

# 2024-09-23-G9-HTG-Suppl.R

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2024-09-23

```
# Version 2024-09-23 Analyses of G9-results and validation cohorts
#
#
#
```

## SETUP

```
Sys.setenv(lang = "en_US")
```

Install required packages if missing —————

```
# Package names
packages <- c("dplyr", "readxl", "ggplot2", "tidyr", "stringr",
              "fmsb", "ggVennDiagram", "ggvenn", "ggrepel")

# Install packages not yet installed
installed_packages <- packages %in% rownames(installed.packages())
if (any(installed_packages == FALSE)) {
  install.packages(packages[!installed_packages])
}

# Packages Loading
invisible(lapply(packages, library, character.only = TRUE))

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union

##
## Attaching package: 'ggVennDiagram'

## The following object is masked from 'package:tidyr':
##
##   unite

## Loading required package: grid
```

```
#
```

## Data import —————

```
# Import of Excel file with data for all 2549 HTG genes
```

```
#
```

```
# 23 total columns
```

```
#
```

```
# Recode "NaN" to NA values
```

```
suppressWarnings(  
  import.data <- read_excel(  
    "input/G9_combined_results_all_genes_24JUL2023.xlsx",  
    na = c("", "NaN"),  
    col_types = c("text", "text", "numeric",  
                  "text", "numeric", "text", "numeric",  
                  "text", "numeric", "text", "numeric",  
                  "text", "numeric", "numeric", "numeric",  
                  "numeric", "numeric", "numeric",  
                  "numeric", "numeric", "numeric",  
                  "numeric", "numeric", "numeric",  
                  "numeric", "text", "text")  
  ),  
  classes = "warning"  
)
```

```
#
```

## Select variables and change names —————

```
data <- import.data %>% # select variables of interest  
  select(  
    c(Genes = variable,  
      OR_pCR_durva,  
      p_log_pCR_durva,  
      OR_pCR_plac,  
      p_log_pCR_plac,  
      HR_durva,  
      p_cox_DDFS_durva,  
      HR_plac,  
      p_cox_DDFS_plac,  
      meanlog2Diff_AB_durva,  
      p_AB_durva,  
      meanlog2Diff_AB_plac,  
      p_AB_plac,  
      meanlog2Diff_AC_durva,  
      p_AC_durva,  
      meanlog2Diff_AC_plac,  
      p_AC_plac,  
      GeoMx.epi.vs.stromal = `GeoMx PanCK- PanCK+ A_mean_log2_difference`,
```

```

    p_strom_vs_epith = `GeoMx PanCK- PanCK+_A_p`,
    `pathway (HTG)`,
    `pathway (hallmark)`
  )
) %>% # split text strings of OR/HR and 95%CI's
separate_wider_delim(
  cols = c(OR_pCR_durva, OR_pCR_plac, HR_durva, HR_plac),
  delim = " ",
  names_sep = "_",
  too_few = "align_start"
) %>% # extract numeric OR/HR values:
mutate(
  OR_pCR_durva = as.numeric(OR_pCR_durva_1),
  OR_pCR_plac = as.numeric(OR_pCR_plac_1),
  HR_durva = as.numeric(HR_durva_1),
  HR_plac = as.numeric(HR_plac_1)
) %>% # rename CI variables:
mutate(
  OR_pCR_durva_CI = OR_pCR_durva_2,
  OR_pCR_plac_CI = OR_pCR_plac_2,
  HR_durva_CI = HR_durva_2,
  HR_plac_CI = HR_plac_2
) %>% # remove renamed duplicate variables:
select(
  !c(OR_pCR_durva_1, OR_pCR_durva_2,
    OR_pCR_plac_1, OR_pCR_plac_2,
    HR_durva_1, HR_durva_2,
    HR_plac_1, HR_plac_2)
)

```

# \* -----

## Definitions of gene sets for all analyses -----

# Geneset containing all genes:

```

g0.all <- data %>%
  select(Genes) %>% pull()

```

# Genesets according to pathways:

```

#
# Pathway information for genes are available from two sources:
# HTG-Molecular pathway information on HTG-panel in data$pathway (HTG)
# Hallmark pathways in data$pathway (hallmark)

```

```

g1.immune <- data %>%
  filter(
    str_detect(`pathway (HTG)`, "immuno-oncology")
    | str_detect(

```

```

    `pathway (hallmark)`,
    "allograft rejection|interferon alpha response|interferon gamma response"
  )
) %>%
select(Genes) %>% pull()

g2.proliferation <- data %>%
  filter(
    str_detect(`pathway (HTG)`, "cell cycle")
    | str_detect(
      `pathway (hallmark)`,
      "E2F targets|G2M checkpoint|mitotic spindle"
    )
  ) %>%
select(Genes) %>% pull()

g3.stromalEMT <- data %>%
  filter(
    str_detect(`pathway (HTG)`, "angiogenesis")
    | str_detect(
      `pathway (hallmark)`,
      "angiogenesis|coagulation|epithelial mesenchymal transition|fatty acid
metabolism|myogenesis"
    )
  ) %>%
select(Genes) %>% pull()

g4.stromal.NonImmune <- g3.stromalEMT[!(g3.stromalEMT %in% g1.immune)]

g5.DNArepair <- data %>%
  filter(
    str_detect(`pathway (HTG)`, "DNA repair")
    | str_detect(
      `pathway (hallmark)`, "DNA repair"
    )
  ) %>%
select(Genes) %>% pull()

g6.stemcell <- data %>%
  filter(
    str_detect(`pathway (HTG)`, "stem cells")
  ) %>%
select(Genes) %>% pull()

# * -----

```

*Gene assignment to unique class —————*

```

# Ranking of unique assignments based on membership in the above genesets:
# a) immune

```

```

# b) proliferation
# c) stromal-EMT
# d) DNA repair
# e) stem cell
# f) other (not in any of the above genesets)
#
# These unique assignments are used for color coding in scatter plots

gene.class <- data %>% select(Genes) %>%
  mutate(gene.class = "other") %>%
  mutate(gene.class = if_else(Genes %in% g6.stemcell, "stemcell", gene.class)) %>%
  mutate(gene.class = if_else(Genes %in% g5.DNArepair, "DNArepair", gene.class)) %>%
  mutate(gene.class = if_else(Genes %in% g3.stromalEMT, "stromalEMT", gene.class)) %>%
  mutate(gene.class = if_else(Genes %in% g2.proliferation, "proliferation", gene.class))
%>%
  mutate(gene.class = if_else(Genes %in% g1.immune, "immune", gene.class))

```

Gene list for scatter plots —————

```

# Filter 126 genelist used for G9-pCR-DDFS-Scatter plot -----
#
# Stringent Selection:
# Select genes with any p-value <0.01
# (either pCR or DDFS in either arm)

g9.pCR.DDFS.scatter <- data %>% left_join(gene.class, by="Genes") %>%
  filter_at(vars(p_log_pCR_durva, p_log_pCR_plac,
                p_cox_DDFS_durva, p_cox_DDFS_plac),
            any_vars(. <0.01)) %>%
  select(Genes, gene.class)

g9.pCR.DDFS.scatter.genes <- g9.pCR.DDFS.scatter$Genes

# *-----
# *-----
#

```

## ANALYSIS

### Gene expression, therapy response and survival —————

```
#  
  
Assemble pCR data for different genelists g0/g1/g2/g3/g4 ———  
  
#####  
  
# Define genelist: g0.all  
  
glist <- g0.all  
  
#####  
# Genelist analysis: #  
#####  
  
# Filter data for genelist  
data.glist <- data %>% filter(Genes %in% glist)  
  
# Prepare a list object for results:  
resp <- vector(mode="list")  
  
# Total set of genes  
resp$all <- data.glist$Genes  
  
# Genes predictive for pCR  
resp$durva.good <- data.glist %>%  
  filter(p_log_pCR_durva <= 0.05) %>%  
  filter(OR_pCR_durva > 1) %>%  
  select(Genes) %>% pull()  
resp$durva.poor <- data.glist %>%  
  filter(p_log_pCR_durva <= 0.05) %>%  
  filter(OR_pCR_durva < 1) %>%  
  select(Genes) %>% pull()  
resp$plac.good <- data.glist %>%  
  filter(p_log_pCR_plac <= 0.05) %>%  
  filter(OR_pCR_plac > 1) %>%  
  select(Genes) %>% pull()  
resp$plac.poor <- data.glist %>%  
  filter(p_log_pCR_plac <= 0.05) %>%  
  filter(OR_pCR_plac < 1) %>%  
  select(Genes) %>% pull()  
resp$unique <- unique(  
  c(resp$durva.good, resp$durva.poor, resp$plac.good, resp$plac.poor)  
)  
  
#####  
  
# Save results for genelist  
  
resp.g0.all <- resp  
  
#####
```

```

# Define genelist: g1.immune

glist <- g1.immune

#####
# Genelist analysis:  #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
resp <- vector(mode="list")

# Total set of genes
resp$all <- data.glist$Genes

# Genes predictive for pCR
resp$durva.good <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva > 1) %>%
  select(Genes) %>% pull()
resp$durva.poor <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva < 1) %>%
  select(Genes) %>% pull()
resp$plac.good <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac > 1) %>%
  select(Genes) %>% pull()
resp$plac.poor <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac < 1) %>%
  select(Genes) %>% pull()
resp$unique <- unique(
  c(resp$durva.good, resp$durva.poor, resp$plac.good, resp$plac.poor)
)

#####

# Save results for genelist

resp.g1.immune <- resp

#####

# Define genelist: g2.proliferation

glist <- g2.proliferation

#####

```

```

# Genelist analysis:  #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
resp <- vector(mode="list")

# Total set of genes
resp$all <- data.glist$Genes

# Genes predictive for pCR
resp$durva.good <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva > 1) %>%
  select(Genes) %>% pull()
resp$durva.poor <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva < 1) %>%
  select(Genes) %>% pull()
resp$plac.good <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac > 1) %>%
  select(Genes) %>% pull()
resp$plac.poor <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac < 1) %>%
  select(Genes) %>% pull()
resp$unique <- unique(
  c(resp$durva.good, resp$durva.poor, resp$plac.good, resp$plac.poor)
)

#####

# Save results for genelist

resp.g2.proliferation <- resp

#####

# Define genelist: g3.stromaleMT

glist <- g3.stromaleMT

#####
# Genelist analysis:  #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:

```



```

resp <- vector(mode="list")

# Total set of genes
resp$all <- data.glist$Genes

# Genes predictive for pCR
resp$durva.good <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva > 1) %>%
  select(Genes) %>% pull()
resp$durva.poor <- data.glist %>%
  filter(p_log_pCR_durva <= 0.05) %>%
  filter(OR_pCR_durva < 1) %>%
  select(Genes) %>% pull()
resp$plac.good <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac > 1) %>%
  select(Genes) %>% pull()
resp$plac.poor <- data.glist %>%
  filter(p_log_pCR_plac <= 0.05) %>%
  filter(OR_pCR_plac < 1) %>%
  select(Genes) %>% pull()
resp$unique <- unique(
  c(resp$durva.good, resp$durva.poor, resp$plac.good, resp$plac.poor)
)

#####

# Save results for genelist
resp.g3.stromalEMT <- resp

#####

# Define genelist: g4.stromal.NonImmune
glist <- g4.stromal.NonImmune

#####
# Genelist analysis: #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
resp <- vector(mode="list")

# Total set of genes
resp$all <- data.glist$Genes

# Genes predictive for pCR
resp$durva.good <- data.glist %>%

```

```

filter(p_log_pCR_durva <= 0.05) %>%
filter(OR_pCR_durva > 1) %>%
select(Genes) %>% pull()
resp$durva.poor <- data.glist %>%
filter(p_log_pCR_durva <= 0.05) %>%
filter(OR_pCR_durva < 1) %>%
select(Genes) %>% pull()
resp$plac.good <- data.glist %>%
filter(p_log_pCR_plac <= 0.05) %>%
filter(OR_pCR_plac > 1) %>%
select(Genes) %>% pull()
resp$plac.poor <- data.glist %>%
filter(p_log_pCR_plac <= 0.05) %>%
filter(OR_pCR_plac < 1) %>%
select(Genes) %>% pull()
resp$unique <- unique(
  c(resp$durva.good, resp$durva.poor, resp$plac.good, resp$plac.poor)
)

```

#####

*# Save results for genelist*

```
resp.g4.stromal.NonImmune <- resp
```

#####

*# Summarize the numbers of genes predictive for pCR -----*

```

resp.sum <- cbind(
  summary(resp.g0.all)[,1],
  summary(resp.g1.immune)[,1],
  summary(resp.g2.proliferation)[,1],
  summary(resp.g3.stromalEMT)[,1],
  summary(resp.g4.stromal.NonImmune)[,1]
)
colnames(resp.sum) <- c("g0.all", "g1.immune", "g2.proliferation",
  "g3.stromalEMT", "g4.stromal.NonImmune")
rn <- rownames(resp.sum)
resp.sum <- apply(resp.sum, 2, as.numeric)
rownames(resp.sum) <- rn

```

*# Numbers of genes predictive for pCR in each geneset:*

```
resp.sum
```

##	g0.all	g1.immune	g2.proliferation	g3.stromalEMT	g4.stromal.NonImmune
## all	2549	431	275	331	264
## durva.good	225	74	72	13	5
## durva.poor	92	7	4	50	48
## plac.good	134	36	39	8	3
## plac.poor	14	2	0	8	6
## unique	422	114	91	74	57

```

# Calculate as percentage
resp.sum.perc <- round(resp.sum/resp.sum[1,] * 100, 2)
# Percentage of genes predictive for pCR in each geneset:
resp.sum.perc

##           g0.all g1.immune g2.proliferation g3.stromalEMT g4.stromal.NonImmune
## all           100.00   100.00           100.00           100.00           100.00
## durva.good    52.20    26.91            21.75            4.92            0.20
## durva.poor    33.45     2.11             1.52            1.96           11.14
## plac.good     40.48    13.64             1.53            1.86            1.09
## plac.poor      5.30     0.08             0.00            2.91            1.81
## unique        16.56    26.45            33.09           22.36           21.59

write.csv2(resp.sum, file="out/resp_summary.csv")
write.csv2(resp.sum.perc, file="out/resp_summary_perc.csv")

# Venn diagrams for pCR -----

library("ggvenn") # color by category
library("ggVennDiagram") # color by number of genes

#

```

Figure 3a (and Fig 4a)

```

#

# g0.all genes

genes <- resp.g0.all
title <- "Genes predictive for pCR among all genes\n"

# Venn diagram colored by category
# (exclude first category of "all" genes)

fn <- "out/Fig3a_Venn-pCR.pdf"
pdf(file = fn)
ggvenn(
  genes[c(3, 2, 4, 5)],
  fill_color = c("#0073C2FF", "#EFC000FF", "#868686FF", "#CD534CFF"),
  stroke_size = 0.5,
  set_name_size = 4
) +
  ggtitle(title)
dev.off()

## png
## 2

#####

# Venn diagrams for pCR Separately for Genesets
#

```

Figure 4a and Fig 4c

```

#

# g1.immune genes

genes <- resp.g1.immune
title <- "Genes predictive for pCR among g1.immune genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4a-immune_Venn-pCR.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

## png
## 2

#####

# g2.proliferation genes

genes <- resp.g2.proliferation
title <- "Genes predictive for pCR among g2.proliferation genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4a-prolif_Venn-pCR.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

## png
## 2

#####

# g3.stromalEMT genes

genes <- resp.g3.stromalEMT
title <- "Genes predictive for pCR among g3.stromalEMT genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4a-stromal_Venn-pCR.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +

```

```
  scale_fill_gradient(low = "white", high = "red") +  
  ggtitle(title)  
dev.off()  
  
## png  
## 2  
  
#####
```

```
#####
```

Assemble DDFS data for different genelists  $g_0/g_1/g_2/g_3/g_4$  ———

```
#####
```

```
# Define genelist: g0.all
```

```
glist <- g0.all
```

```
#####
```

```
# Genelist DDFS analysis: #
```

```
#####
```

```
# Filter data for genelist
```

```
data.glist <- data %>% filter(Genes %in% glist)
```

```
# Prepare a list object for results:
```

```
ddfs <- vector(mode="list")
```

```
# Total set of genes
```

```
ddfs$all <- data.glist$Genes
```

```
# Genes predictive for improved DDFS
```

```
ddfs$durva.good <- data.glist %>%
```

```
  filter(p_cox_DDFS_durva <= 0.05) %>%
```

```
  filter(HR_durva < 1) %>%
```

```
  select(Genes) %>% pull()
```

```
ddfs$durva.poor <- data.glist %>%
```

```
  filter(p_cox_DDFS_durva <= 0.05) %>%
```

```
  filter(HR_durva > 1) %>%
```

```
  select(Genes) %>% pull()
```

```
ddfs$plac.good <- data.glist %>%
```

```
  filter(p_cox_DDFS_plac <= 0.05) %>%
```

```
  filter(HR_plac < 1) %>%
```

```
  select(Genes) %>% pull()
```

```
ddfs$plac.poor <- data.glist %>%
```

```
  filter(p_cox_DDFS_plac <= 0.05) %>%
```

```
  filter(HR_plac > 1) %>%
```

```
  select(Genes) %>% pull()
```

```
ddfs$unique <- unique(
```

```
  c(ddfs$durva.good, ddfs$durva.poor, ddfs$plac.good, ddfs$plac.poor)
```

```
)
```

```
#####
```

```
# Save results for genelist
```

```
ddfs.g0.all <- ddfs
```

```
#####
```

```
# Define genelist: g1.immune
```

```
glist <- g1.immune
```

```
#####
# Genelist DDFS analysis:  #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
ddfs <- vector(mode="list")

# Total set of genes
ddfs$all <- data.glist$Genes

# Genes predictive for improved DDFS
ddfs$durva.good <- data.glist %>%
  filter(p_cox_DDFS_durva <= 0.05) %>%
  filter(HR_durva < 1) %>%
  select(Genes) %>% pull()
ddfs$durva.poor <- data.glist %>%
  filter(p_cox_DDFS_durva <= 0.05) %>%
  filter(HR_durva > 1) %>%
  select(Genes) %>% pull()
ddfs$plac.good <- data.glist %>%
  filter(p_cox_DDFS_plac <= 0.05) %>%
  filter(HR_plac < 1) %>%
  select(Genes) %>% pull()
ddfs$plac.poor <- data.glist %>%
  filter(p_cox_DDFS_plac <= 0.05) %>%
  filter(HR_plac > 1) %>%
  select(Genes) %>% pull()
ddfs$unique <- unique(
  c(ddfs$durva.good, ddfs$durva.poor, ddfs$plac.good, ddfs$plac.poor)
)

#####

# Save results for genelist

ddfs.g1.immune <- ddfs

#####

# Define genelist: g2.proliferation

glist <- g2.proliferation

#####
# Genelist DDFS analysis:  #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)
```

```

# Prepare a list object for results:
ddfs <- vector(mode="list")

# Total set of genes
ddfs$all <- data.glist$Genes

# Genes predictive for improved DDFS
ddfs$durva.good <- data.glist %>%
  filter(p_cox_DDFS_durva <= 0.05) %>%
  filter(HR_durva < 1) %>%
  select(Genes) %>% pull()
ddfs$durva.poor <- data.glist %>%
  filter(p_cox_DDFS_durva <= 0.05) %>%
  filter(HR_durva > 1) %>%
  select(Genes) %>% pull()
ddfs$plac.good <- data.glist %>%
  filter(p_cox_DDFS_plac <= 0.05) %>%
  filter(HR_plac < 1) %>%
  select(Genes) %>% pull()
ddfs$plac.poor <- data.glist %>%
  filter(p_cox_DDFS_plac <= 0.05) %>%
  filter(HR_plac > 1) %>%
  select(Genes) %>% pull()
ddfs$unique <- unique(
  c(ddfs$durva.good, ddfs$durva.poor, ddfs$plac.good, ddfs$plac.poor)
)

#####

# Save results for genelist

ddfs.g2.proliferation <- ddfs

#####

# Define genelist: g3.stromaLEMT

glist <- g3.stromaLEMT

#####
# Genelist DDFS analysis: #
#####

# Filter data for genelist
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
ddfs <- vector(mode="list")

# Total set of genes
ddfs$all <- data.glist$Genes

# Genes predictive for improved DDFS
ddfs$durva.good <- data.glist %>%

```



```

filter(p_cox_DDFS_durva <= 0.05) %>%
filter(HR_durva < 1) %>%
select(Genes) %>% pull()
ddfs$durva.poor <- data.glist %>%
filter(p_cox_DDFS_durva <= 0.05) %>%
filter(HR_durva > 1) %>%
select(Genes) %>% pull()
ddfs$plac.good <- data.glist %>%
filter(p_cox_DDFS_plac <= 0.05) %>%
filter(HR_plac < 1) %>%
select(Genes) %>% pull()
ddfs$plac.poor <- data.glist %>%
filter(p_cox_DDFS_plac <= 0.05) %>%
filter(HR_plac > 1) %>%
select(Genes) %>% pull()
ddfs$unique <- unique(
  c(ddfs$durva.good, ddfs$durva.poor, ddfs$plac.good, ddfs$plac.poor)
)

```

```
#####
```

```
# Save results for genelist
```

```
ddfs.g3.stromalEMT <- ddfs
```

```
#####
```

```
# Define genelist: g4.stromal.NonImmune
```

```
glist <- g4.stromal.NonImmune
```

```
#####
```

```
# Genelist DDFS analysis: #
```

```
#####
```

```
# Filter data for genelist
```

```
data.glist <- data %>% filter(Genes %in% glist)
```

```
# Prepare a list object for results:
```

```
ddfs <- vector(mode="list")
```

```
# Total set of genes
```

```
ddfs$all <- data.glist$Genes
```

```
# Genes predictive for improved DDFS
```

```
ddfs$durva.good <- data.glist %>%
```

```
filter(p_cox_DDFS_durva <= 0.05) %>%
```

```
filter(HR_durva < 1) %>%
```

```
select(Genes) %>% pull()
```

```
ddfs$durva.poor <- data.glist %>%
```

```
filter(p_cox_DDFS_durva <= 0.05) %>%
```

```
filter(HR_durva > 1) %>%
```

```
select(Genes) %>% pull()
```

```
ddfs$plac.good <- data.glist %>%
```

```

filter(p_cox_DDFS_plac <= 0.05) %>%
filter(HR_plac < 1) %>%
select(Genes) %>% pull()
ddfs$plac.poor <- data.glist %>%
filter(p_cox_DDFS_plac <= 0.05) %>%
filter(HR_plac > 1) %>%
select(Genes) %>% pull()
ddfs$unique <- unique(
  c(ddfs$durva.good, ddfs$durva.poor, ddfs$plac.good, ddfs$plac.poor)
)

#####

# Save results for genelist

ddfs.g4.stromal.NonImmune <- ddfs

#####

# Summarize results on DDFS -----

ddfs.sum <- cbind(
  summary(ddfs.g0.all)[,1],
  summary(ddfs.g1.immune)[,1],
  summary(ddfs.g2.proliferation)[,1],
  summary(ddfs.g3.stromalEMT)[,1],
  summary(ddfs.g4.stromal.NonImmune)[,1]
)
colnames(ddfs.sum) <- c("g0.all", "g1.immune", "g2.proliferation",
  "g3.stromalEMT", "g4.stromal.NonImmune")
rn <- rownames(ddfs.sum)
ddfs.sum <- apply(ddfs.sum, 2, as.numeric)
rownames(ddfs.sum) <- rn

ddfs.sum

##           g0.all g1.immune g2.proliferation g3.stromalEMT g4.stromal.NonImmune
## all           2549      431           275           331           264
## durva.good     169       45            18            21            13
## durva.poor      12        0             2             2             2
## plac.good       15        4             4             2             0
## plac.poor       69        7             8            11             9
## unique         262       56            31            36            24

# Calculate as percentage
ddfs.sum.perc <- round(ddfs.sum/ddfs.sum[1,] * 100, 2)
# Percentage of genes prognostic for DDFS in each geneset:
ddfs.sum.perc

##           g0.all g1.immune g2.proliferation g3.stromalEMT g4.stromal.NonImmune
## all           100.00   100.00           100.00           100.00           100.00
## durva.good     39.21    16.36            5.44            7.95            0.51
## durva.poor      4.36     0.00            0.76            0.08            0.46

```

```
## plac.good      4.53      1.52      0.16      0.46      0.00
## plac.poor     26.14      0.27      1.86      4.00      2.72
## unique        10.28     12.99     11.27     10.88     9.09
```

```
write.csv2(ddfs.sum, file="out/ddfs_summary.csv")
write.csv2(ddfs.sum.perc, file="out/ddfs_summary_perc.csv")
```

```
# Venn diagrams for DDFS -----
```

```
library("ggvenn") # color by category
library("ggVennDiagram") # color by number of genes
```

```
# g0.all genes
```

```
#
```

*Figure 3b (and Fig 4c)*

```
#
```

```
genes <- ddfs.g0.all
title <- "Genes prognostic for DDFS among all genes\n"
```

```
# Venn diagram colored by category
# (exclude first category of "all" genes)
```

```
fn <- "out/Fig3b_Venn-DDFS.pdf"
pdf(file = fn)
ggvenn(
  genes[c(3, 2, 4, 5)],
  fill_color = c("#0073C2FF", "#EFC000FF", "#868686FF", "#CD534CFF"),
  stroke_size = 0.5,
  set_name_size = 4
) +
  ggtitle(title)
dev.off()
```

```
## png
## 2
```

```
#####
```

```
# Venn diagrams for DDFS Separately for Genesets
#
```

*Figure 4c*

```
#
```

```
# g1.immune genes
```

```

genes <- ddfs.g1.immune
title <- "Genes prognostic for DDFS among g1.immune genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4c-immune_Venn-DDFS.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

## png
## 2

#####

# g2.proliferation genes

genes <- ddfs.g2.proliferation
title <- "Genes prognostic for DDFS among g2.proliferation genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4c-prolif_Venn-DDFS.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

## png
## 2

#####

# g3.stromalEMT genes

genes <- ddfs.g3.stromalEMT
title <- "Genes prognostic for DDFS among g3.stromalEMT genes\n"

# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig4c-stromal_Venn-DDFS.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 2, 4, 5)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

```

## png  
## 2

#####

```

# Venn diagrams  pCR vs DDFS -----

library("ggvenn") # color by category
library("ggVennDiagram") # color by number of genes

#####

# g0.all genes

resp <- resp.g0.all
ddfs <- ddfs.g0.all
title <-
  "Genes predictive for pCR and prognostic for DDFS (among all genes)\n"

# Prepare a list object with all signif genes combined (good+poor):
resp.ddfs <- vector(mode = "list")
resp.ddfs$resp.durva <- c(resp$durva.good, resp$durva.poor)
resp.ddfs$resp.plac <- c(resp$plac.good, resp$plac.poor)
resp.ddfs$ddfs.durva <- c(ddfs$durva.good, ddfs$durva.poor)
resp.ddfs$ddfs.plac <- c(ddfs$plac.good, ddfs$plac.poor)

genes <- resp.ddfs

#

```

Figure 3d

```

#
# Venn diagram colored by number of genes
# (exclude first category of "all" genes)

fn <- "out/Fig3d_Venn-pCR-DDFS.pdf"
pdf(file = fn)
ggVennDiagram(genes[c(3, 1, 2, 4)], label_alpha = 0) +
  scale_fill_gradient(low = "white", high = "red") +
  ggtitle(title)
dev.off()

## png
## 2

#####

```

```
#
```

## Figure 6a and Fig 6b:

### Scatter plot figures pCR vs DDFS

```
#
```

```
library(dplyr)
library(ggplot2)
library(ggrepel)

# Scatter plot for genes with any p-value <0.01
# (either pCR or DDFS in either arm)
#
# These genes are assembled in geneset "g9.pCR.DDFS.scatter.genes"
# (see section "Data-Import and data table generation" above)
#
# Color genes by gene.class (unique assignment, see first section)
#

# Select geneset:

gene.set.name <- "g9.pCR.DDFS.scatter.genes"

gene.set <- get(gene.set.name)

plotdat <- data %>% left_join(gene.class, by="Genes") %>%
  filter(Genes %in% gene.set) %>%
  select(Genes, gene.class, OR_pCR_durva, HR_durva,
         p_log_pCR_durva, p_cox_DDFS_durva,
         OR_pCR_plac, HR_plac,
         p_log_pCR_plac, p_cox_DDFS_plac) %>%
  filter(Genes != "PIK3C2A") # exclude outlier

OR.min <- min(c(plotdat$OR_pCR_durva, plotdat$OR_pCR_plac))
OR.max <- max(c(plotdat$OR_pCR_durva, plotdat$OR_pCR_plac))
HR.min <- min(c(plotdat$HR_durva, plotdat$HR_plac))
HR.max <- max(c(plotdat$HR_durva, plotdat$HR_plac))

# Define color palette ("Dark2" from RColorBrewer):

# 6 groups: DNArepair, immune, other, proliferation, stemcell, stromaleMT
colpal <- c("#1B9E77", "#7570B3", "#666666",
            "#E7298A", "#66A61E", "#A6761D")
```

```
# Plot to pdf files
```

```
# Durvalumab arm pCR vs DDFS
```

```
#
```

```
fn <- "out/Fig6a_Scatter-pCR-DDFS-Durva.pdf"
```

```
pdf(file = fn, width = 11, height = 8.5)
```

```
plotdat %>% ggplot(aes(OR_pCR_durva, 1/HR_durva, color = gene.class)) +
```

```
  theme_light() +
```

```
  scale_color_manual(values = colpal) +
```

```
  geom_point(size = 10, alpha = 0.8) +
```

```
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
```

```
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
```

```
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
```

```
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
```

```
  geom_text_repel(aes(label = Genes, color = gene.class),
```

```
    size = 4,
```

```
    box.padding = 0.5,
```

```
    point.padding = 0.3,
```

```
    segment.size = 0.5,
```

```
    max.overlaps = 50,
```

```
    segment.color = 'darkgrey', show.legend = F) +
```

```
  ggtitle("Durvalumab arm") +
```

```
  xlab("OR for pCR") +
```

```
  ylab("1 / HR for DDFS")
```

```
dev.off()
```

```
## png
```

```
## 2
```

```
# Placebo arm pCR vs DDFS
```

```
#
```

```
fn <- "out/Fig6b_Scatter-pCR-DDFS-Plac.pdf"
```

```
pdf(file = fn, width = 11, height = 8.5)
```

```
plotdat %>% ggplot(aes(OR_pCR_plac, 1/HR_plac, color = gene.class)) +
```

```
  theme_light() +
```

```
  scale_color_manual(values = colpal) +
```

```
  geom_point(size = 10, alpha = 1) +
```

```
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
```

```
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
```

```
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
```

```
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
```

```
  geom_text_repel(aes(label = Genes, color = gene.class),
```

```
    size = 4,
```

```
    box.padding = 0.5,
```

```
    point.padding = 0.3,
```

```
    segment.size = 0.5,
```

```
    max.overlaps = 50,
```

```
    segment.color = 'darkgrey', show.legend = F) +
```

```
  ggtitle("Placebo arm") +
```

```
  xlab("OR for pCR") +
```

```
  ylab("1 / HR for DDFS")
```

```
## Warning: ggrepel: 2 unlabeled data points (too many overlaps). Consider
```

```
## increasing max.overlaps
```



```

dev.off()

## png
## 2

#####

### Additional figures including p-value information:
### Filled circles size based on log10(p-value for pCR)
### Open circles size based on log10(p-value for DDFS)

# Durvalumab arm pCR vs DDFS
#
fn <- "out/Suppl_Scatter-pCR-DDFS-Durva-pVal.pdf"
pdf(file = fn, width = 11, height = 8.5)
ggplot(plotdat) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(aes(x = OR_pCR_durva, y = 1/HR_durva, color = gene.class,
                 size = -log10(p_log_pCR_durva)), alpha = 0.5) +
  geom_point(aes(x = OR_pCR_durva, y = 1/HR_durva, color = gene.class,
                 size = -log10(p_cox-DDFS_durva)), shape = 1) +
  scale_size(range = c(.1, 14), name = "-log10(P-value) [pCR, DDFS]") +
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
  geom_text_repel(aes(x = OR_pCR_durva, y = 1/HR_durva,
                     label = Genes, color = gene.class),
                 size = 3,
                 box.padding = 0.5,
                 point.padding = 0.3,
                 segment.size = 0.5,
                 max.overlaps = 50,
                 segment.color = 'darkgrey', show.legend = F) +
  ggtitle("Durvalumab arm \n(filled circles: pCR-p-Value / open circles: DDFS-p-Value)") +
  xlab("OR for pCR") +
  ylab("1 / HR for DDFS")
dev.off()

## png
## 2

# Placebo arm pCR vs DDFS
#
fn <- "out/Suppl_Scatter-pCR-DDFS-Plac-pval.pdf"
pdf(file = fn, width = 11, height = 8.5)
ggplot(plotdat) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(aes(x = OR_pCR_plac, y = 1/HR_plac, color = gene.class,
                 size = -log10(p_log_pCR_plac)), alpha = 0.5) +
  geom_point(aes(x = OR_pCR_plac, y = 1/HR_plac, color = gene.class,
                 size = -log10(p_cox-DDFS_plac)), shape = 1) +
  scale_size(range = c(.1, 14), name = "-log10(P-value) [pCR, DDFS]") +

```

```

scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
geom_text_repel(aes(x = OR_pCR_plac, y = 1/HR_plac,
                    label = Genes, color = gene.class),
                size = 3,
                box.padding = 0.3,
                point.padding = 0.3,
                segment.size = 0.5,
                max.overlaps = 50,
                segment.color = 'darkgrey', show.legend = F) +
ggtitle("Placebo arm \n(filled circles: pCR-p-Value / open circles: DDFS-p-Value") +
xlab("OR for pCR") +
ylab("1 / HR for DDFS")
dev.off()

## png
## 2

```

```
#####
```

```
#
```

## Alteration of stromal and epithelial gene expression by durvalumab

```
#
```

```
# Analysis expression changes during window (A vs. B)  
# for stromal and epithelial genes
```

```
# Define genelist: Select genes from GeoMx significantly enriched  
# in epithelial compartment
```

```
glist <- data %>% filter(p_strom_vs_epith <= 0.05) %>%  
  filter(GeoMx.epi.vs.stromal > 0) %>% select(Genes) %>% pull()
```

```
#####  
# Window-AB analysis:  #  
#####
```

```
# Filter data using genelist:  
data.glist <- data %>% filter(Genes %in% glist)
```

```
# Prepare a list object for results:  
longAB <- vector(mode="list", length=5 )  
names(longAB) = c("all", "durva.up", "durva.down",  
  "plac.up", "plac.down")
```

```
# Total set of genes  
longAB$all <- data.glist %>% select(Genes) %>% pull()  
# Durvalumab arm AB changes  
longAB$durva.up <- data.glist %>%  
  filter(p_AB_durva <= 0.05 & meanlog2Diff_AB_durva > 0) %>%  
  select(Genes) %>% pull()  
longAB$durva.down <- data.glist %>%  
  filter(p_AB_durva <= 0.05 & meanlog2Diff_AB_durva < 0) %>%  
  select(Genes) %>% pull()  
# Placebo arm AB changes  
longAB$plac.up <- data.glist %>%  
  filter(p_AB_plac <= 0.05 & meanlog2Diff_AB_plac > 0) %>%  
  select(Genes) %>% pull()  
longAB$plac.down <- data.glist %>%  
  filter(p_AB_plac <= 0.05 & meanlog2Diff_AB_plac < 0) %>%  
  select(Genes) %>% pull()
```

```
#####
```

```
# Save results for epi:
```

```
longAB.GeoMx.epi <- longAB
```

```
#####
```

```
# Define genelist: Select genes from GeoMx significantly enriched
```

```

# in stromal compartment
glist <- data %>% filter(p_strom_vs_epith <= 0.05) %>%
  filter(GeoMx.epi.vs.stromal < 0) %>%
  select(Genes) %>% pull()

#####
# Window-AB analysis:      #
#####

# Filter data using genelist:
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
longAB <- vector(mode="list", length=5 )
names(longAB) = c("all", "durva.up", "durva.down",
                  "plac.up", "plac.down")

# Total set of genes
longAB$all <- data.glist %>% select(Genes) %>% pull()
# Durvalumab arm AB changes
longAB$durva.up <- data.glist %>%
  filter(p_AB_durva <= 0.05 & meanlog2Diff_AB_durva > 0) %>%
  select(Genes) %>% pull()
longAB$durva.down <- data.glist %>%
  filter(p_AB_durva <= 0.05 & meanlog2Diff_AB_durva < 0) %>%
  select(Genes) %>% pull()
# Placebo arm AB changes
longAB$plac.up <- data.glist %>%
  filter(p_AB_plac <= 0.05 & meanlog2Diff_AB_plac > 0) %>%
  select(Genes) %>% pull()
longAB$plac.down <- data.glist %>%
  filter(p_AB_plac <= 0.05 & meanlog2Diff_AB_plac < 0) %>%
  select(Genes) %>% pull()

#####

# Save results for stroma:

longAB.GeoMx.stroma <- longAB

#####

# Summarize the numbers of genes changed:

change.AB <- tibble(
  Genes = c("up", "down", "unchanged"),
  Durva.epi = c(
    length(longAB.GeoMx.epi$durva.up),
    length(longAB.GeoMx.epi$durva.down),
    length(longAB.GeoMx.epi$all)
  ) - c(
    length(longAB.GeoMx.epi$durva.up),
    length(longAB.GeoMx.epi$durva.down)
  ),

```

```

Plac.epi = c(
  length(longAB.GeoMx.epi$plac.up),
  length(longAB.GeoMx.epi$plac.down),
  length(longAB.GeoMx.epi$all)
- length(longAB.GeoMx.epi$plac.up)
- length(longAB.GeoMx.epi$plac.down)
),
Durva.stromal = c(
  length(longAB.GeoMx.stroma$durva.up),
  length(longAB.GeoMx.stroma$durva.down),
  length(longAB.GeoMx.stroma$all)
- length(longAB.GeoMx.stroma$durva.up)
- length(longAB.GeoMx.stroma$durva.down)
),
Plac.stromal = c(
  length(longAB.GeoMx.stroma$plac.up),
  length(longAB.GeoMx.stroma$plac.down),
  length(longAB.GeoMx.stroma$all)
- length(longAB.GeoMx.stroma$plac.up)
- length(longAB.GeoMx.stroma$plac.down)
)
)

```

change.AB

```

## # A tibble: 3 × 5
##   Genes      Durva.epi Plac.epi Durva.stromal Plac.stromal
##   <chr>      <int>    <int>      <int>      <int>
## 1 up          0         8         54         1
## 2 down       47         1          2        10
## 3 unchanged 116        154       158       203

```

*# Plot Change\_A\_vs\_B\_stromal\_epithelial.pdf -----*

```

library(tidyr)
df <- pivot_longer(change.AB, cols = -1)
colnames(df) <- c("Genes", "Treatment arm - compartment", "value")

```

```
fn <- "out/Change_A_vs_B_stromal_epithelial.pdf"
```

```

pdf(file = fn, width = 5.5, height = 6)
ggplot(df,
  aes(
    x = Genes,
    y = `Treatment arm - compartment`,
    colour = Genes,
    size = value
  )) +
  geom_point(shape = 19, stroke = 0) +
  geom_text(aes(label = value),
    colour = "white",
    size = 4) +
  scale_x_discrete(position = "top") +
  scale_size_continuous(range = c(0, 60)) + #adjusted to observ-1 (below)

```

```
scale_color_manual(values = c("#79AF97FF", "#80796BFF", "#B24745FF")) +
labs(x = NULL, y = NULL) +
theme(
  legend.position = "none",
  panel.background = element_blank(),
  panel.grid = element_blank(),
  axis.ticks = element_blank()
) +
ggtitle("Gene expression changes \nduring window (A vs. B) \nfor stromal and epithelial
genes\n")
dev.off()

## png
## 2

# *-----
```

```

# Analysis of expression changes during chemotherapy (A vs. C)
# for stromal and epithelial genes

# Define genelist: Select genes from GeoMx significantly enriched
# in epithelial compartment
glist <- data %>% filter(p_strom_vs_epith <= 0.05) %>%
  filter(GeoMx.epi.vs.stromal > 0) %>%
  select(Genes) %>% pull()

#####
# Chemo-AC analysis:      #
#####

# Filter data using genelist:
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
longAC <- vector(mode = "list", length = 5)
names(longAC) = c("all", "durva.up", "durva.down",
                  "plac.up", "plac.down")

# Total set of genes
longAC$all <- data.glist %>% select(Genes) %>% pull()
# Durvalumab arm AC changes
longAC$durva.up <- data.glist %>%
  filter(p_AC_durva <= 0.05 & meanlog2Diff_AC_durva > 0) %>%
  select(Genes) %>% pull()
longAC$durva.down <- data.glist %>%
  filter(p_AC_durva <= 0.05 & meanlog2Diff_AC_durva < 0) %>%
  select(Genes) %>% pull()
# Placebo arm stromal genes LongACudinal changes
longAC$plac.up <- data.glist %>%
  filter(p_AC_plac <= 0.05 & meanlog2Diff_AC_plac > 0) %>%
  select(Genes) %>% pull()
longAC$plac.down <- data.glist %>%
  filter(p_AC_plac <= 0.05 & meanlog2Diff_AC_plac < 0) %>%
  select(Genes) %>% pull()

#####

# Save results for epi:

longAC.GeoMx.epi <- longAC

#####

# Define genelist: Select genes from GeoMx significantly enriched
# in stromal compartment
glist <- data %>% filter(p_strom_vs_epith <= 0.05) %>%
  filter(GeoMx.epi.vs.stromal < 0) %>%
  select(Genes) %>% pull()

```

```
#####
# Chemo-AC analysis:      #
#####

# Filter data using genelist:
data.glist <- data %>% filter(Genes %in% glist)

# Prepare a list object for results:
longAC <- vector(mode = "list", length = 5)
names(longAC) = c("all", "durva.up", "durva.down",
                  "plac.up", "plac.down")

# Total set of genes
longAC$all <- data.glist %>% select(Genes) %>% pull()
# Durvalumab arm AC changes
longAC$durva.up <- data.glist %>%
  filter(p_AC_durva <= 0.05 & meanlog2Diff_AC_durva > 0) %>%
  select(Genes) %>% pull()
longAC$durva.down <- data.glist %>%
  filter(p_AC_durva <= 0.05 & meanlog2Diff_AC_durva < 0) %>%
  select(Genes) %>% pull()
# Placebo arm stromal genes LongACudinal changes
longAC$plac.up <- data.glist %>%
  filter(p_AC_plac <= 0.05 & meanlog2Diff_AC_plac > 0) %>%
  select(Genes) %>% pull()
longAC$plac.down <- data.glist %>%
  filter(p_AC_plac <= 0.05 & meanlog2Diff_AC_plac < 0) %>%
  select(Genes) %>% pull()

#####

# Save results for stroma:

longAC.GeoMx.stroma <- longAC

#####

# Summarize the numbers of genes changed:

change.AC <- tibble(
  Genes = c("up", "down", "unchanged"),
  Durva.epi = c(
    length(longAC.GeoMx.epi$durva.up),
    length(longAC.GeoMx.epi$durva.down),
    length(longAC.GeoMx.epi$all)
    - length(longAC.GeoMx.epi$durva.up)
    - length(longAC.GeoMx.epi$durva.down)
  ),
  Plac.epi = c(
    length(longAC.GeoMx.epi$plac.up),
    length(longAC.GeoMx.epi$plac.down),
    length(longAC.GeoMx.epi$all)
    - length(longAC.GeoMx.epi$plac.up)
    - length(longAC.GeoMx.epi$plac.down)
  ),
)
```



```

Durva.stromal = c(
  length(longAC.GeoMx.stroma$durva.up),
  length(longAC.GeoMx.stroma$durva.down),
  length(longAC.GeoMx.stroma$all)
- length(longAC.GeoMx.stroma$durva.up)
- length(longAC.GeoMx.stroma$durva.down)
),
Plac.stromal = c(
  length(longAC.GeoMx.stroma$plac.up),
  length(longAC.GeoMx.stroma$plac.down),
  length(longAC.GeoMx.stroma$all)
- length(longAC.GeoMx.stroma$plac.up)
- length(longAC.GeoMx.stroma$plac.down)
)
)

```

change.AC

```

## # A tibble: 3 × 5
##   Genes      Durva.epi Plac.epi Durva.stromal Plac.stromal
##   <chr>      <int>    <int>      <int>      <int>
## 1 up          1        2         35         22
## 2 down       64       44         18         32
## 3 unchanged  98      117        161        160

```

*# Plot Change\_A\_vs\_C\_stromal\_epithelial.pdf -----*

```

library(tidyr)
df <- pivot_longer(change.AC, cols = -1)
colnames(df) <- c("Genes", "Treatment arm - compartment", "value")

fn <- "out/Change_A_vs_C_stromal_epithelial.pdf"

pdf(file = fn, width = 5.5, height = 6)
ggplot(df,
  aes(
    x = Genes,
    y = `Treatment arm - compartment`,
    colour = Genes,
    size = value
  )) +
  geom_point(shape = 19, stroke = 1) +
  geom_text(aes(label = value),
    colour = "white",
    size = 4) +
  scale_x_discrete(position = "top") +
  scale_size_continuous(range = c(3, 55)) + # Adjusted to sizes observation-1 !
  scale_color_manual(values = c("#79AF97FF", "#80796BFF", "#B24745FF")) +
  labs(x = NULL, y = NULL) +
  theme(
    legend.position = "none",
    panel.background = element_blank(),
    panel.grid = element_blank(),
    axis.ticks = element_blank()
  )

```

```
) +  
ggtitle(  
  "Gene expression changes during chemotherapy (A vs. C) \nfor stromal and epithelial  
genes\n"  
)  
dev.off()  
  
## png  
## 2  
  
# *-----
```

## VALIDATION ANALYSIS

### Assemble validation RNA-Seq datasets

```
# Import Log2 RNAseq data for available HTG genes of 3 validation datasets

load("input/valid_datasets-HTG.RData")

# MEDI (NCT02489448):
# medi.htg
# medi.htg.cli.dat
# Source:
# 55 samples with pCR information
# RNAseq data for 2508 of 2549 HTG genes

# BRTN (NCT02032277):
# brtn.htg
# brtn.htg.cli.dat
# Source: GSE164458_BrightNess_RNAseq_Log2_Processed_ASTOR.txt
# 482 samples with pCR information
# RNAseq data for 2505 of 2549 HTG genes

# SCANB (NCT02306096) 326 TNBC:
# scanb.htg
# scanb.htg.cli.dat
# Source:
# 326 samples with survival information
# RNAseq data for 2540 of 2549 HTG genes

# Add pCR status as T/F to cli.dat:
medi.htg.cli.dat$pCR <- medi.htg.cli.dat$pathologic.complete.response == "Yes"
brtn.htg.cli.dat$pCR <- brtn.htg.cli.dat$pathologic_complete_response == "pCR"
```

### Assemble pCR-ORs and DFS-HRs for validation datasets —————

```
#####
###      pCR-datasets:      ###
#####

#####
# Calculate Odds Ratios for all 2549 HTG genes in validation datasets #####
#####

val.genes <- g0.all # all 2549 genes from HTG panel

### Dataset medi.htg.Rseq

# Define dataset and genes
```

```

coh <- "medi"
rseq <- medi.htg.Rseq
cli.dat <- medi.htg.cli.dat
cli.dat$resp <-
  as.numeric(cli.dat$pCR) # pCR=1, RD=0
gen.set <- val.genes

# Select data (SCALED)
dat <- rseq[row.names(rseq) %in% gen.set,
  colnames(rseq) %in% rownames(cli.dat)]
dat <- dat[order(rownames(dat)), ] # order by gene name
dat <- na.omit(t(scale(t(dat)))) # scale RNA-Seq for each gene
pCR <- cli.dat$resp

# define dataframe for results
ORtab <- data.frame(gene=NA, OR=NA, CI.lo=NA, CI.up=NA, p.value=NA)

# Loop for odds ratios of pCR for all genes
stopifnot(colnames(dat) == rownames(cli.dat))
suppressWarnings(suppressMessages(
  for (i in 1:nrow(dat)) {
    mod <-
      glm(pCR ~ dat[i, ],
        family = binomial(link = "logit"),
        na.action = na.pass) # logit model of pCR
    ORtab[i, 1] <- rownames(dat)[i] # gene name
    ORtab[i, 2] <- exp(mod$coefficients)[2] # odds ratio
    ORtab[i, 3:4] <- exp(confint(mod))[2, ] # CI
    ORtab[i, 5] <- summary(mod)$coefficients[2, 'Pr(>|z|)'] # pval
  }
))

# Save the result as named variable (SCALED)
assign(paste0("ORtab.", coh, ".scaled"), ORtab)

#####

### Dataset brtn.htg.Rseq

# Define dataset and genes
coh <- "brtn"
rseq <- brtn.htg.Rseq
cli.dat <- brtn.htg.cli.dat
cli.dat$resp <- as.numeric(cli.dat$pCR) # code pCR=1, RD=0
gen.set <- val.genes

# Select data (SCALED)
dat <- rseq[row.names(rseq) %in% gen.set,
  colnames(rseq) %in% rownames(cli.dat)]
dat <- dat[order(rownames(dat)), ] # order by gene name
dat <- na.omit(t(scale(t(dat)))) # scale RNA-Seq for each gene
pCR <- cli.dat$resp

```

```

# define dataframe for results
ORtab <- data.frame(gene=NA, OR=NA, CI.lo=NA, CI.up=NA, p.value=NA)

# Loop for odds ratios of pCR for all genes
stopifnot(colnames(dat) == rownames(cli.dat))
suppressWarnings(suppressMessages(
  for (i in 1:nrow(dat)) {
    mod <-
      glm(pCR ~ dat[i, ],
          family = binomial(link = "logit"),
          na.action = na.pass) # Logit model of pCR
    ORtab[i, 1] <- rownames(dat)[i] # gene name
    ORtab[i, 2] <- exp(mod$coefficients)[2] # odds ratio
    ORtab[i, 3:4] <- exp(confint(mod))[2, ] # CI
    ORtab[i, 5] <- summary(mod)$coefficients[2, 'Pr(>|z|)'] # pval
  }
))

# Save the result as named variable (SCALED)
assign(paste0("ORtab.", coh, ".scaled"), ORtab)

#####
#   Assemble combined pCR-OR-tables for cohorts #####
#####

# Assemble OR for G9

ORtab.g9 <- data %>%
  select(
    Genes,
    OR_pCR_durva,
    OR_pCR_durva_CI,
    p_log_pCR_durva,
    OR_pCR_plac,
    OR_pCR_plac_CI,
    p_log_pCR_plac
  )

#### Combine OR tables for datasets
#### by left-joining on ORtab.g9 the data
#### of the respective genes from
#### ORtab.medi.scaled and ORtab.brtn.scaled

ORtab.g9.medi.brtn.scaled <- left_join(ORtab.g9, ORtab.medi.scaled,
                                       join_by(Genes == gene)) %>%

  mutate(
    OR_medi = OR,
    OR_medi_CI = paste(as.character(round(CI.lo, digits = 2)),
                       as.character(round(CI.up, digits = 2)),
                       sep = "-"),
    p_medi = p.value,
    OR = NULL,
    CI.lo = NULL,
    CI.up = NULL,

```

```

    p.value = NULL
  ) %>%
left_join(ORtab.brtn.scaled,
          join_by(Genes == gene)) %>%
mutate(
  OR_brtn = OR,
  OR_brtn_CI = paste(as.character(round(CI.lo, digits = 2)),
                    as.character(round(CI.up, digits = 2)),
                    sep = "-"),
  p_brtn = p.value,
  OR = NULL,
  CI.lo = NULL,
  CI.up = NULL,
  p.value = NULL
)

```

```

#####
### Survival-Dataset ###
#####

```

```
library("survival")
```

```

#####
# Calculate Hazard Ratios for all 2549 HTG genes in validation datasets #####
#####

```

```
val.genes <- g0.all # all 2549 genes from HTG panel
```

```

#####
### Dataset scanb.htg.Rseq ###
#####

```

```

# Define dataset and genes
coh <- "scanb"
rseq <- scanb.htg.Rseq
cli.dat <- scanb.htg.cli.dat

```

```
gen.set <- val.genes
```

```

# Select data (scaled):
dat <- rseq[row.names(rseq) %in% gen.set,
           colnames(rseq) %in% rownames(cli.dat)]
dat <- dat[order(rownames(dat)),] # order by gene name
dat <- dat[,order(colnames(dat))] # order by sample names
dat <- na.omit(t(scale(t(dat)))) # scale RNA-Seq for each gene
cli.dat <- cli.dat[order(rownames(cli.dat)),]
cli.dat$time <- cli.dat$OS_months

```

```

cli.dat$status <- cli.dat$OS_event

# define dataframe for results
HRtab <- data.frame(gene=NA, HR=NA, CI.lo=NA, CI.up=NA, p.value=NA)

# Loop for hazard ratios of survival for all genes
stopifnot(colnames(dat)==rownames(cli.dat))

suppressWarnings(suppressMessages(
  for(i in 1:nrow(dat)){
    mod <- summary(coxph(Surv(cli.dat$time, cli.dat$status) ~ dat[i,]))
    HRtab[i,1] <- rownames(dat)[i] # gene name
    HRtab[i,2] <- mod$conf.int[1] # HR = exp(coef)
    HRtab[i,3:4] <- mod$conf.int[3:4] # CI of HR
    HRtab[i,5] <- mod$logtest[3] # p-value
  }
))

# Save the result as named variable
assign(paste0("HRtab.", coh, ".scaled"), HRtab)

#####

#####
# Assemble combined HR-tables for cohorts #####
#####

# Assemble HR info for G9

HRtab.g9 <- data %>%
  select(Genes,
    HR_durva, HR_durva_CI, p_cox_DDFS_durva,
    HR_plac, HR_plac_CI, p_cox_DDFS_plac
  )

HRtab.g9.scanb.scaled <- left_join(HRtab.g9, HRtab.scanb.scaled,
  join_by(Genes == gene)) %>%
  mutate(
    HR_scanb = HR,
    HR_scanb_CI = paste(as.character(round(CI.lo, digits = 2)),
      as.character(round(CI.up, digits = 2)),
      sep = "-"),
    p_scanb = p.value,
    HR = NULL,
    CI.lo = NULL,
    CI.up = NULL,
    p.value = NULL
  )

#####

```





```
#
```

## Figure 7a, 7b:

### Scatter plot figures pCR-Durva vs pCR-Placebo

```
#
```

*FINDING-cohort G9*

```
val.genes.set <- "g9.pCR.DDFS.scatter.genes"
val.genes <- get(val.genes.set)

plotdat <- gene.class %>%
  filter(Genes %in% val.genes) %>%
  left_join(ORtab.g9.medi.brtn.scaled,
            join_by(Genes)) %>%
  select(Genes, gene.class,
         OR_pCR_durva,
         p_log_pCR_durva,
         OR_pCR_plac,
         p_log_pCR_plac,
         OR_medi,
         p_medi,
         OR_brtn,
         p_brtn) %>%
  filter(Genes != "IL9") # exclude outlier

# Set axis limits for comparison of plots

Durva.min <- min(c(plotdat$OR_pCR_durva), na.rm = T)
Durva.max <- max(c(plotdat$OR_pCR_durva), na.rm = T)
NonDurva.min <- min(c(plotdat$OR_pCR_plac), na.rm = T)
NonDurva.max <- max(c(plotdat$OR_pCR_plac), na.rm = T)

# Define color palette:

# 6 groups: DNArepair, immune, other, proliferation, stemcell, stromaleMT
colpal <- c("#1B9E77", "#7570B3", "#666666",
            "#E7298A", "#66A61E", "#A6761D")

# Finding cohort: pCR-g9-durva vs pCR-g9-placebo

fn <- "out/Fig7a_Scatter-pCR-Durva-Plac-G9.pdf"

pdf(file = fn, width = 11, height = 8.5)
plotdat %>% ggplot(aes(OR_pCR_durva, OR_pCR_plac, color = gene.class)) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(size = 10, alpha = 0.8) +
  scale_x_continuous(trans='log2', limits = c(Durva.min, Durva.max)) +
```

```

scale_y_continuous(trans='log2', limits = c(NonDurva.min, NonDurva.max)) +
geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
geom_text_repel(aes(label = Genes, color = gene.class),
                size = 4,
                box.padding = 0.5,
                point.padding = 0.3,
                segment.size = 0.5,
                max.overlaps = 50,
                segment.color = 'darkgrey', show.legend = F) +
ggtitle("pCR-G9-Durva vs pCR-G9-Placebo") +
xlab("OR for pCR Durva") +
ylab("OR for pCR Placebo")
dev.off()

## png
## 2

#

```

*VALIDATION-cohorts: pCR-MEDI-Durva vs. pCR-BrighTNess-NonDurva*

*# Set axis limits for comparison of plots*

```

Durva.min <- min(c(plotdat$OR_medi), na.rm = T)
Durva.max <- max(c(plotdat$OR_medi), na.rm = T)
NonDurva.min <- min(c(plotdat$OR_brtn), na.rm = T)
NonDurva.max <- max(c(plotdat$OR_brtn), na.rm = T)

```

*# pCR-MEDI-durva vs pCR-BrighTNess-placebo*

```
fn <- "out/Fig7b_Scatter-pCR-Durva-MEDI-NonDurva-Brightn.pdf"
```

```

pdf(file = fn, width = 11, height = 8.5)
plotdat %>% ggplot(aes(OR_medi, OR_brtn, color = gene.class)) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(size = 10, alpha = 0.8) +
  scale_x_continuous(trans='log2', limits = c(Durva.min, Durva.max)) +
  scale_y_continuous(trans='log2', limits = c(NonDurva.min, NonDurva.max)) +
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
  geom_text_repel(aes(label = Genes, color = gene.class),
                  size = 4,
                  box.padding = 0.5,
                  point.padding = 0.3,
                  segment.size = 0.5,
                  max.overlaps = 50,
                  segment.color = 'darkgrey', show.legend = F) +
ggtitle("pCR-MEDI-Durva vs pCR-BrighTNess-NonDurva") +
xlab("OR for pCR Durva") +
ylab("OR for pCR NonDurva")

```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range
## (`geom_point()`).
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range
## (`geom_text_repel()`).
```

```
dev.off()
```

```
## png
## 2
```

```
#####
```

```
#
```

## Scatter plot figures pCR vs DDFS

Fig. 7c 7d

```
#
```

```
val.genes.set <- "g9.pCR.DDFS.scatter.genes"
val.genes <- get(val.genes.set)

# Scatter plot for genes with any p-value <0.01 in G9
# (either pCR or DDFS in either arm)
# color genes by gene.class, Palette "Dark2" colors from RColorBrewer
#
# These 126 genes are in genelist "g9.pCR.DDFS.scatter.genes"
#
# The OR and HR data for these 126 genes for the different validation
# datasets will be extracted from the following tables:
#   ORtab.g9.medi.brtn.scaled
#   HRtab.g9.scanb.scaled
#
# Combine all data needed for scatter plots in one table (plotdat):

plotdat <- gene.class %>%
  filter(Genes %in% val.genes) %>%
  left_join(ORtab.g9.medi.brtn.scaled,
            join_by(Genes)
          ) %>%
  left_join(HRtab.g9.scanb.scaled,
            join_by(Genes)
          ) %>%
  select(Genes, gene.class,
         OR_medi, p_medi,
         OR_brtn, p_brtn,
         HR_scanb, p_scanb
        ) %>%
  filter(Genes != "IL9") # exclude outlier in SCANB

# Set axis limits for comparison of plots
HR.min <- min(plotdat$HR_scanb, na.rm = T)
HR.max <- max(plotdat$HR_scanb, na.rm = T)

# Define color palette:

# 6 groups: DNArepair, immune, other, proliferation, stemcell, stromaleMT
colpal <- c("#1B9E77", "#7570B3", "#666666",
            "#E7298A", "#66A61E", "#A6761D")

# Plot to pdf files

# pCR-MEDI vs DFS-SCANB
```

```

OR.min <- min(c(plotdat$OR_medi), na.rm = T)
OR.max <- max(c(plotdat$OR_medi), na.rm = T)

fn <- "out/Fig7c_Scatter-pCR-DDFS-MEDI-SCANB.pdf"

pdf(file = fn, width = 11, height = 8.5)
plotdat %>% ggplot(aes(OR_medi, 1/HR_scanb, color = gene.class)) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(size = 10, alpha = 0.8) +
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
  geom_text_repel(aes(label = Genes, color = gene.class),
    size = 4,
    box.padding = 0.5,
    point.padding = 0.3,
    segment.size = 0.5,
    max.overlaps = 50,
    segment.color = 'darkgrey', show.legend = F) +
  ggtitle("pCR-MEDI vs DFS-SCANB") +
  xlab("OR for pCR") +
  ylab("1 / HR for DDFS")
dev.off()

## png
## 2

# pCR-BrightNess vs DFS-SCANB

OR.min <- min(c(plotdat$OR_brtn), na.rm = T)
OR.max <- max(c(plotdat$OR_brtn), na.rm = T)

fn <- "out/Fig7d_Scatter-pCR-DDFS-BRTN-SCANB.pdf"
pdf(file = fn, width = 11, height = 8.5)
plotdat %>% ggplot(aes(OR_brtn, 1/HR_scanb, color = gene.class)) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(size = 10, alpha = 1) +
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
  geom_text_repel(aes(label = Genes, color = gene.class),
    size = 4,
    box.padding = 0.5,
    point.padding = 0.3,
    segment.size = 0.5,
    max.overlaps = 50,
    segment.color = 'darkgrey', show.legend = F) +
  ggtitle("pCR-BrightNess vs DFS-SCANB") +
  xlab("OR for pCR") +
  ylab("1 / HR for DDFS")

```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range
## (`geom_point()`).
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range
## (`geom_text_repel()`).
```

```
dev.off()
```

```
## png
## 2
```

```
#####
```

```
### Additional figures including p-value information:
### Filled circles size based on log10(p-value for pCR)
### Open circles size based on log10(p-value for DDFS)
```

```
# pCR-MEDI vs DFS-SCANB
```

```
fn <- "out/Suppl_Scatter-pCR-DDFS-MEDI-SCANB-pVal.pdf"
```

```
OR.min <- min(c(plotdat$OR_medi), na.rm = T)
OR.max <- max(c(plotdat$OR_medi), na.rm = T)
```

```
pdf(file = fn, width = 11, height = 8.5)
```

```
ggplot(plotdat) +
  theme_light() +
  scale_color_manual(values = colpal) +
  geom_point(aes(x = OR_medi, y = 1/HR_scanb, color = gene.class,
                 size = -log10(p_medi)), alpha = 0.5) +
  geom_point(aes(x = OR_medi, y = 1/HR_scanb, color = gene.class,
                 size = -log10(p_scanb)), shape = 1) +
  scale_size(range = c(.1, 14), name = "-log10(P-value) [pCR, DDFS]") +
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +
  geom_text_repel(aes(x = OR_medi, y = 1/HR_scanb,
                     label = Genes, color = gene.class),
                 size = 3,
                 box.padding = 0.5,
                 point.padding = 0.3,
                 segment.size = 0.5,
                 max.overlaps = 50,
                 segment.color = 'darkgrey', show.legend = F) +
  ggtitle("pCR-MEDI vs DFS-SCANB \n(filled circles: pCR-p-Value / open circles: DDFS-p-Value") +
  xlab("OR for pCR") +
  ylab("1 / HR for DDFS")
dev.off()
```

```
## png
## 2
```

```
# pCR-BrightNess vs DFS-SCANB
```

```
OR.min <- min(c( plotdat$OR_brtn), na.rm = T)  
OR.max <- max(c(plotdat$OR_brtn), na.rm = T)
```

```
fn <- "out/Suppl_Scatter-pCR-DDFS-BRTN-SCANB-pVal.pdf"
```

```
pdf(file = fn, width = 11, height = 8.5)
```

```
ggplot(plotdat) +  
  theme_light() +  
  scale_color_manual(values = colpal) +  
  geom_point(aes(x = OR_brtn, y = 1/HR_scanb, color = gene.class,  
                 size = -log10(p_brtn)), alpha = 0.5) +  
  geom_point(aes(x = OR_brtn, y = 1/HR_scanb, color = gene.class,  
                 size = -log10(p_scanb)), shape = 1) +  
  scale_size(range = c(.1, 14), name = "-log10(P-value) [pCR, DDFS]") +  
  scale_x_continuous(trans='log2', limits = c(OR.min, OR.max)) +  
  scale_y_continuous(trans='log2', limits = c(1/HR.max, 1/HR.min)) +  
  geom_hline(yintercept = 1, color = "blue", linewidth = 1) +  
  geom_vline(xintercept = 1, color = "orange", linewidth = 1) +  
  geom_text_repel(aes(x = OR_brtn, y = 1/HR_scanb,  
                     label = Genes, color = gene.class),  
                 size = 3,  
                 box.padding = 0.3,  
                 point.padding = 0.3,  
                 segment.size = 0.5,  
                 max.overlaps = 50,  
                 segment.color = 'darkgrey', show.legend = F) +  
  ggtitle("pCR-BrightNess vs DFS-SCANB \n(filled circles: pCR-p-Value / open circles:  
DDFS-p-Value)") +  
  xlab("OR for pCR") +  
  ylab("1 / HR for DDFS")
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range  
## (`geom_point()`).
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range  
## (`geom_point()`).
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range  
## (`geom_text_repel()`).
```

```
dev.off()
```

```
## png
```

```
## 2
```

#

## Generate Signatures from genesets -----

```
#

# The data frames
# resp.g1.immune,
# resp.g2.proliferation,
# resp.g4.stromal.NonImmune
# contain the separate list of the genes, which are
# associated either with good or poor response (pCR) in
# each treatment arm in G9, based on the respective geneset.
#
# These dataframes will be used to select the specific genes
# for calculating three signatures based on the mean of the
# scaled expression in the code below.
#
#
# For immune and proliferation signatures
# positively predictive (good) genes will be included (OR>1, p<=0.05)
#
# resp.g1.immune$durva.good
# resp.g2.proliferation$durva.good
#
# For the stromal signature
# negatively predictive (poor) genes will be included (OR<1, p<=0.05)
#
# resp.g4.stromal.NonImmune$durva.poor

# Export gene lists:

write.csv2(resp.g1.immune$durva.good,
           file = "out/signature-immune-genes.csv")
write.csv2(resp.g2.proliferation$durva.good,
           file = "out/signature-proliferation-genes.csv")
write.csv2(resp.g4.stromal.NonImmune$durva.poor,
           file = "out/signature-stromal-genes.csv")

#####
###          MEDI dataset          ###
#####

# Define data

dat <- medi.htg.Rseq
coh <- "medi"

# The following code uses dat and coh
# and is IDENTICAL for BOTH COHORTS (medi & brtn)

#####
```



```
### CALCULATE SIGNATURES: ####  
#####
```

```
### Only Durva signatures that are USED for Figures calculated here:
```

```
### Signature "Good pCR Durva g1.immune": ###
```

```
# calculate mean expression of SCALED genes from genelist  
# predictive for pCR in durva arm:  
sig.durva.good.g1.immune.scaled <- dat[  
  rownames(dat) %in% resp.g1.immune$durva.good,] %>%  
  t() %>%  
  scale() %>%  
  t() %>%  
  na.omit() %>%  
  apply(2, mean)
```

```
### Signature "Good pCR Durva g2.proliferation" ###
```

```
# calculate mean expression of SCALED genes from genelist  
# predictive for pCR in durva arm:  
sig.durva.good.g2.proliferation.scaled <- dat[  
  rownames(dat) %in% resp.g2.proliferation$durva.good,] %>%  
  t() %>%  
  scale() %>%  
  t() %>%  
  na.omit() %>%  
  apply(2, mean)
```

```
### Signature "Poor pCR Durva g4.stromal.NonImmune" ###
```

```
# calculate mean expression of SCALED genes from genelist  
# predictive for pCR in durva arm:  
sig.durva.poor.g4.stromal.NonImmune.scaled <- dat[  
  rownames(dat) %in% resp.g4.stromal.NonImmune$durva.poor,] %>%  
  t() %>%  
  scale() %>%  
  t() %>%  
  na.omit() %>%  
  apply(2, mean)
```

```
#####
```

```
### Assemble all signature results in one data.frame  
### for the cohort
```

```
sig <- data.frame(  
  cbind(  
    sig.durva.good.g1.immune.scaled,  
    sig.durva.good.g2.proliferation.scaled,  
    sig.durva.poor.g4.stromal.NonImmune.scaled
```

```

)
)

# Add categories (based on cutoff = 0) for g1, g2, g4
# in order to calculate frequencies in Quadrants:

sig <- sig %>%
  mutate(
    cat.durva.good.g1.immune=cut(sig.durva.good.g1.immune.scaled,
                                breaks=c(-Inf, 0, Inf),
                                labels=c("low", "high")),
    cat.durva.good.g2.proliferation=cut(sig.durva.good.g2.proliferation.scaled,
                                       breaks=c(-Inf, 0, Inf),
                                       labels=c("low", "high")),
    cat.durva.poor.g4.stromal=cut(sig.durva.poor.g4.stromal.NonImmune.scaled,
                                  breaks=c(-Inf, 0, Inf),
                                  labels=c("low", "high"))
  )

# Get cli.dat for the selected cohort (coh):

cli <- get(paste(coh, ".htg.cli.dat", sep = ""))

# Add pCR info:
sig$pCR <- cli[rownames(sig), colnames(cli)=="pCR"]

# Calculate pCR frequencies in Quadrants based on combination of g1, g2, g4

#####

# categories g1 vs g2:
cat1 <- "cat.durva.good.g1.immune"
cat2 <- "cat.durva.good.g2.proliferation"

### Calculate pCR frequencies and percentages and save results
quadr <- list()
quadr$low1.low2 <- sig %>%
  filter(get(cat1) == "low", get(cat2) == "low") %>% count(pCR)
quadr$high1.low2 <- sig %>%
  filter(get(cat1) == "high", get(cat2) == "low") %>% count(pCR)
quadr$low1.high2 <- sig %>%
  filter(get(cat1) == "low", get(cat2) == "high") %>% count(pCR)
quadr$high1.high2 <- sig %>%
  filter(get(cat1) == "high", get(cat2) == "high") %>% count(pCR)
# add percentages
quadr$low1.low2$perc <- round(quadr$low1.low2$n/sum(quadr$low1.low2$n)*100, 1)
quadr$high1.low2$perc <- round(quadr$high1.low2$n/sum(quadr$high1.low2$n)*100, 1)
quadr$low1.high2$perc <- round(quadr$low1.high2$n/sum(quadr$low1.high2$n)*100, 1)
quadr$high1.high2$perc <- round(quadr$high1.high2$n/sum(quadr$high1.high2$n)*100, 1)
# output the results:
quadr

```

```
## $low1.low2
##      pCR  n perc
## 1 FALSE 10 71.4
## 2  TRUE  4 28.6
##
## $high1.low2
##      pCR n perc
## 1 FALSE 6   60
## 2  TRUE 4   40
##
## $low1.high2
##      pCR  n perc
## 1 FALSE 10 76.9
## 2  TRUE  3 23.1
##
## $high1.high2
##      pCR  n perc
## 1 FALSE  4 22.2
## 2  TRUE 14 77.8
```

```
# save the variable by adding the signature names
assign(paste(coh,"quadr",cat1,cat2, sep = "_"), quadr)
#####
```

```
# categories g1 vs g4:
cat1 <- "cat.durva.good.g1.immune"
cat2 <- "cat.durva.poor.g4.stromal"
```

```
### Calculate pCR frequencies and percentages and save results
```

```
quadr <- list()
quadr$low1.low2 <- sig %>%
  filter(get(cat1) == "low", get(cat2) == "low") %>% count(pCR)
quadr$high1.low2 <- sig %>%
  filter(get(cat1) == "high", get(cat2) == "low") %>% count(pCR)
quadr$low1.high2 <- sig %>%
  filter(get(cat1) == "low", get(cat2) == "high") %>% count(pCR)
quadr$high1.high2 <- sig %>%
  filter(get(cat1) == "high", get(cat2) == "high") %>% count(pCR)
# add percentages
quadr$low1.low2$perc <- round(quadr$low1.low2$n/sum(quadr$low1.low2$n)*100, 1)
quadr$high1.low2$perc <- round(quadr$high1.low2$n/sum(quadr$high1.low2$n)*100, 1)
quadr$low1.high2$perc <- round(quadr$low1.high2$n/sum(quadr$low1.high2$n)*100, 1)
quadr$high1.high2$perc <- round(quadr$high1.high2$n/sum(quadr$high1.high2$n)*100, 1)
# output the results:
quadr
```

```
## $low1.low2
##      pCR n perc
## 1 FALSE 7 58.3
## 2  TRUE 5 41.7
##
## $high1.low2
```

```

##      pCR  n perc
## 1 FALSE  4 26.7
## 2  TRUE 11 73.3
##
## $low1.high2
##      pCR  n perc
## 1 FALSE 13 86.7
## 2  TRUE  2 13.3
##
## $high1.high2
##      pCR n perc
## 1 FALSE  6 46.2
## 2  TRUE  7 53.8

# save the variable by adding the signature names
assign(paste(coh,"quadr",cat1,cat2, sep = "_"), quadr)
#####

# SAVE THE SIGNATURE DATA FORT THE COHORT (coh)

assign(paste("sig.", coh, sep = ""), sig)
#####

```

```
#
```

## pCR Plots in MEDI validation Cohort

\*Figures 7f, 7h, and Supplementary Figures 4b,4d,4f

```
#
```

```
colpal <- c("#D55E00", "#009E73")
```

```
#####  
#  MEDI cohort #  
#####
```

```
coh <- "MEDI"
```

```
plotdat <- sig.medi
```

```
### Scatter Plots: ###
```

```
# Figures 7f, 7h
```

```
sig.pairs <- tribble(  
  ~pname, ~x.ax, ~y.ax,  
  "Fig7f_MEDI_g1sca_vs_g4sca", "sig.durva.good.g1.immune.scaled",  
  "sig.durva.poor.g4.stromal.NonImmune.scaled",  
  "Fig7h_MEDI_g1sca_vs_g2sca", "sig.durva.good.g1.immune.scaled",  
  "sig.durva.good.g2.proliferation.scaled"  
)
```

```
for (i in 1:nrow(sig.pairs)){  
  pname <- sig.pairs$pname[i]  
  x.ax <- sig.pairs$x.ax[i]  
  y.ax <- sig.pairs$y.ax[i]  
  # Generate plot  
  p <- ggplot(plotdat, aes(get(x.ax),  
                           get(y.ax),  
                           color = pCR)) +  
    theme_light() +  
    geom_point(size = 10, alpha = 0.8) +  
    scale_x_continuous() +  
    scale_y_continuous() +  
    scale_color_manual(values = colpal) +  
    geom_hline(yintercept = 0, color = "black", linewidth = 1) +  
    geom_vline(xintercept = 0, color = "black", linewidth = 1) +  
    ggtitle(paste(coh, x.ax, "vs.", y.ax)) +  
    xlab(x.ax) +  
    ylab(y.ax)  
  # export plot  
  fn <- paste0("out/", pname, "_SigScatter", ".pdf")  
  pdf(file = fn, width = 11, height = 8.5)  
  print(p)  
  dev.off()
```

```

}

# Distribution of pCR according signatures -----

# Supplementary Figure 4 (b,d,f)

colpal <- c("#D55E00", "#009E73")

# c("#999999", "#E69F00", "#56B4E9", "#009E73", "#F0E442", "#0072B2", "#D55E00",
"#CC79A7")

siglist <- list("sig.durva.good.g1.immune.scaled",
               "sig.durva.good.g2.proliferation.scaled",
               "sig.durva.poor.g4.stromal.NonImmune.scaled")

# Loop through siglist and save plots as pdf files:

for(plotsig in siglist) {
  # create plot
  p <- ggplot(plotdat,
              aes(x = get(plotsig))) +
    geom_density(aes(color = pCR,
                     fill = pCR),
                 position = "identity",
                 alpha = 0.3) +
    scale_color_manual(values = colpal) +
    scale_fill_manual(values = colpal) +
    ggtitle(paste(coh, " ", plotsig)) +
    xlab(plotsig)
  # export plot
  fn <- paste0("out/SuppFig4_pCRDistr_", coh, "_", plotsig, ".pdf")
  pdf(file = fn,
      width = 11,
      height = 8.5)
  print(p)
  dev.off()
}

# end -----

```

## sessionInfo()

```
## R version 4.4.1 (2024-06-14 ucrt)
## Platform: x86_64-w64-mingw32/x64
## Running under: Windows 11 x64 (build 22631)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=German_Germany.utf8  LC_CTYPE=German_Germany.utf8
## [3] LC_MONETARY=German_Germany.utf8 LC_NUMERIC=C
## [5] LC_TIME=German_Germany.utf8
##
## time zone: Europe/Berlin
## tzcode source: internal
##
## attached base packages:
## [1] grid      stats      graphics  grDevices  utils      datasets  methods
## [8] base
##
## other attached packages:
## [1] survival_3.7-0      ggrepel_0.9.6      ggvenn_0.1.10
## [4] ggVennDiagram_1.5.2 fmsb_0.7.6         stringr_1.5.1
## [7] tidyr_1.3.1         ggplot2_3.5.1      readxl_1.4.3
## [10] dplyr_1.1.4
##
## loaded via a namespace (and not attached):
## [1] Matrix_1.7-0      gtable_0.3.5      compiler_4.4.1    Rcpp_1.0.13
## [5] tidyselect_1.2.1  splines_4.4.1     scales_1.3.0      yaml_2.3.10
## [9] fastmap_1.2.0     lattice_0.22-6    R6_2.5.1          labeling_0.4.3
## [13] generics_0.1.3    knitr_1.48        tibble_3.2.1      munsell_0.5.1
## [17] pillar_1.9.0      rlang_1.1.4       utf8_1.2.4        stringi_1.8.4
## [21] xfun_0.47         cli_3.6.3         withr_3.0.1       magrittr_2.0.3
## [25] digest_0.6.37     rstudioapi_0.16.0 lifecycle_1.0.4   vctrs_0.6.5
## [29] evaluate_1.0.0    glue_1.7.0        farver_2.1.2      cellranger_1.1.0
## [33] fansi_1.0.6       colorspace_2.1-1  rmarkdown_2.28    purrr_1.0.2
## [37] tools_4.4.1       pkgconfig_2.0.3   htmltools_0.5.8.1
```