E.

```
colnames(Series100509)[5:54] <- newNames
colnames(Series100509)
```

```
##  [1] "SPOT_ID"                       "GENE_SYMBOL"
##  [3] "DESCRIPTION"                   "SEQUENCE"
##  [5] "GSM2685693_CoV_0hr_Group_A"    "GSM2685694_CoV_0hr_Group_B"
##  [7] "GSM2685695_CoV_0hr_Group_C"    "GSM2685696_CoV_0hr_Group_D"
##  [9] "GSM2685697_CoV_0hr_Group_E"    "GSM2685698_ctrl_0hr_Group_A"
## [11] "GSM2685699_ctrl_0hr_Group_B"   "GSM2685700_ctrl_0hr_Group_C"
## [13] "GSM2685701_ctrl_0hr_Group_D"   "GSM2685702_ctrl_0hr_Group_E"
## [15] "GSM2685703_CoV_12hr_Group_A"   "GSM2685704_CoV_12hr_Group_B"
## [17] "GSM2685705_CoV_12hr_Group_C"   "GSM2685706_CoV_12hr_Group_D"
## [19] "GSM2685707_CoV_12hr_Group_E"   "GSM2685708_ctrl_12hr_Group_A"
## [21] "GSM2685709_ctrl_12hr_Group_B"  "GSM2685710_ctrl_12hr_Group_C"
## [23] "GSM2685711_ctrl_12hr_Group_D"  "GSM2685712_ctrl_12hr_Group_E"
## [25] "GSM2685713_CoV_24hr_Group_A"   "GSM2685714_CoV_24hr_Group_B"
## [27] "GSM2685715_CoV_24hr_Group_C"   "GSM2685716_CoV_24hr_Group_D"
## [29] "GSM2685717_CoV_24hr_Group_E"   "GSM2685718_ctrl_24hr_Group_A"
## [31] "GSM2685719_ctrl_24hr_Group_B"  "GSM2685720_ctrl_24hr_Group_C"
## [33] "GSM2685721_ctrl_24hr_Group_D"  "GSM2685722_ctrl_24hr_Group_E"
## [35] "GSM2685723_CoV_36hr_Group_A"   "GSM2685724_CoV_36hr_Group_B"
## [37] "GSM2685725_CoV_36hr_Group_C"   "GSM2685726_CoV_36hr_Group_D"
## [39] "GSM2685727_CoV_36hr_Group_E"   "GSM2685728_ctrl_36hr_Group_A"
## [41] "GSM2685729_ctrl_36hr_Group_B"  "GSM2685730_ctrl_36hr_Group_C"
```

```
## [43] "GSM2685731_ctrl_36hr_Group_D" "GSM2685732_ctrl_36hr_Group_E"
## [45] "GSM2685733_CoV_48hr_Group_A"  "GSM2685734_CoV_48hr_Group_B"
## [47] "GSM2685735_CoV_48hr_Group_C"  "GSM2685736_CoV_48hr_Group_D"
## [49] "GSM2685737_CoV_48hr_Group_E"  "GSM2685738_ctrl_48hr_Group_A"
## [51] "GSM2685739_ctrl_48hr_Group_B" "GSM2685740_ctrl_48hr_Group_C"
## [53] "GSM2685741_ctrl_48hr_Group_D" "GSM2685742_ctrl_48hr_Group_E"
```

Remove the ID and SPOT_ID fields of the probe labels that won't be needed for the analysis.

```
Series89 <- Series89166_89160[,-1]
Series100 <- Series100509[,-c(1,3,4)]
```

Now combine the series together by genes in common.

```
ComboLiverCapillarySequences <- merge(Series89,Series100, by.x='GENE_SYMBOL',
                                      by.y='GENE_SYMBOL')
```

There should be different genotypes or copy number variations in the SEQUENCE feature column, which will identify which nucleotide jumps, is deleted, rearranged in the gene expressions. This time around lets group by SEQUENCE to see how many genotypes there are in all the genes. This could give more information in the analysis of any genotypes of genes could be more susceptible to pathogenesis of CoV or immunity to it. ***

```
library(dplyr)
```

---

This next portion of this analysis shows the top five genes in the data, the number of genotypes or copy number variations of the nucleotide sequences are in each gene, and the gene name. This could be useful to determine how well the genotypes within these five genes that were expressed more than the other 65k genes were when analyzing the effects of CoV, inactive CoV, CoV treated with an interleukin, and the control samples.

```
SeqGroup <- ComboLiverCapillarySequences %>% group_by(GENE_SYMBOL) %>%
count(n=n())
SeqGroup <- SeqGroup[order(SeqGroup$n, decreasing=TRUE),-3]

SeqGroup5 <- SeqGroup[1:5,]

genes5sequences <- merge(SeqGroup5,ComboLiverCapillarySequences,
                         by.x='GENE_SYMBOL', by.y='GENE_SYMBOL')

genotypes5 <- genes5sequences %>% group_by(SEQUENCE) %>% count(n=n)

genotypes5$n <- as.factor(genotypes5$n)
SeqGroup5$n <- as.factor(SeqGroup5$n)

genotypes5_1 <- merge(genotypes5, SeqGroup5, by.x='n', by.y='n')
colnames(genotypes5_1)[c(1,3)] <- c('geneCount','genotypeCount')
head(genotypes5_1)
```

```
##   geneCount                                                      SEQUENCE
## 1       255 AAACTTACTCCAGAGCTCCTTGTGCATCTGACCAGCACCATCGACAGAATAAACACAGAA
## 2       255 AACAGAGTCCTCAGGGAAGAAAATCGAAGACTTCAGGCTCAACTGAGTCATGTTTCCAGA
## 3       255 GCACCTGTGTTCTTTGAGTTCACATCATGAATGTGGTGATTTCCCAGATACCATCTCAGG
## 4       255 ATGGGGTGCTCTGGGGAAATATTGGAGGGTCATCCATTCCACATTAAAAGAGCAAGTTGT
## 5       255 AAGTGCTTGGAAATACTTGGGTGAATGTTACCAGACTCCTTCTCTCTCAGCTTACAGCCT
## 6       255 AATCTACGAGGCACTTTATGGCAATTCCAAGAAGGGGCTGAAAGGTATGTGTTCTTCTCC
##   genotypeCount GENE_SYMBOL
## 1            15     PDE4DIP
## 2            15     PDE4DIP
## 3            15     PDE4DIP
## 4            15     PDE4DIP
## 5            15     PDE4DIP
## 6            15     PDE4DIP
```

Write the files above out to csv.

```
write.csv(ComboLiverCapillarySequences,
'SequencesBothCleaned.csv',row.names=FALSE)
write.csv(genotypes5_1, 'Genotypes_5_1.csv', row.names=FALSE)

ComboCNV <- ComboLiverCapillarySequences[,-c(1,2)]
copynumbers <- merge(genotypes5_1,ComboCNV,
                     by.x='SEQUENCE', by.y='SEQUENCE')
CNV <- copynumbers[!duplicated(copynumbers$SEQUENCE),]
write.csv(CNV, 'copyNumbers.csv', row.names=FALSE)

CNV
```

```
##                                                          SEQUENCE geneCount
## 1   AAACTTACTCCAGAGCTCCTTGTGCATCTGACCAGCACCATCGACAGAATAAACACAGAA       255
## 16  AACAGAGTCCTCAGGGAAGAAAATCGAAGACTTCAGGCTCAACTGAGTCATGTTTCCAGA       255
## 31  AAGGATTTGCTTATAAGGGTTCCTGCTTTCACAAAATTATTCCAGGTTTTATGTGTCAGG        70
## 41  AAGGATTTGGTTGTAAGGGCTCCCGCTTTCACAGAATTATTCCAGGGTTTATGTGTCAGG        70
## 51  AAGTGCTTGGAAATACTTGGGTGAATGTTACCAGACTCCTTCTCTCTCAGCTTACAGCCT       255
## 66  AATCTACGAGGCACTTTATGGCAATTCCAAGAAGGGGCTGAAAGGTATGTGTTCTTCTCC       255
## 81  AATGATCAGAAAAAGAAAGAAGCCAAAGAGAAAGGTACCTGGGTTCAACTGAAGTGCCAG        81
## 90  ACAAGTGTTACCATGGCAAAACTGGAAGAGTCTACAATGTTACCCAGCATGCTGTTGGCA        81
## 99  ACCCTACAGCTCTTCCAAATATGCCACTGACCTTTTGAGTGTGGCTTTGAACAGGAACTT        70
## 109 ACGCTGTTGATGCCGGCAATATTGCTACTTCGCTTTTTTGCAAATGCATTCACTTTGACA        70
## 209 AGGTCAAGTTTATACATCTTAATTATGGTGGAATTCCTATGTAGAGTCTAAAAAGCCAGG        70
## 219 ATATGTAAAGGGCCATTCTTAAGTTCTCTCCTTAAACTTAATGCTGTCAAGTGTTAGATG        90
## 279 ATCCGGGACATGATCCGCAGGGCCCAGAGTTACCGAGTCCTCACTACTTTTCTTCCAGAC        90
## 285 ATCTTGTCCATGGCAAATGCTGGACCCAACACAAATGGTTCCCAGTTTTTCATCTGCACT        70
## 385 ATGGAGATTACAACTGCTTGTTGGAGACGATCCTGTGTGATCAGCTTCATAAAAGGGCTT        90
## 391 ATGGATGACACAAACAGCGAGCAGCAGTTTAGAGTCTTCAGAGACTTCGACTTCCTAGAT        90
## 397 ATGGGGTGCTCTGGGGAAATATTGGAGGGTCATCCATTCCACATTAAAAGAGCAAGTTGT       255
## 412 ATTTGCCTTGTTTATTGTGAGCATGGAATACTTCTGGAAGCTTTCCTAGTAGATTTTTCT        70
## 422 CAAAAAATGGACTAGAAGAGAAGCTGGCTGAGGAGCTGAGATCAGCCTCGTGGCCTGGGT       255
## 437 CAAAAACTGGGAAGATGTACCAGGAGACCAGGTCAAGCCCGACCAATACACTGAGGCCCT       255
## 452 CAGGACAAGTTCCTTCTAAAATCAATCCTTTGCTTTGGCCTGGAAGACCGAACATATTAG       255
```

```
## 467 CCTTTCTGACAGCTATGGAATACCGTTAGCCAAGGTCCACTTGGCCCAGCACTAAGAAAA       255
## 482 CTACCAAAGCTGTGTATTTTTCATTTCTTCATGGCACTGTGCTGTTAATTTCTGTTAACA       255
## 497 CTATGGAATACGATTAGCCAAGGTCCACTTGGCCCAGCACTAAGAAGAAGATGCATAGTT       255
## 512 CTGTTCCTTTGGCGACGTATATGCGAATCTATAAGAAAGGTGATATTGTAGACATCAAGG        81
## 521 GAACACAAAGAGAAAGAGGAGGGGCACCCGATATATGTTCTTTAGGCCTTTTAGAAAACA        81
## 530 GAAGCTGCTGCTATCAGAAGCCACTGTCTTTGCTCAGGCGAACGAGCTGGAGAAATACAG       255
## 545 GAGGTTTCTTCGTTTTGGAAAAGTAGAGGTATAAAATAACCTTTTTTGCTGGATACTGTC        90
## 551 GCACCTGTGTTCTTTGAGTTCACATCATGAATGTGGTGATTTCCCAGATACCATCTCAGG       255
## 566 GGAAGGAGTCTGAGCTGCTGGAACCTATTCCCTATGAATTCATGGCATAATAGGTGTTAA        81
## 575 GGCCACATATATGCTAATCTATAAGAAAGGTGATATTGCAGACATCAAGGGAAGGGGTAC        81
## 584 GTGGACAACTCGAATAAGTTTGACTTGTGTTTTATCTTAACCACCAGATCATTCCTTCTG        70
## 594 GTGTTGAGTCAGTGGGGACCAGCCTGCCCACAGGAGAAAATTAAAAGACACAAAAACAAA       255
## 609 GTTACCCAGCATGCTGTTGGCATTGTTGTAAACAAACAAGTTAAAGGCAAGATTCTTGCC        81
## 618 GTTGTAAACAAACAAGTTAAGGGCAAGATTCTTGCCAAGAGAATTAATGTGCGTATTGAG        81
## 627 TCCCAGATACCATTTCAGGCTTAACCTAGCACATCCTATTTCTTTTCTTCTATGATATCC       255
## 642 TGGTATAAAAGGCAAAATGGCATTGAGGATGAATCACATGAATACAGACCAAGAACAAGC        90
## 648 TTAAGCACTCTAAGAGCCGAGATAGCTTCCTGAAATGTGTGAAGGAAAATGATCAGAAAA        81
## 657 TTCCATCACCTTTCCTTGAAAATATATCTTCAGCTTTGGGTAGGAGGAATCTTGGTGTAT       255
## 672 TTGAGGAAGTCTGTATAGGGTGACCCATTGTGTCTCAGTACCACGTTTTCTTTCTTTTTT        70
## 682 TTTGGCGTGCAGGAATATGAGCAAGGCAGAAGCTGTCTGTGCTGCTCTGCTGGCCTCTCA        70
## 692 TTTTAAAGAAGGCAAGCACTAACTTAGAGGAACCATGCAAGAAGCGCAGCCACCAGAAGT       255
##     genotypeCount GENE_SYMBOL GSM2359851_CoV1 GSM2359853_CoV2
GSM2359910_CoV3
## 1              15     PDE4DIP        27.80000        12.33750
3.696339
## 16             15     PDE4DIP        14.38750        20.88750
2.637107
## 31              5     HSD17B7      5145.79000      5373.31250
12.672146
## 41              5     HSD17B7     11934.96500     10287.10500
13.095230
## 51             15     PDE4DIP        32.27375        16.51000
3.847676
## 66             15     PDE4DIP        16.67250        23.47500
3.444825
## 81              9       RPL21     13038.30250     11010.62750
13.528036
## 90              9       RPL21     30119.53750     30572.70750
14.712802
## 99              5     HSD17B7       371.82000       322.18250
8.134598
## 109            50     HSD17B7       213.67500       195.09500
7.177490
## 209             5     HSD17B7       268.28000       198.08250
7.012814
## 219            60         FRY       271.65250       357.92000
8.202159
## 279             6         FRY        58.96375        84.71000
5.671111
## 285            50     HSD17B7     17904.94250     19128.75750
```

```
13.734397
## 385             6         FRY         9.06500        20.70250
3.829277
## 391             6         FRY        32.45750        23.73000
4.310822
## 397            15     PDE4DIP        75.22875        90.13250
5.752750
## 412             5     HSD17B7        15.40250        19.88250
4.420457
## 422            15     PDE4DIP        10.65000        12.76750
2.504837
## 437            15     PDE4DIP        91.41000       103.70750
6.408463
## 452            15     PDE4DIP       237.00000        63.49250
7.746742
## 467            15     PDE4DIP        30.81875        39.75750
4.488047
## 482            15     PDE4DIP       125.58750       134.66250
5.723797
## 497            15     PDE4DIP        29.16750        11.06750
3.676894
## 512             9       RPL21      5280.45750      3875.71750
12.254249
## 521             9       RPL21      6381.22250      6865.95250
12.451731
## 530            15     PDE4DIP        19.30000        36.25375
3.989351
## 545             6         FRY        22.37500        36.61625
5.296403
## 551            15     PDE4DIP       104.62875        85.94500
5.821977
## 566             9       RPL21     46392.50000     45883.44000
15.416743
## 575             9       RPL21      3746.36500      2738.23500
12.059480
## 584             5     HSD17B7     43078.28000     35250.26250
15.063675
## 594            15     PDE4DIP        18.22125        34.20625
5.068949
## 609             9       RPL21     24563.01000     27131.15750
14.494375
## 618             9       RPL21      6638.93000      6876.98250
12.970757
## 627            15     PDE4DIP        63.95375        61.22750
5.621959
## 642             6         FRY        32.43250        19.90500
4.781334
## 648             9       RPL21     28633.13750     35054.02500
14.760531
## 657            15     PDE4DIP        70.56500        45.82500
```

```
5.832804
## 672             5     HSD17B7        23.60250        12.80875
3.931491
## 682             5     HSD17B7       119.60500       123.33000
6.507425
## 692            15     PDE4DIP        18.62250        18.30500
3.088424
##     GSM2359913_CoV4 GSM2359850_ctrl1 GSM2359852_ctrl2 GSM2359911_ctrl3
## 1          3.790725          16.5200         17.73000         3.578243
## 16         3.344586          11.3625         18.11250         3.551566
## 31        11.573693        9277.9550       8067.56500        12.808809
## 41        11.838288       17429.8675      16112.38250        13.205094
## 51         4.423909          18.1100         13.44125         4.284877
## 66         4.177188          18.1550         17.48000         3.766645
## 81        13.571143       13483.4400       9879.27000        13.472757
## 90        14.614834       34445.3250      28827.18500        14.702680
## 99         8.181267         154.2550        220.73750         6.715907
## 109        7.729111         121.7325        172.01750         6.576652
## 209        6.513342         553.5950        301.95250         7.412307
## 219        8.706800          97.3250        202.96750         7.429588
## 279        6.315514          31.9675         48.28000         4.905673
## 285       12.522699       21680.6475      27867.61750        13.917649
## 385        3.968947          12.5900         13.29000         4.006208
## 391        3.833337          13.9325         16.31500         3.619992
## 397        6.626211          78.0075         68.24750         6.160618
## 412        4.407728          19.2275         30.75000         5.107143
## 422        4.583563           8.9625         14.71000         4.094687
## 437        6.654450         138.3750        138.58000         6.012364
## 452        7.233624          16.8675         11.08500         4.309826
## 467        4.560705          16.7325         30.56750         3.631049
## 482        6.186636         118.2613         77.22250         5.631851
## 497        3.528587          13.5300         15.50500         4.189106
## 512       12.136696        7492.1175       4175.44000        12.504104
## 521       12.137630        8573.3300       6704.05500        12.609506
## 530        3.853302          23.2675         22.38500         4.161641
## 545        5.767478          37.2500         51.34750         4.881077
## 551        5.744729          58.5300         35.14000         5.162767
## 566       15.387552       47613.6350      44025.17500        15.357757
## 575       11.973380        5260.6125       3136.01000        12.295686
## 584       14.145177       49908.4750      42313.35750        15.161325
## 594        4.875253          31.3550         26.55875         5.163443
## 609       14.396291       25395.2325      27531.33250        14.490896
## 618       12.907781        9555.7550       7781.74500        13.138377
## 627        5.613410          33.8425         60.97500         4.944435
## 642        5.524324          20.2175         18.00625         4.146513
## 648       14.719929       30448.7650      30448.76500        14.784022
## 657        5.556593          33.6350         46.85125         4.272972
## 672        3.564095          17.3825         28.25250         4.269237
## 682        6.579500          67.2175         90.32750         5.815040
## 692        3.260962          29.7900         11.46000         3.011269
```

```
##     GSM2359914_ctrl4 GSM2359912_Il1 GSM2359917_IL2
GSM2359915_inactiveHeatCoV1
## 1           3.624038       3.140928       3.670410
3.546095
## 16          4.151561       2.785070       2.552815
4.287654
## 31         12.783884      13.140587      12.767002
13.136716
## 41         12.949140      13.434763      13.042793
13.454729
## 51          3.420708       3.601485       3.039668
3.450441
## 66          4.254487       4.957138       3.629882
3.956468
## 81         13.614149      13.633448      13.630940
13.430600
## 90         14.702680      14.750075      14.688661
14.633296
## 99          6.808397       6.558839       6.755108
6.888168
## 109         6.391192       6.560465       6.498674
6.666895
## 209         7.243844       7.590200       7.424797
7.242360
## 219         6.633365       7.263232       7.037296
7.826073
## 279         4.654331       5.951235       5.315131
5.197742
## 285        13.530332      13.984778      13.664711
14.101873
## 385         4.078738       3.198799       3.613910
4.292263
## 391         2.635114       4.035037       3.496328
5.051240
## 397         5.843770       6.207442       6.010504
6.287897
## 412         4.780039       5.136244       3.083101
4.441393
## 422         3.395185       3.520729       4.372599
3.739993
## 437         6.430275       5.891864       6.410106
6.434970
## 452         2.912074       3.819033       4.434493
2.699398
## 467         3.428464       3.873689       4.308965
3.544474
## 482         6.086149       5.750065       5.901224
5.722239
## 497         3.798390       3.882634       3.369441
4.407039
```

```
## 512        12.605234      12.523691      12.559814
12.367516
## 521        12.586550      12.674812      12.614916
12.498591
## 530         3.876763       3.252636       3.868612
3.849681
## 545         5.088791       5.049082       5.006710
5.221105
## 551         5.219856       4.821215       5.311027
5.561438
## 566        15.331644      15.416743      15.309413
15.230848
## 575        12.471203      12.359393      12.492727
12.373389
## 584        14.933096      15.247829      14.906973
15.262285
## 594         6.126075       4.908142       5.656664
5.879604
## 609        14.451526      14.423394      14.512645
14.388731
## 618        13.191864      13.159157      13.149836
13.099425
## 627         5.193310       5.223439       5.285965
4.153434
## 642         4.469801       4.652000       4.351019
4.885096
## 648        14.876129      14.859144      14.836318
14.767892
## 657         5.027764       5.223439       4.305323
4.621451
## 672         5.066429       3.447057       4.335341
3.690485
## 682         5.849889       5.674321       5.635349
6.016112
## 692         3.249961       3.208008       3.379703
3.524824
##     GSM2359916_inactiveHeatCoV2 GSM2685693_CoV_0hr_Group_A
## 1                      3.478594                   6.046074
## 16                     3.088424                   6.844269
## 31                    12.926635                  13.743911
## 41                    13.390188                  13.354586
## 51                     3.302000                   6.558291
## 66                     3.372408                   6.123684
## 81                    13.564872                  15.471859
## 90                    14.805995                  13.952961
## 99                     6.090212                   7.760966
## 109                    6.421314                   7.760966
## 209                    7.501435                   9.039621
## 219                    7.244399                   5.959534
## 279                    5.555414                  11.322402
```

```
## 285                    13.863342                    9.039621
## 385                     2.960501                   11.322402
## 391                     2.435691                   10.206249
## 397                     6.065265                    6.558291
## 412                     3.771957                    7.443340
## 422                     3.962144                    6.642102
## 437                     6.320798                    6.642102
## 452                     3.481031                    6.141494
## 467                     2.245824                    7.494292
## 482                     5.751764                    6.642102
## 497                     3.064070                    6.558291
## 512                    12.608269                   14.216561
## 521                    12.717626                   14.379203
## 530                     4.276882                    6.141494
## 545                     5.310430                   10.206249
## 551                     4.847402                    6.642102
## 566                    15.381582                   12.710011
## 575                    12.473387                   14.379203
## 584                    15.137849                    9.039621
## 594                     5.326159                    7.494292
## 609                    14.530418                   13.952961
## 618                    13.191864                   13.952961
## 627                     4.898910                    6.141494
## 642                     4.637404                   11.322402
## 648                    14.915921                   15.209228
## 657                     5.464345                    6.141494
## 672                     3.477792                    6.585250
## 682                     5.770293                    7.760966
## 692                     3.860184                    6.558291
##     GSM2685694_CoV_0hr_Group_B GSM2685695_CoV_0hr_Group_C
## 1                     5.934566                    5.909934
## 16                    6.971307                    7.045377
## 31                   14.112591                   13.731221
## 41                   13.772142                   13.242660
## 51                    6.538601                    6.586001
## 66                    6.109128                    6.141085
## 81                   15.541398                   15.753597
## 90                   13.758973                   13.253953
## 99                    7.679814                    7.857275
## 109                   7.679814                    7.857275
## 209                   9.012739                    8.926670
## 219                   5.955123                    6.360556
## 279                  11.419858                   11.426284
## 285                   9.012739                    8.926670
## 385                  11.419858                   11.426284
## 391                  10.558187                   10.338125
## 397                   6.538601                    6.586001
## 412                   7.360626                    7.568523
## 422                   6.488311                    6.650799
## 437                   6.488311                    6.650799
```

```
## 452                     6.146797                     6.177145
## 467                     7.657015                     7.460948
## 482                     6.488311                     6.650799
## 497                     6.538601                     6.586001
## 512                    14.150090                    13.748373
## 521                    14.347845                    14.203153
## 530                     6.146797                     6.177145
## 545                    10.558187                    10.338125
## 551                     6.488311                     6.650799
## 566                    12.681303                    12.567839
## 575                    14.347845                    14.203153
## 584                     9.012739                     8.926670
## 594                     7.657015                     7.460948
## 609                    13.758973                    13.253953
## 618                    13.758973                    13.253953
## 627                     6.180332                     6.177145
## 642                    11.419858                    11.426284
## 648                    15.162455                    15.081966
## 657                     6.146797                     6.177145
## 672                     6.552001                     6.801947
## 682                     7.679814                     7.857275
## 692                     6.538601                     6.586001
##     GSM2685696_CoV_0hr_Group_D GSM2685697_CoV_0hr_Group_E
## 1                     5.928474                     6.049563
## 16                    7.000706                     7.075463
## 31                   13.879932                    13.711439
## 41                   13.423286                    13.239789
## 51                    6.563639                     6.563182
## 66                    6.181922                     6.206088
## 81                   15.743156                    15.721350
## 90                   13.545156                    13.621073
## 99                    7.798678                     7.866392
## 109                   7.798678                     7.866392
## 209                   8.949465                     8.842747
## 219                   5.958143                     6.037140
## 279                  11.359374                    11.441523
## 285                   8.949465                     8.842747
## 385                  11.359374                    11.441523
## 391                  10.330821                    10.326638
## 397                   6.563639                     6.563182
## 412                   7.419171                     7.472914
## 422                   6.697222                     6.627382
## 437                   6.697222                     6.627382
## 452                   6.137030                     6.250091
## 467                   7.350873                     7.432630
## 482                   6.697222                     6.627382
## 497                   6.563639                     6.563182
## 512                  14.150090                    14.144609
## 521                  14.358264                    14.321305
## 530                   6.137030                     6.250091
```

```
## 545                   10.330821                   10.326638
## 551                    6.697222                    6.627382
## 566                   12.706625                   12.736276
## 575                   14.358264                   14.321305
## 584                    8.949465                    8.842747
## 594                    7.350873                    7.432630
## 609                   13.545156                   13.621073
## 618                   13.545156                   13.621073
## 627                    6.088795                    6.182121
## 642                   11.359374                   11.441523
## 648                   15.220710                   15.204887
## 657                    6.137030                    6.250091
## 672                    6.764389                    6.805821
## 682                    7.798678                    7.866392
## 692                    6.563639                    6.563182
##     GSM2685698_ctrl_0hr_Group_A GSM2685699_ctrl_0hr_Group_B
## 1                      5.968496                    5.917775
## 16                     7.021435                    6.877443
## 31                    13.679609                   13.690249
## 41                    13.189063                   13.052863
## 51                     6.640295                    6.454374
## 66                     6.130249                    6.183511
## 81                    15.721350                   15.550718
## 90                    13.582989                   13.866949
## 99                     7.742188                    7.684730
## 109                    7.742188                    7.684730
## 209                    8.900764                    8.808501
## 219                    5.887260                    5.873911
## 279                   11.517387                   11.472704
## 285                    8.900764                    8.808501
## 385                   11.517387                   11.472704
## 391                   10.480783                   10.308663
## 397                    6.640295                    6.454374
## 412                    7.415712                    7.155158
## 422                    6.564249                    6.732084
## 437                    6.564249                    6.732084
## 452                    6.236379                    6.226813
## 467                    7.430458                    7.661405
## 482                    6.564249                    6.732084
## 497                    6.640295                    6.454374
## 512                   14.113341                   14.273581
## 521                   14.361286                   14.343081
## 530                    6.236379                    6.226813
## 545                   10.480783                   10.308663
## 551                    6.564249                    6.732084
## 566                   12.748984                   12.847926
## 575                   14.361286                   14.343081
## 584                    8.900764                    8.808501
## 594                    7.430458                    7.661405
## 609                   13.582989                   13.866949
```

```
## 618                    13.582989                    13.866949
## 627                     6.142107                     6.213495
## 642                    11.517387                    11.472704
## 648                    15.239825                    15.250367
## 657                     6.236379                     6.226813
## 672                     6.694174                     6.657960
## 682                     7.742188                     7.684730
## 692                     6.640295                     6.454374
##     GSM2685700_ctrl_0hr_Group_C GSM2685701_ctrl_0hr_Group_D
## 1                       5.900602                     5.973161
## 16                      6.843578                     7.033153
## 31                     13.961256                    14.155264
## 41                     13.405484                    13.621073
## 51                      6.529181                     6.591771
## 66                      6.192774                     6.209796
## 81                     15.560146                    15.569952
## 90                     13.842350                    13.774116
## 99                      7.532076                     7.701530
## 109                     7.532076                     7.701530
## 209                     8.868502                     8.890951
## 219                     5.946961                     6.347886
## 279                    11.495049                    11.440057
## 285                     8.868502                     8.890951
## 385                    11.495049                    11.440057
## 391                    10.169702                    10.282719
## 397                     6.529181                     6.591771
## 412                     7.145501                     7.226388
## 422                     6.588402                     6.522684
## 437                     6.588402                     6.522684
## 452                     6.124304                     6.158761
## 467                     7.544183                     7.562423
## 482                     6.588402                     6.522684
## 497                     6.529181                     6.591771
## 512                    14.298329                    14.214335
## 521                    14.338710                    14.413252
## 530                     6.124304                     6.158761
## 545                    10.169702                    10.282719
## 551                     6.588402                     6.522684
## 566                    12.755767                    12.755081
## 575                    14.338710                    14.413252
## 584                     8.868502                     8.890951
## 594                     7.544183                     7.562423
## 609                    13.842350                    13.774116
## 618                    13.842350                    13.774116
## 627                     6.192774                     6.258751
## 642                    11.495049                    11.440057
## 648                    15.315381                    15.310287
## 657                     6.124304                     6.158761
## 672                     6.664146                     6.663506
## 682                     7.532076                     7.701530
```

```
## 692                     6.529181                     6.591771
##     GSM2685702_ctrl_0hr_Group_E GSM2685703_CoV_12hr_Group_A
## 1                     5.965960                     6.034281
## 16                    6.998620                     6.550617
## 31                   13.806404                    12.563610
## 41                   13.289162                    12.293758
## 51                    6.439847                     6.361784
## 66                    6.250186                     6.078798
## 81                   15.486730                    15.791166
## 90                   13.715296                    13.793138
## 99                    7.715531                     7.140323
## 109                   7.715531                     7.140323
## 209                   8.866401                     8.389528
## 219                   5.979920                     5.940803
## 279                  11.482451                     9.984313
## 285                   8.866401                     8.389528
## 385                  11.482451                     9.984313
## 391                  10.311346                    11.123686
## 397                   6.439847                     6.361784
## 412                   7.227923                     6.437373
## 422                   6.730183                     6.617164
## 437                   6.730183                     6.617164
## 452                   6.122752                     6.218734
## 467                   7.728887                     7.959343
## 482                   6.730183                     6.617164
## 497                   6.439847                     6.361784
## 512                  14.176559                    14.214335
## 521                  14.272338                    14.427768
## 530                   6.122752                     6.218734
## 545                  10.311346                    11.123686
## 551                   6.730183                     6.617164
## 566                  12.780676                    12.710683
## 575                  14.272338                    14.427768
## 584                   8.866401                     8.389528
## 594                   7.728887                     7.959343
## 609                  13.715296                    13.793138
## 618                  13.715296                    13.793138
## 627                   6.200249                     6.120370
## 642                  11.482451                     9.984313
## 648                  15.204887                    15.384111
## 657                   6.122752                     6.218734
## 672                   6.672430                     6.539512
## 682                   7.715531                     7.140323
## 692                   6.439847                     6.361784
##     GSM2685704_CoV_12hr_Group_B GSM2685705_CoV_12hr_Group_C
## 1                     5.986079                     5.976717
## 16                    6.692292                     7.076586
## 31                   12.931461                    12.725504
## 41                   12.506969                    12.484960
## 51                    6.351778                     6.239437
```

```
## 66                        5.986079                        6.136415
## 81                       15.989759                       15.811264
## 90                       13.756643                       13.821900
## 99                        7.179646                        7.139658
## 109                       7.179646                        7.139658
## 209                       8.009192                        7.905606
## 219                       5.996914                        5.926815
## 279                      10.224721                        9.970963
## 285                       8.009192                        7.905606
## 385                      10.224721                        9.970963
## 391                      11.205396                       11.354632
## 397                       6.351778                        6.239437
## 412                       6.385745                        6.401408
## 422                       6.501226                        6.364588
## 437                       6.501226                        6.364588
## 452                       6.117671                        6.081783
## 467                       8.018902                        7.924227
## 482                       6.501226                        6.364588
## 497                       6.351778                        6.239437
## 512                      14.194950                       14.194950
## 521                      14.444955                       14.410594
## 530                       6.117671                        6.081783
## 545                      11.205396                       11.354632
## 551                       6.501226                        6.364588
## 566                      12.707371                       12.707371
## 575                      14.444955                       14.410594
## 584                       8.009192                        7.905606
## 594                       8.018902                        7.924227
## 609                      13.756643                       13.821900
## 618                      13.756643                       13.821900
## 627                       6.093028                        6.136415
## 642                      10.224721                        9.970963
## 648                      15.418299                       15.310287
## 657                       6.117671                        6.081783
## 672                       6.578775                        6.465496
## 682                       7.179646                        7.139658
## 692                       6.351778                        6.239437
##     GSM2685706_CoV_12hr_Group_D GSM2685707_CoV_12hr_Group_E
## 1                         5.856839                        5.976717
## 16                        6.551540                        6.801301
## 31                       12.735467                       13.112807
## 41                       12.449308                       12.457226
## 51                        6.289630                        6.313741
## 66                        6.123684                        6.140472
## 81                       15.943282                       16.123661
## 90                       13.931108                       13.637411
## 99                        7.096637                        7.207673
## 109                       7.096637                        7.207673
## 209                       7.834892                        8.052411
## 219                       5.914191                        5.929894
```

```
## 279                     9.965923                     9.961133
## 285                     7.834892                     8.052411
## 385                     9.965923                     9.961133
## 391                    11.237178                    12.011102
## 397                     6.289630                     6.313741
## 412                     6.341379                     6.788131
## 422                     6.471339                     6.454703
## 437                     6.471339                     6.454703
## 452                     6.183709                     6.237144
## 467                     8.058512                     7.772063
## 482                     6.471339                     6.454703
## 497                     6.289630                     6.313741
## 512                    14.266920                    14.212112
## 521                    14.501147                    14.459021
## 530                     6.183709                     6.237144
## 545                    11.237178                    12.011102
## 551                     6.471339                     6.454703
## 566                    12.828171                    12.789918
## 575                    14.501147                    14.459021
## 584                     7.834892                     8.052411
## 594                     8.058512                     7.772063
## 609                    13.931108                    13.637411
## 618                    13.931108                    13.637411
## 627                     6.143740                     6.182915
## 642                     9.965923                     9.961133
## 648                    15.427256                    15.815665
## 657                     6.183709                     6.237144
## 672                     6.511225                     6.687345
## 682                     7.096637                     7.207673
## 692                     6.289630                     6.313741
##     GSM2685708_ctrl_12hr_Group_A GSM2685709_ctrl_12hr_Group_B
## 1                       6.101625                     6.054130
## 16                      7.304274                     7.267867
## 31                     13.469030                    13.714536
## 41                     13.045695                    12.976714
## 51                      6.556913                     6.581489
## 66                      6.319955                     6.301538
## 81                     15.617498                    15.684402
## 90                     13.461204                    13.242660
## 99                      7.879929                     7.815682
## 109                     7.879929                     7.815682
## 209                     9.474104                     9.384559
## 219                     6.375403                     5.919921
## 279                    11.347625                    11.309167
## 285                     9.474104                     9.384559
## 385                    11.347625                    11.309167
## 391                    11.198476                    11.681931
## 397                     6.556913                     6.581489
## 412                     7.353212                     7.733486
## 422                     6.677654                     6.524879
```

```
## 437                      6.677654                      6.524879
## 452                      6.556913                      6.658103
## 467                      8.266159                      8.119336
## 482                      6.677654                      6.524879
## 497                      6.556913                      6.581489
## 512                     13.906088                     13.848895
## 521                     14.079932                     14.111086
## 530                      6.556913                      6.658103
## 545                     11.198476                     11.681931
## 551                      6.677654                      6.524879
## 566                     12.471825                     12.287010
## 575                     14.079932                     14.111086
## 584                      9.474104                      9.384559
## 594                      8.266159                      8.119336
## 609                     13.461204                     13.242660
## 618                     13.461204                     13.242660
## 627                      6.239819                      6.132205
## 642                     11.347625                     11.309167
## 648                     15.152809                     15.320354
## 657                      6.556913                      6.658103
## 672                      6.844834                      6.907652
## 682                      7.879929                      7.815682
## 692                      6.556913                      6.581489
##     GSM2685710_ctrl_12hr_Group_C GSM2685711_ctrl_12hr_Group_D
## 1                        6.056733                      6.073452
## 16                       7.233682                      7.044011
## 31                      13.529718                     13.383898
## 41                      12.970346                     13.184021
## 51                       6.587802                      6.601072
## 66                       6.278182                      6.040386
## 81                      15.651198                     15.595299
## 90                      13.642893                     13.710017
## 99                       7.818273                      7.596400
## 109                      7.818273                      7.596400
## 209                      9.389666                      9.595884
## 219                      5.837683                      5.928711
## 279                     11.282345                     11.381308
## 285                      9.389666                      9.595884
## 385                     11.282345                     11.381308
## 391                     11.098940                     11.147201
## 397                      6.587802                      6.601072
## 412                      7.306484                      7.133544
## 422                      6.604914                      7.049685
## 437                      6.604914                      7.049685
## 452                      6.579152                      6.367561
## 467                      8.186986                      8.135535
## 482                      6.604914                      7.049685
## 497                      6.587802                      6.601072
## 512                     14.033361                     14.051589
## 521                     14.260434                     14.250394
```

```
## 530                      6.579152                      6.367561
## 545                     11.098940                     11.147201
## 551                      6.604914                      7.049685
## 566                     12.569342                     12.463613
## 575                     14.260434                     14.250394
## 584                      9.389666                      9.595884
## 594                      8.186986                      8.135535
## 609                     13.642893                     13.710017
## 618                     13.642893                     13.710017
## 627                      6.298242                      6.040386
## 642                     11.282345                     11.381308
## 648                     15.271108                     15.134904
## 657                      6.579152                      6.367561
## 672                      6.834263                      6.810573
## 682                      7.818273                      7.596400
## 692                      6.587802                      6.601072
##     GSM2685712_ctrl_12hr_Group_E GSM2685713_CoV_24hr_Group_A
## 1                        5.943683                      5.852162
## 16                       7.003569                      6.871181
## 31                      13.331293                     11.921824
## 41                      13.078701                     11.600564
## 51                       6.452728                      6.771657
## 66                       6.066732                      6.237144
## 81                      15.753597                     15.727376
## 90                      13.871693                     13.644290
## 99                       7.567679                      7.437216
## 109                      7.567679                      7.437216
## 209                      9.422309                      7.967724
## 219                      6.042577                      5.981748
## 279                     11.504963                      8.847859
## 285                      9.422309                      7.967724
## 385                     11.504963                      8.847859
## 391                     11.269751                     11.056136
## 397                      6.452728                      6.771657
## 412                      7.036521                      6.781927
## 422                      7.036124                      6.689429
## 437                      7.036124                      6.689429
## 452                      6.269044                      6.237144
## 467                      8.242917                      7.835208
## 482                      7.036124                      6.689429
## 497                      6.452728                      6.771657
## 512                     14.164148                     14.073373
## 521                     14.394424                     14.290879
## 530                      6.269044                      6.237144
## 545                     11.269751                     11.056136
## 551                      7.036124                      6.689429
## 566                     12.603593                     12.505019
## 575                     14.394424                     14.290879
## 584                      9.422309                      7.967724
## 594                      8.242917                      7.835208
```

```
## 609                      13.871693                      13.644290
## 618                      13.871693                      13.644290
## 627                       6.145983                       7.148629
## 642                      11.504963                       8.847859
## 648                      15.191398                      15.334556
## 657                       6.269044                       6.237144
## 672                       6.781657                       6.595712
## 682                       7.567679                       7.437216
## 692                       6.452728                       6.771657
##     GSM2685714_CoV_24hr_Group_B GSM2685715_CoV_24hr_Group_C
## 1                        5.994476                       5.975571
## 16                       6.762131                       7.027862
## 31                      11.927784                      11.939520
## 41                      11.648884                      11.386459
## 51                       6.554766                       6.962202
## 66                       6.217184                       6.279483
## 81                      15.684402                      15.989759
## 90                      13.645558                      13.465904
## 99                       7.360648                       7.359945
## 109                      7.360648                       7.359945
## 209                      7.845939                       7.896977
## 219                      5.840833                       5.837683
## 279                      8.801857                       8.940537
## 285                      7.845939                       7.896977
## 385                      8.801857                       8.940537
## 391                     11.164641                      11.167653
## 397                      6.554766                       6.962202
## 412                      6.727406                       6.858181
## 422                      6.582995                       6.700971
## 437                      6.582995                       6.700971
## 452                      6.207846                       6.556300
## 467                      7.793875                       7.589638
## 482                      6.582995                       6.700971
## 497                      6.554766                       6.962202
## 512                     14.033361                      13.983045
## 521                     14.200832                      14.115127
## 530                      6.207846                       6.556300
## 545                     11.164641                      11.167653
## 551                      6.582995                       6.700971
## 566                     12.564091                      12.663837
## 575                     14.200832                      14.115127
## 584                      7.845939                       7.896977
## 594                      7.793875                       7.589638
## 609                     13.645558                      13.465904
## 618                     13.645558                      13.465904
## 627                      7.006153                       7.128624
## 642                      8.801857                       8.940537
## 648                     15.310287                      15.537292
## 657                      6.207846                       6.556300
## 672                      6.582995                       6.743885
```

```
## 682                    7.360648                    7.359945
## 692                    6.554766                    6.962202
##     GSM2685716_CoV_24hr_Group_D GSM2685717_CoV_24hr_Group_E
## 1                      6.113093                    6.081570
## 16                     7.096057                    7.274542
## 31                    12.099577                   12.317984
## 41                    11.575374                   11.876350
## 51                     6.900674                    6.827556
## 66                     6.339209                    6.214855
## 81                    15.950377                   15.955840
## 90                    13.553828                   13.536745
## 99                     7.465240                    7.550122
## 109                    7.465240                    7.550122
## 209                    7.999472                    8.024288
## 219                    5.982204                    6.329555
## 279                    8.960830                    8.883563
## 285                    7.999472                    8.024288
## 385                    8.960830                    8.883563
## 391                   11.197719                   11.185996
## 397                    6.900674                    6.827556
## 412                    7.019623                    7.078983
## 422                    6.728551                    6.627090
## 437                    6.728551                    6.627090
## 452                    6.601369                    6.523155
## 467                    7.550776                    7.513327
## 482                    6.728551                    6.627090
## 497                    6.900674                    6.827556
## 512                   14.147362                   14.130915
## 521                   14.069355                   14.099160
## 530                    6.601369                    6.523155
## 545                   11.197719                   11.185996
## 551                    6.728551                    6.627090
## 566                   12.709173                   12.825505
## 575                   14.069355                   14.099160
## 584                    7.999472                    8.024288
## 594                    7.550776                    7.513327
## 609                   13.553828                   13.536745
## 618                   13.553828                   13.536745
## 627                    7.188175                    7.254043
## 642                    8.960830                    8.883563
## 648                   15.556080                   15.605467
## 657                    6.601369                    6.523155
## 672                    6.738571                    6.763061
## 682                    7.465240                    7.550122
## 692                    6.900674                    6.827556
##     GSM2685718_ctrl_24hr_Group_A GSM2685719_ctrl_24hr_Group_B
## 1                       5.971028                    6.006996
## 16                      7.236172                    7.108756
## 31                     13.648472                   13.539470
## 41                     13.110465                   13.124500
```

```
## 51                        6.716954                        6.591846
## 66                        6.136825                        6.274459
## 81                       15.908781                       15.698081
## 90                       13.711263                       13.752605
## 99                        7.841700                        7.824587
## 109                       7.841700                        7.824587
## 209                       8.907840                        8.912668
## 219                       5.822295                        5.874648
## 279                      11.936456                       11.941699
## 285                       8.907840                        8.912668
## 385                      11.936456                       11.941699
## 391                      11.162259                       11.112189
## 397                       6.716954                        6.591846
## 412                       7.566727                        7.559356
## 422                       6.689709                        6.704019
## 437                       6.689709                        6.704019
## 452                       6.533938                        6.482192
## 467                       7.825446                        7.853444
## 482                       6.689709                        6.704019
## 497                       6.716954                        6.591846
## 512                      14.166197                       14.210078
## 521                      14.203153                       14.316351
## 530                       6.533938                        6.482192
## 545                      11.162259                       11.112189
## 551                       6.689709                        6.704019
## 566                      12.718928                       12.526797
## 575                      14.203153                       14.316351
## 584                       8.907840                        8.912668
## 594                       7.825446                        7.853444
## 609                      13.711263                       13.752605
## 618                      13.711263                       13.752605
## 627                       6.181525                        6.087523
## 642                      11.936456                       11.941699
## 648                      15.507334                       15.519886
## 657                       6.533938                        6.482192
## 672                       6.944874                        6.829460
## 682                       7.841700                        7.824587
## 692                       6.716954                        6.591846
##     GSM2685720_ctrl_24hr_Group_C GSM2685721_ctrl_24hr_Group_D
## 1                         6.054347                        6.016164
## 16                        7.072893                        7.111257
## 31                       13.625575                       13.478230
## 41                       13.292808                       13.190435
## 51                        6.568645                        6.576811
## 66                        6.116008                        6.084124
## 81                       15.569952                       15.591344
## 90                       13.777280                       13.791536
## 99                        7.783632                        7.805239
## 109                       7.783632                        7.805239
## 209                       9.091769                        8.998199
```

```
## 219                      6.383866                      5.961156
## 279                     12.027264                     11.940062
## 285                      9.091769                      8.998199
## 385                     12.027264                     11.940062
## 391                     11.039873                     11.061724
## 397                      6.568645                      6.576811
## 412                      7.551625                      7.509755
## 422                      6.740191                      6.801430
## 437                      6.740191                      6.801430
## 452                      6.414388                      6.366862
## 467                      7.939793                      7.793160
## 482                      6.740191                      6.801430
## 497                      6.568645                      6.576811
## 512                     14.245321                     14.178808
## 521                     14.216561                     14.062458
## 530                      6.414388                      6.366862
## 545                     11.039873                     11.061724
## 551                      6.740191                      6.801430
## 566                     12.521572                     12.518281
## 575                     14.216561                     14.062458
## 584                      9.091769                      8.998199
## 594                      7.939793                      7.793160
## 609                     13.777280                     13.791536
## 618                     13.777280                     13.791536
## 627                      6.116008                      6.100574
## 642                     12.027264                     11.940062
## 648                     15.239825                     15.262706
## 657                      6.414388                      6.366862
## 672                      6.996312                      6.968890
## 682                      7.783632                      7.805239
## 692                      6.568645                      6.576811
##     GSM2685722_ctrl_24hr_Group_E GSM2685723_CoV_36hr_Group_A
## 1                       6.065871                     6.037753
## 16                      7.153700                     7.290151
## 31                     13.511865                    12.155727
## 41                     13.198260                    11.842594
## 51                      6.596607                     7.031230
## 66                      6.189750                     6.508058
## 81                     15.575092                    15.928588
## 90                     13.818910                    13.565265
## 99                      7.700074                     7.075356
## 109                     7.700074                     7.075356
## 209                     9.018607                     8.415451
## 219                     5.946259                     6.354954
## 279                    11.842310                     9.547340
## 285                     9.018607                     8.415451
## 385                    11.842310                     9.547340
## 391                    11.162237                    10.390335
## 397                     6.596607                     7.031230
## 412                     7.483871                     6.848334
```

```
## 422                      6.601666                      6.813655
## 437                      6.601666                      6.813655
## 452                      6.306285                      6.793453
## 467                      7.728207                      8.067333
## 482                      6.601666                      6.813655
## 497                      6.596607                      7.031230
## 512                     14.167395                     14.075771
## 521                     14.060533                     14.212112
## 530                      6.306285                      6.793453
## 545                     11.162237                     10.390335
## 551                      6.601666                      6.813655
## 566                     12.560602                     12.502460
## 575                     14.060533                     14.212112
## 584                      9.018607                      8.415451
## 594                      7.728207                      8.067333
## 609                     13.818910                     13.565265
## 618                     13.818910                     13.565265
## 627                      6.158761                      7.258195
## 642                     11.842310                      9.547340
## 648                     15.217024                     15.330807
## 657                      6.306285                      6.793453
## 672                      6.891355                      6.508058
## 682                      7.700074                      7.075356
## 692                      6.596607                      7.031230
##     GSM2685724_CoV_36hr_Group_B GSM2685725_CoV_36hr_Group_C
## 1                      6.075165                      6.035602
## 16                     7.038979                      7.256969
## 31                    12.263597                     12.424504
## 41                    11.984688                     12.033150
## 51                     6.920563                      7.063761
## 66                     6.419116                      6.501226
## 81                    15.963635                     15.983105
## 90                    13.673362                     13.633552
## 99                     7.076960                      7.301533
## 109                    7.076960                      7.301533
## 209                    8.349640                      8.680838
## 219                    5.813953                      6.057816
## 279                    9.470814                      9.856731
## 285                    8.349640                      8.680838
## 385                    9.470814                      9.856731
## 391                   10.657755                     10.350293
## 397                    6.920563                      7.063761
## 412                    6.838491                      6.904409
## 422                    6.648788                      6.671737
## 437                    6.648788                      6.671737
## 452                    6.564707                      6.796636
## 467                    8.033099                      8.012799
## 482                    6.648788                      6.671737
## 497                    6.920563                      7.063761
## 512                   14.151924                     14.171229
```

```
## 521                    14.264767                    14.295878
## 530                     6.564707                     6.796636
## 545                    10.657755                    10.350293
## 551                     6.648788                     6.671737
## 566                    12.621199                    12.500993
## 575                    14.264767                    14.295878
## 584                     8.349640                     8.680838
## 594                     8.033099                     8.012799
## 609                    13.673362                    13.633552
## 618                    13.673362                    13.633552
## 627                     7.091198                     6.988153
## 642                     9.470814                     9.856731
## 648                    15.410491                    15.437017
## 657                     6.564707                     6.796636
## 672                     6.540443                     6.609427
## 682                     7.076960                     7.301533
## 692                     6.920563                     7.063761
##     GSM2685726_CoV_36hr_Group_D GSM2685727_CoV_36hr_Group_E
## 1                       6.040386                     6.130249
## 16                      7.247512                     7.275706
## 31                     12.440354                    12.351661
## 41                     12.082020                    11.793496
## 51                      6.929104                     7.136585
## 66                      6.419622                     6.452728
## 81                     15.943282                    15.823487
## 90                     13.520099                    13.440834
## 99                      7.613149                     7.419926
## 109                     7.613149                     7.419926
## 209                     8.576810                     8.465203
## 219                     5.894553                     6.025496
## 279                     9.696370                     9.585969
## 285                     8.576810                     8.465203
## 385                     9.696370                     9.585969
## 391                    10.378994                    10.490391
## 397                     6.929104                     7.136585
## 412                     6.833708                     6.954109
## 422                     6.626798                     6.763061
## 437                     6.626798                     6.763061
## 452                     6.671737                     6.726782
## 467                     8.166043                     8.051814
## 482                     6.626798                     6.763061
## 497                     6.929104                     7.136585
## 512                    14.097307                    13.856158
## 521                    14.230680                    14.194950
## 530                     6.671737                     6.726782
## 545                    10.378994                    10.490391
## 551                     6.626798                     6.763061
## 566                    12.440331                    12.523054
## 575                    14.230680                    14.194950
## 584                     8.576810                     8.465203
```

```
## 594                     8.166043                     8.051814
## 609                    13.520099                    13.440834
## 618                    13.520099                    13.440834
## 627                     7.194883                     7.223682
## 642                     9.696370                     9.585969
## 648                    15.315381                    15.372981
## 657                     6.671737                     6.726782
## 672                     6.615693                     6.350894
## 682                     7.613149                     7.419926
## 692                     6.929104                     7.136585
##     GSM2685728_ctrl_36hr_Group_A GSM2685729_ctrl_36hr_Group_B
## 1                       6.026382                     6.192380
## 16                      7.224261                     7.247512
## 31                     13.717610                    13.768831
## 41                     13.315157                    13.328181
## 51                      6.797545                     6.722416
## 66                      6.220477                     6.297905
## 81                     15.705959                    15.786439
## 90                     13.530735                    13.575280
## 99                      7.815874                     7.751624
## 109                     7.815874                     7.751624
## 209                     8.793558                     8.893911
## 219                     6.125711                     5.970798
## 279                    12.382962                    12.326271
## 285                     8.793558                     8.893911
## 385                    12.382962                    12.326271
## 391                    11.308817                    11.352996
## 397                     6.797545                     6.722416
## 412                     7.509502                     7.556387
## 422                     6.478637                     6.545394
## 437                     6.478637                     6.545394
## 452                     6.437685                     6.461104
## 467                     8.036592                     7.952603
## 482                     6.478637                     6.545394
## 497                     6.797545                     6.722416
## 512                    14.084852                    14.200832
## 521                    14.176559                    14.341048
## 530                     6.437685                     6.461104
## 545                    11.308817                    11.352996
## 551                     6.478637                     6.545394
## 566                    12.611342                    12.621199
## 575                    14.176559                    14.341048
## 584                     8.793558                     8.893911
## 594                     8.036592                     7.952603
## 609                    13.530735                    13.575280
## 618                    13.530735                    13.575280
## 627                     6.235422                     6.186089
## 642                    12.382962                    12.326271
## 648                    15.213389                    15.217024
## 657                     6.437685                     6.461104
```

```
## 672                      6.815439                      6.832745
## 682                      7.815874                      7.751624
## 692                      6.797545                      6.722416
##     GSM2685730_ctrl_36hr_Group_C GSM2685731_ctrl_36hr_Group_D
## 1                        6.083912                      6.013710
## 16                       7.135662                      7.204644
## 31                      13.867985                     13.830899
## 41                      13.379796                     13.341531
## 51                       6.836527                      6.763127
## 66                       6.236570                      6.174351
## 81                      15.807433                     15.781413
## 90                      13.536745                     13.535802
## 99                       7.830082                      7.789513
## 109                      7.830082                      7.789513
## 209                      8.814025                      8.812357
## 219                      5.881211                      5.946493
## 279                     12.428664                     12.362715
## 285                      8.814025                      8.812357
## 385                     12.428664                     12.362715
## 391                     11.305894                     11.262485
## 397                      6.836527                      6.763127
## 412                      7.571243                      7.522806
## 422                      6.544776                      6.608540
## 437                      6.544776                      6.608540
## 452                      6.321218                      6.506314
## 467                      7.977058                      7.960183
## 482                      6.544776                      6.608540
## 497                      6.836527                      6.763127
## 512                     14.082690                     14.103762
## 521                     14.264767                     14.302531
## 530                      6.321218                      6.506314
## 545                     11.305894                     11.262485
## 551                      6.544776                      6.608540
## 566                     12.570815                     12.623629
## 575                     14.264767                     14.302531
## 584                      8.814025                      8.812357
## 594                      7.977058                      7.960183
## 609                     13.536745                     13.535802
## 618                     13.536745                     13.535802
## 627                      6.282822                      6.118087
## 642                     12.428664                     12.362715
## 648                     15.330807                     15.320354
## 657                      6.321218                      6.506314
## 672                      6.870133                      6.829460
## 682                      7.830082                      7.789513
## 692                      6.836527                      6.763127
##     GSM2685732_ctrl_36hr_Group_E GSM2685733_CoV_48hr_Group_A
## 1                        5.996010                     6.245535
## 16                       7.221895                     7.588102
## 31                      13.814027                    13.145100
```

```
## 41                      13.283499                      12.611342
## 51                       6.748119                       7.418830
## 66                       6.206479                       6.421979
## 81                      15.863114                      15.770868
## 90                      13.505737                      13.308149
## 99                       7.876741                       7.615284
## 109                      7.876741                       7.615284
## 209                      8.907780                       8.896563
## 219                      5.986761                       5.952795
## 279                     12.360358                      11.238626
## 285                      8.907780                       8.896563
## 385                     12.360358                      11.238626
## 391                     11.386529                       9.754081
## 397                      6.748119                       7.418830
## 412                      7.549440                       7.106147
## 422                      6.522449                       6.655672
## 437                      6.522449                       6.655672
## 452                      6.511225                       6.737557
## 467                      7.931425                       8.121772
## 482                      6.522449                       6.655672
## 497                      6.748119                       7.418830
## 512                     14.155982                      13.910041
## 521                     14.330268                      14.161250
## 530                      6.511225                       6.737557
## 545                     11.386529                       9.754081
## 551                      6.522449                       6.655672
## 566                     12.655145                      12.470038
## 575                     14.330268                      14.161250
## 584                      8.907780                       8.896563
## 594                      7.931425                       8.121772
## 609                     13.505737                      13.308149
## 618                     13.505737                      13.308149
## 627                      6.206479                       6.885510
## 642                     12.360358                      11.238626
## 648                     15.405375                      15.169967
## 657                      6.511225                       6.737557
## 672                      6.856325                       6.516730
## 682                      7.876741                       7.615284
## 692                      6.748119                       7.418830
##     GSM2685734_CoV_48hr_Group_B GSM2685735_CoV_48hr_Group_C
## 1                      6.171151                       6.220090
## 16                     7.624817                       7.440707
## 31                    12.930745                      13.184153
## 41                    12.477358                      12.738455
## 51                     7.609460                       7.428115
## 66                     6.675679                       6.538291
## 81                    15.811264                      15.943282
## 90                    13.268812                      12.955313
## 99                     7.377139                       7.650819
## 109                    7.377139                       7.650819
```

```
## 209                      8.807600                      8.831738
## 219                      5.916103                      5.924204
## 279                     11.011476                     11.453377
## 285                      8.807600                      8.831738
## 385                     11.011476                     11.453377
## 391                      9.813139                      9.731903
## 397                      7.609460                      7.428115
## 412                      7.060422                      7.233038
## 422                      6.824505                      6.832745
## 437                      6.824505                      6.832745
## 452                      6.675679                      6.895957
## 467                      8.274663                      8.323442
## 482                      6.824505                      6.832745
## 497                      7.609460                      7.428115
## 512                     13.891601                     13.584385
## 521                     14.260434                     14.084852
## 530                      6.675679                      6.895957
## 545                      9.813139                      9.731903
## 551                      6.824505                      6.832745
## 566                     12.385422                     12.066142
## 575                     14.260434                     14.084852
## 584                      8.807600                      8.831738
## 594                      8.274663                      8.323442
## 609                     13.268812                     12.955313
## 618                     13.268812                     12.955313
## 627                      7.301030                      6.822849
## 642                     11.011476                     11.453377
## 648                     15.204887                     15.148994
## 657                      6.675679                      6.895957
## 672                      6.489574                      6.563411
## 682                      7.377139                      7.650819
## 692                      7.609460                      7.428115
##     GSM2685736_CoV_48hr_Group_D GSM2685737_CoV_48hr_Group_E
## 1                        6.193563                      6.168183
## 16                       7.487355                      7.538375
## 31                      13.418502                     13.056731
## 41                      12.884399                     12.555566
## 51                       7.451626                      7.479294
## 66                       6.562724                      6.449183
## 81                      15.943282                     15.770868
## 90                      12.889978                     13.048290
## 99                       7.822518                      7.494732
## 109                      7.822518                      7.494732
## 209                      8.962595                      8.838498
## 219                      5.724779                      5.929894
## 279                     11.408702                     11.297811
## 285                      8.962595                      8.838498
## 385                     11.408702                     11.297811
## 391                      9.693743                      9.734166
## 397                      7.451626                      7.479294
```

```
## 412                     7.263597                     7.147329
## 422                     7.032002                     6.806906
## 437                     7.032002                     6.806906
## 452                     6.819596                     6.878967
## 467                     8.479178                     8.383752
## 482                     7.032002                     6.806906
## 497                     7.451626                     7.479294
## 512                    13.594991                    13.642893
## 521                    14.281527                    14.103762
## 530                     6.819596                     6.878967
## 545                     9.693743                     9.734166
## 551                     7.032002                     6.806906
## 566                    12.290165                    12.237340
## 575                    14.281527                    14.103762
## 584                     8.962595                     8.838498
## 594                     8.479178                     8.383752
## 609                    12.889978                    13.048290
## 618                    12.889978                    13.048290
## 627                     7.001776                     6.854082
## 642                    11.408702                    11.297811
## 648                    15.181885                    15.077245
## 657                     6.819596                     6.878967
## 672                     6.604914                     6.551078
## 682                     7.822518                     7.494732
## 692                     7.451626                     7.479294
##     GSM2685738_ctrl_48hr_Group_A GSM2685739_ctrl_48hr_Group_B
## 1                       6.113510                     6.118294
## 16                      7.351580                     7.255082
## 31                     13.479785                    13.809171
## 41                     12.913809                    13.272047
## 51                      6.884900                     6.755348
## 66                      6.132513                     6.191788
## 81                     15.840441                    15.823487
## 90                     13.642893                    13.424247
## 99                      7.822295                     7.826527
## 109                     7.822295                     7.826527
## 209                     8.661194                     8.709415
## 219                     5.805983                     6.059503
## 279                    12.087007                    12.095376
## 285                     8.661194                     8.709415
## 385                    12.087007                    12.095376
## 391                    11.252360                    11.380947
## 397                     6.884900                     6.755348
## 412                     7.482716                     7.507635
## 422                     6.651517                     6.676103
## 437                     6.651517                     6.676103
## 452                     6.429698                     6.527384
## 467                     7.880480                     7.940615
## 482                     6.651517                     6.676103
## 497                     6.884900                     6.755348
```

```
## 512                      14.218930                      14.054635
## 521                      14.335814                      14.307798
## 530                       6.429698                       6.527384
## 545                      11.252360                      11.380947
## 551                       6.651517                       6.676103
## 566                      12.669945                      12.641231
## 575                      14.335814                      14.307798
## 584                       8.661194                       8.709415
## 594                       7.880480                       7.940615
## 609                      13.642893                      13.424247
## 618                      13.642893                      13.424247
## 627                       6.229315                       6.288708
## 642                      12.087007                      12.095376
## 648                      15.478388                      15.289801
## 657                       6.429698                       6.527384
## 672                       6.768088                       6.790796
## 682                       7.822295                       7.826527
## 692                       6.884900                       6.755348
##     GSM2685740_ctrl_48hr_Group_C GSM2685741_ctrl_48hr_Group_D
## 1                         6.178938                       6.181525
## 16                        7.147917                       7.127182
## 31                       13.768155                      13.649614
## 41                       13.290203                      13.167372
## 51                        6.925081                       6.742202
## 66                        6.108500                       6.154514
## 81                       15.770868                      15.786439
## 90                       13.695565                      13.390078
## 99                        7.672054                       7.855158
## 109                       7.672054                       7.855158
## 209                       8.469137                       8.748683
## 219                       5.850421                       6.065332
## 279                      12.205447                      12.108098
## 285                       8.469137                       8.748683
## 385                      12.205447                      12.108098
## 391                      11.440833                      11.395297
## 397                       6.925081                       6.742202
## 412                       7.413660                       7.568577
## 422                       6.617604                       6.551694
## 437                       6.617604                       6.551694
## 452                       6.314647                       6.477990
## 467                       7.844684                       7.929474
## 482                       6.617604                       6.551694
## 497                       6.925081                       6.742202
## 512                      14.253092                      13.973822
## 521                      14.345264                      14.221843
## 530                       6.314647                       6.477990
## 545                      11.440833                      11.395297
## 551                       6.617604                       6.551694
## 566                      12.795429                      12.503914
## 575                      14.345264                      14.221843
```

```
## 584                      8.469137                      8.748683
## 594                      7.844684                      7.929474
## 609                     13.695565                     13.390078
## 618                     13.695565                     13.390078
## 627                      6.225850                      6.136620
## 642                     12.205447                     12.108098
## 648                     15.471859                     15.279920
## 657                      6.314647                      6.477990
## 672                      6.867602                      6.882945
## 682                      7.672054                      7.855158
## 692                      6.925081                      6.742202
##     GSM2685742_ctrl_48hr_Group_E
## 1                        6.050870
## 16                       7.342277
## 31                      13.621482
## 41                      13.121641
## 51                       6.787927
## 66                       6.120162
## 81                      15.815665
## 90                      13.471967
## 99                       7.714570
## 109                      7.714570
## 209                      8.781281
## 219                      5.903015
## 279                     12.159429
## 285                      8.781281
## 385                     12.159429
## 391                     11.449781
## 397                      6.787927
## 412                      7.398872
## 422                      6.586001
## 437                      6.586001
## 452                      6.458481
## 467                      7.953244
## 482                      6.586001
## 497                      6.787927
## 512                     14.119631
## 521                     14.228603
## 530                      6.458481
## 545                     11.449781
## 551                      6.586001
## 566                     12.656605
## 575                     14.228603
## 584                      8.781281
## 594                      7.953244
## 609                     13.471967
## 618                     13.471967
## 627                      6.282451
## 642                     12.159429
## 648                     15.275427
```

```
## 657                      6.458481
## 672                      6.783099
## 682                      7.714570
## 692                      6.787927
```

---

The above table shows the five genes that had the highest count and then the genotypes within those five genes by number or count of those genotypes of DNA copy number variations in the SEQUENCE.

It would be interesting to analyze those sequences of copy number variations within the top 5 genes expressed the most number of times in this data. Comparing networks of genes associated with processes in the body like immune response, pathogenesis of disease onset, networks of human processes in the body associated with cancer or subsequent diseases like autoimmune, celiac disease, hemochromatosis, anemia, etc. To see how well any of those genotypes fair. We could also detect patterns in the fold change values between genotypes of the genes expressed in comparing the capillary samples all within 1 hour after being inoculated with CoV, inactive CoV, CoV and an interleukin alpha, or control group. Then compare the liver tumor samples of each group A through E that was monitored after being inoculated with CoV at 0,12,24,36, and 48 hours side by side with the control groups of groups A through E.

---

---