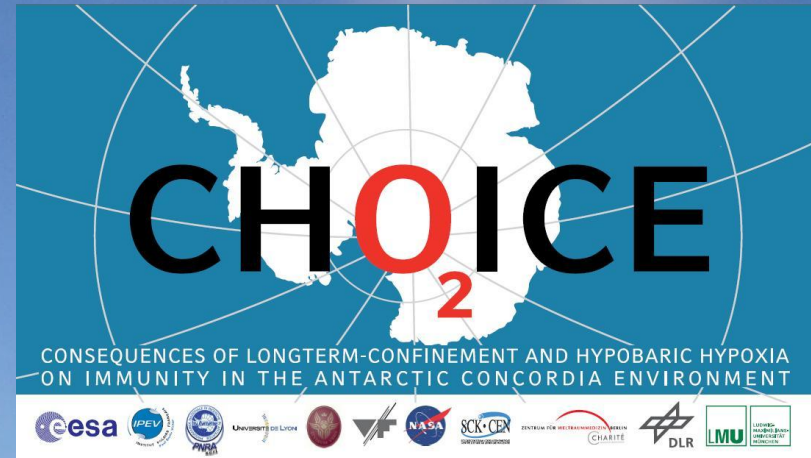


# CONCORDIA STATION, DOME C, ANTARCTICA AS A GROUND-BASED ANALOG FOR SPACEFLIGHT/PLANETARY EXPLORATION:

The *CHOICE*\* Immunology Study

*Final Data; NASA Assays - February, 2012*

*\*Consequences of both long-term confinement ("Confinement Stress") and hypobaric hypoxia ("Hypoxic Stress") on Immunity ("Immune-Modulation/Suppression") in the Antarctic CONCORDIA Environment.*



Brian Crucian, Alexander Chouker, Satish Mehta, Raymond Stowe, Alex Salam, Ales Rybka, Heather Quiariarte, Duane Pierson and Clarence Sams



## Environmental Factors

Difficult travel in/out

Extreme isolation, even greater than ISS

Altitude 3200m (10,500 ft)

Air pressure 645hPa (mbar)

12-13 Vol% of O<sub>2</sub>

Lack of CO<sub>2</sub> in air

Higher ionization in air (increases oxidative metabolism)

} *chronic hypobaric hypoxia*

- Relative humidity 3-5%
- Snowfall ~1cm/yr
- High winds
- Elevated UV exposure (summer), UV deficiency (winter)
- Mean winter temperature -60 C (-72 F)
- Mean summer temperature -30 C (-22 F)
- Disrupted circadian rhythms.





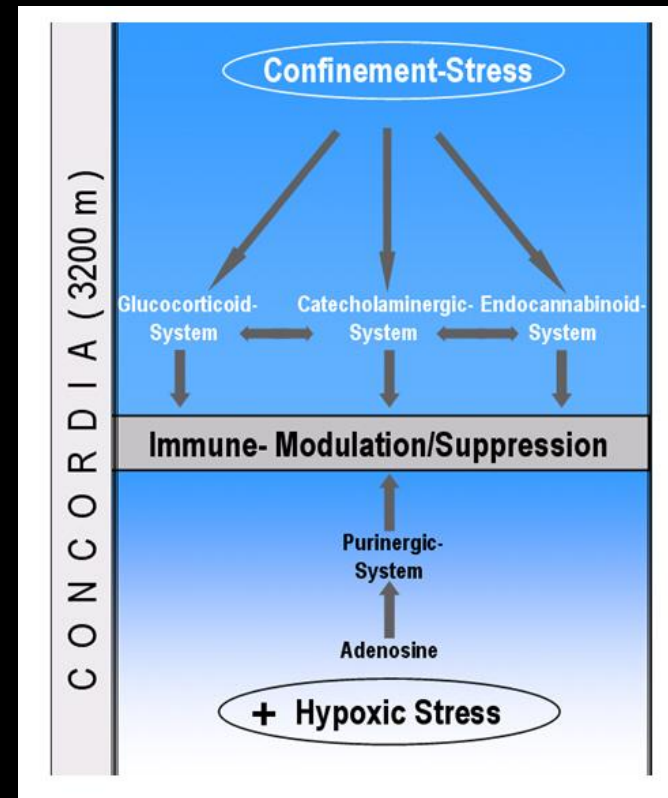
# Human Factors

- Isolation, confinement for prolonged duration
- Limited communication capability with outside world (more isolated than ISS!)
- International crew, multiple languages
- Realistic station lifestyle
- Sleep/wake cycles disrupted
- Actual extreme environment deployment w/ associated risks (not a mission analog!)
- Winter over crew: 12
- Summer crew: ~50



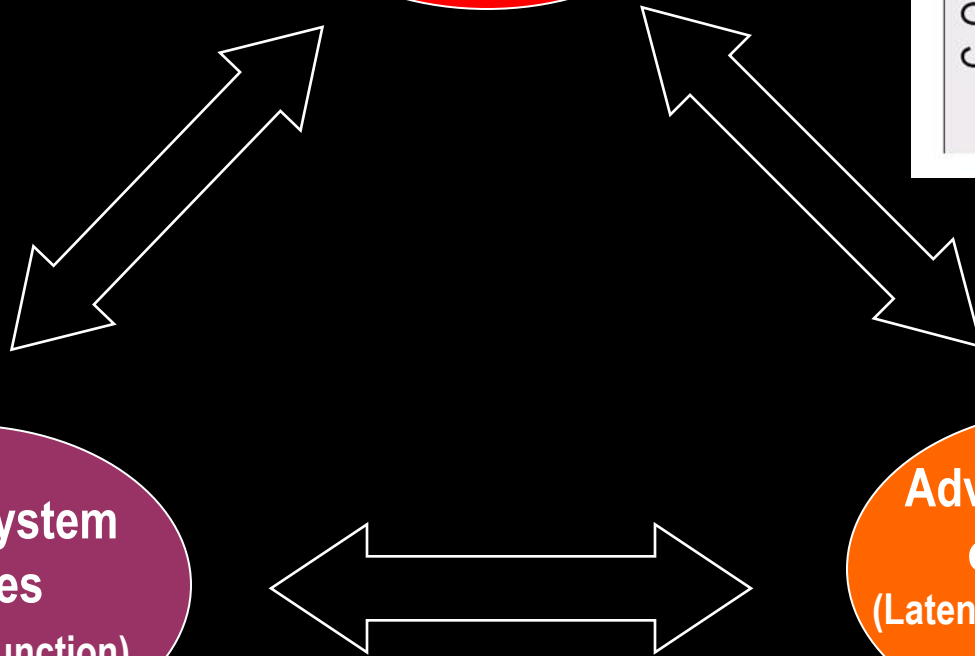
# NASA Paradigm

**Effects of Space Flight**



**Immune System Changes**  
(Status and Function)

**Adverse clinical outcomes**  
(Latent Viral Reactivation)



# Assays

## BLOOD ASSAYS

Comprehensive immunophenotype  
Intracellular cytokine profiles (T cell)  
T cell function  
Secreted cytokine profiles  
Viral DNA - PBMC  
Circulating viral-specific T cells  
Viral-specific T cell function  
Viral antibodies titers  
Viral antibodies titers  
Plasma stress hormones

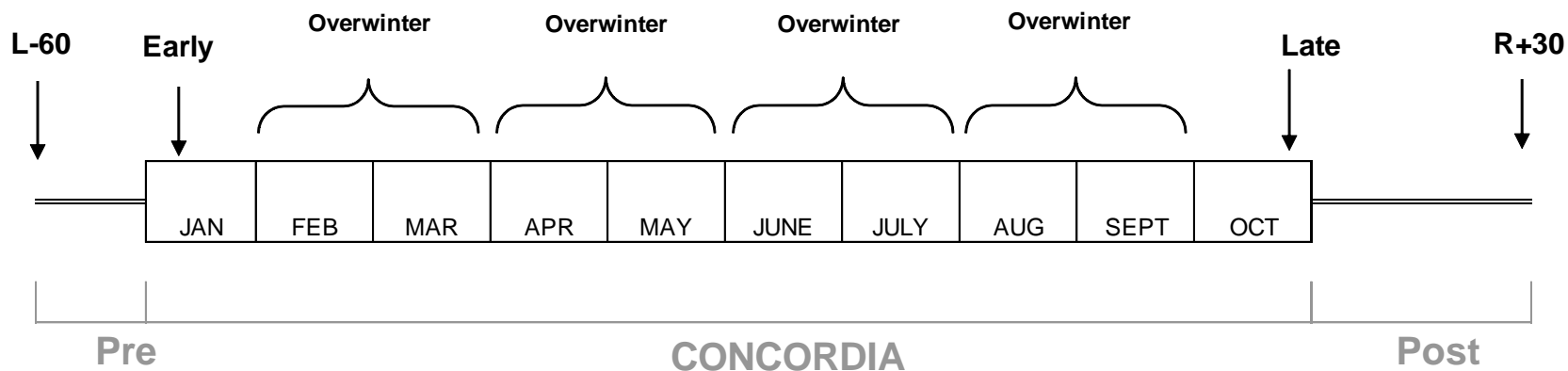
## SALIVA ASSAYS

Saliva stress hormones, Diurnal  
Viral DNA by PCR

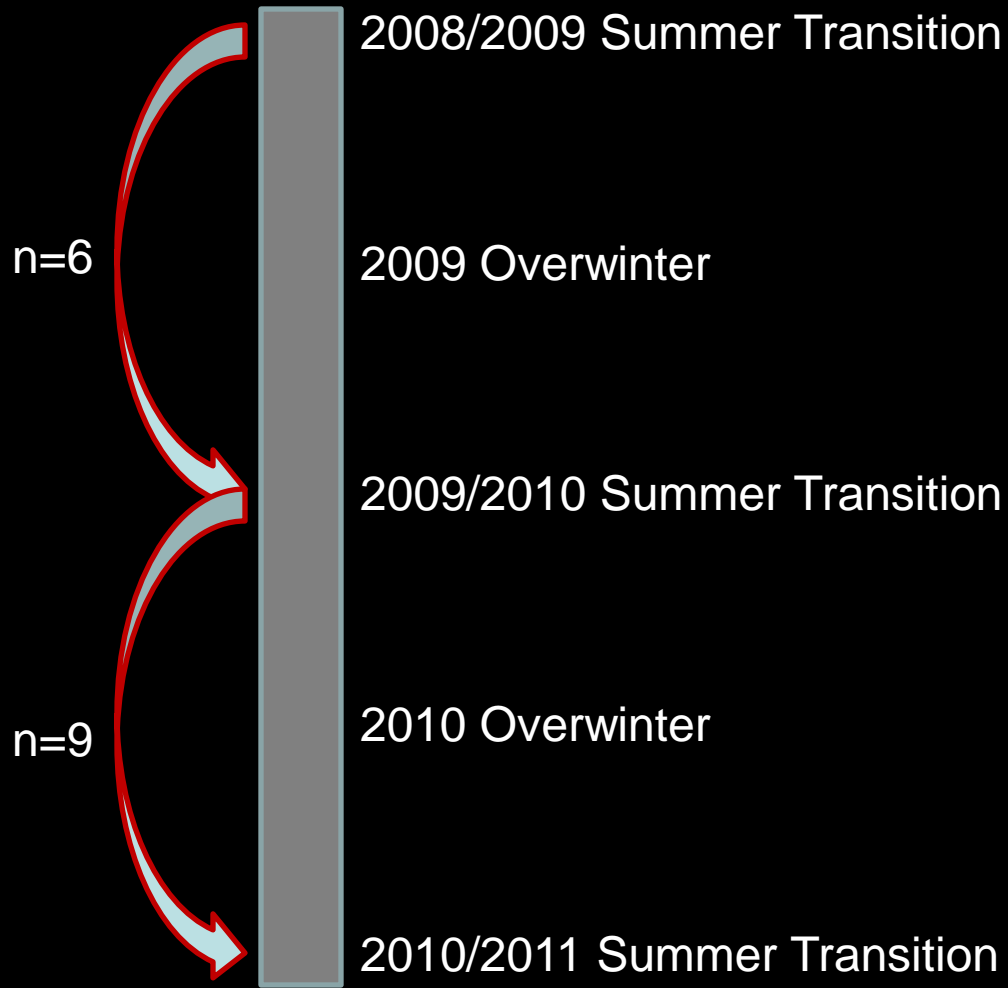
## URINE ASSAYS

Viral DNA by PCR  
Urine stress hormones

# Sampling



# Subjects/Logistics



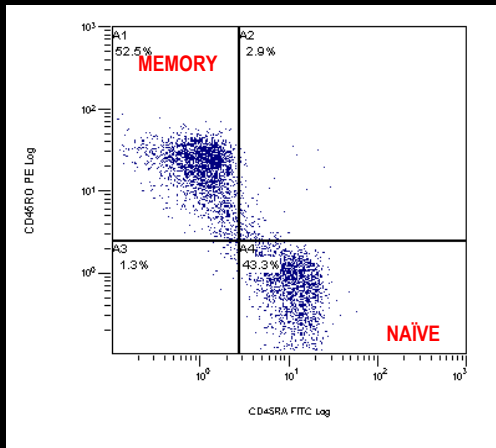
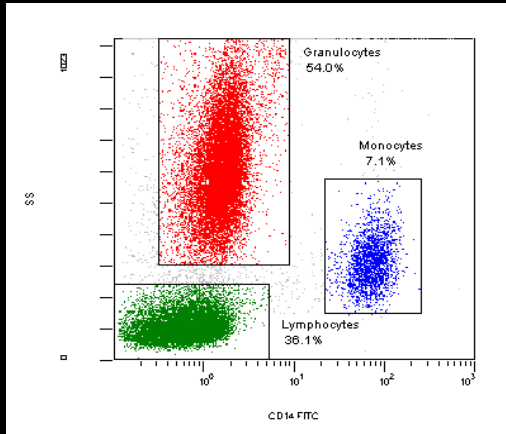


# Overwinter Flow Cytometry





# Overwinter Data: Phenotype



	L-30	Ear.	M2	M4	M6	Late	R+60
Granulocytes	52	44*	31*	37*	44*	46*	63
Lymphocytes	40	47*	49*	50*	45	44	32
Monocytes	5.0	5.0	10*	7*	5.0	5.0	3.0
T Cells	67	60*	65	55*	54*	56*	77
B Cells	7	13*	12*	11*	19*	13*	12
NK Cells	6	9	10*	12	5	11*	18
CD4+ T Cells	59	55*	50*	51*	50*	53*	61
CD8+ T Cells	33	32	29	26*	25*	30	27

	L-30	Ear.	M2	M4	M6	Late	R+60
Bulk Memory CD4+	54	59	56	59	62*	68*	49
Bulk Memory CD8+	37	59*	41	58*	59*	74*	32
CD8: Naïve/ctx	85	49*	65*	57*	62*	53*	92
CD8: Senescent	12	35*	24*	26*	21	27*	7
CD8: True Naïve	38	35	27	31	35	28	21
Central memory	6	10	5	13	10	13	34
Effector Memory	39	32*	37	33	32*	35	38
Term. Differentiated	17	23	31	22	24*	25	7

	L-30	Ear.	M2	M4	M6	Late	R+60
CD4/CD69	1	6*	1	2	2	2	0
CD8/CD69	2	9*	3	3	3	3	2
CD4/HLA-DR	2	3	3	2	1	1	2
CD8/HLA-DR	3	5*	2	2	1	1	3

# 2009/10 Summer Transition period – Incidence Rates

(mid-November to mid-January)

- Approx. 50% of summer participants contacted infectious disease

- Historically, extremely high incidence rate

- Three periods of epidemic viral infections:

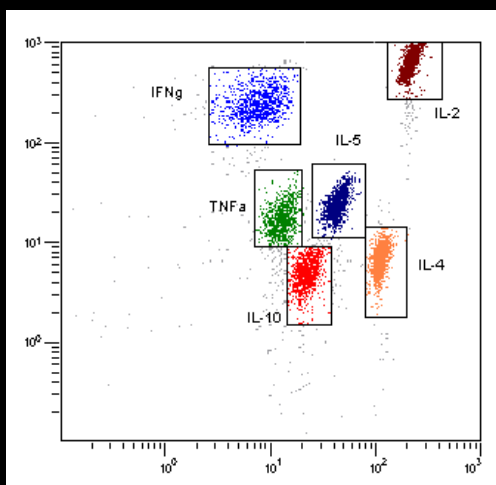
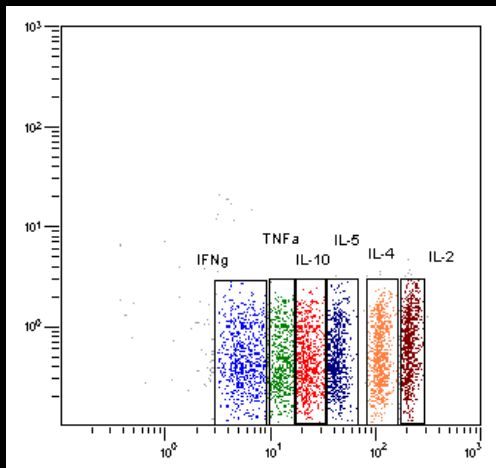
Period 1: Flu-like (mid-Nov. to mid-Dec.)

Period 2: Rhinoparyngitis (mid-Dec. to early Jan.)

Period 3: Gastro-enteritis (late-Dec. to early Jan.)



# Overwinter Data: Secreted Cytokine Profiles



## T cells: CD3+CD28 - 48hr

	L-30	Ear.	F-M	A-M	J-J	A-S	Late	R+60
IFN $\gamma$	74	58	100	104	116	138	59	2
TNF $\alpha$	20	24	24	13	15	21	9	3
IL-10	6	16	5	8	8	9	3	2
IL-4	0	0	0	0	0	0	0	0
IL-5	4	2	7	8	9	5	3	1
IL-2	32	4	64	33	33	43	12	4

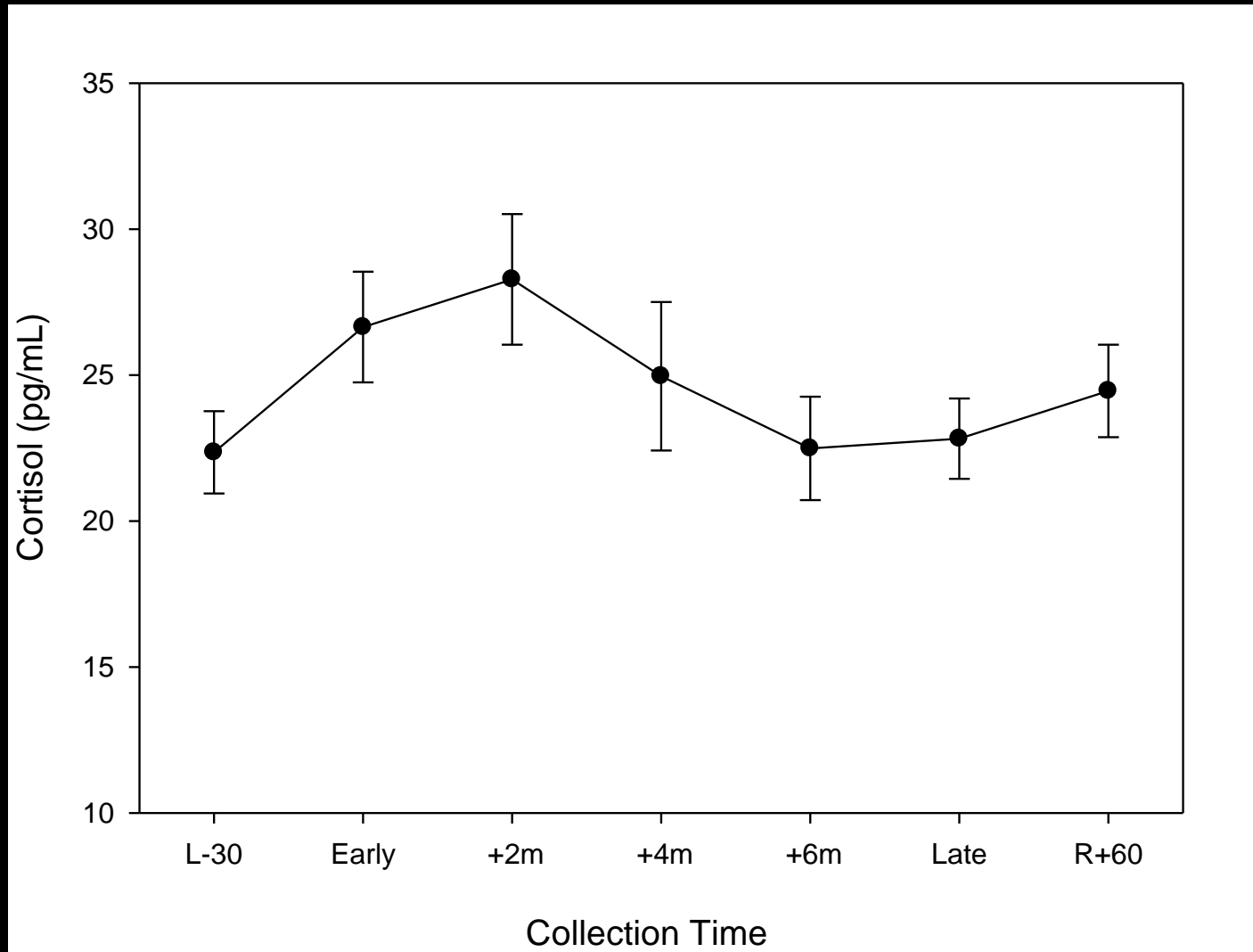
## All Leukocytes: PMA+Ionomycin - 48hr

	L-30	Ear.	F-M	A-M	J-J	A-S	Late	R+60
IFN $\gamma$	287	281	251	247	248	238*	220*	238
TNF $\alpha$	51	82*	105*	127*	98*	111*	35*	52
IL-10	7	19*	16*	21*	19*	20*	5	5
IL-4	3	5*	4*	5*	5*	6*	2	1
IL-5	15	19	17	19*	18	20	11	4
IL-2	689	701	725	764*	764*	736*	526*	572

## Monocytes: LPS - 48hr

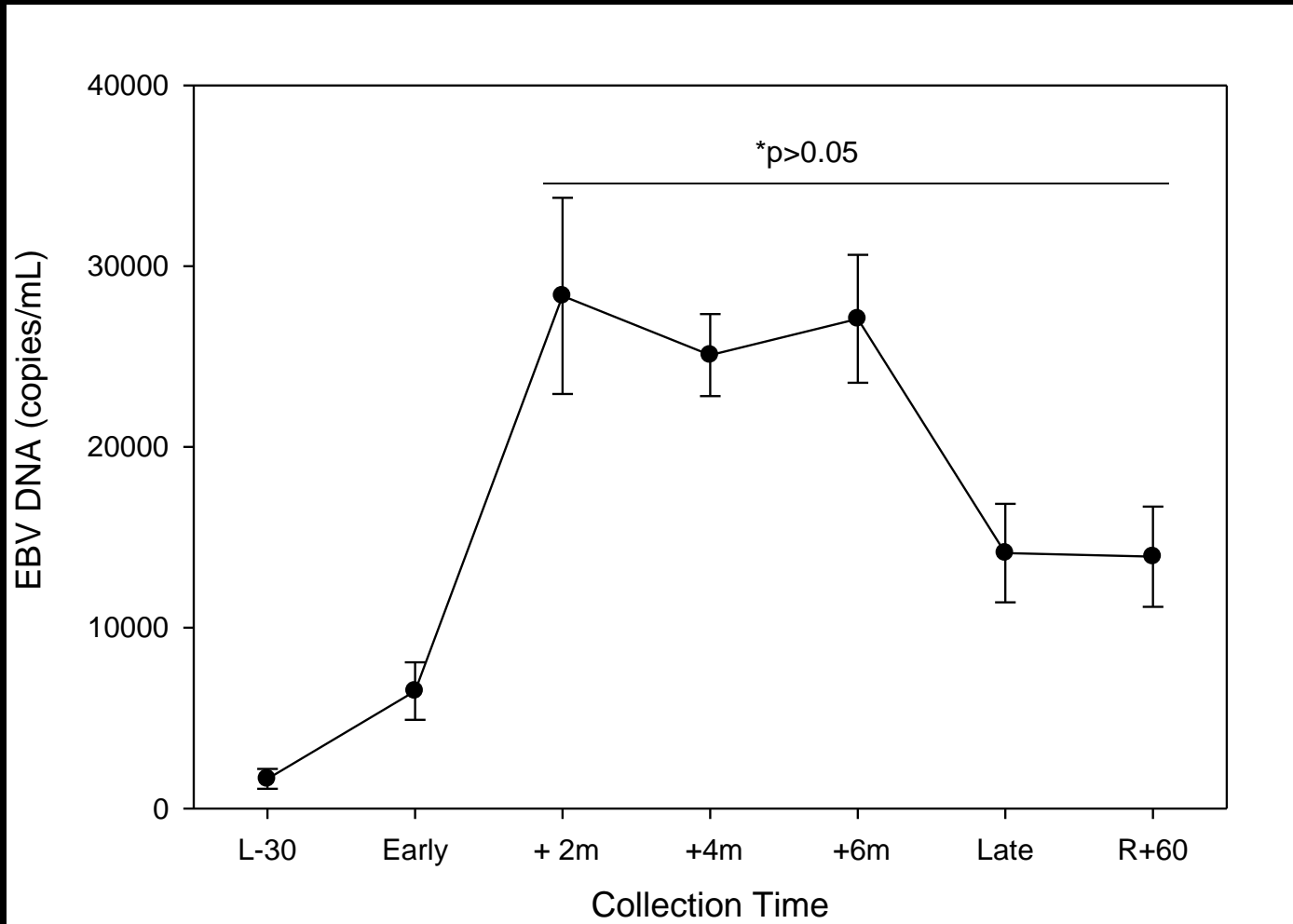
	L-30	Ear.	F-M	A-M	J-J	A-S	Late	R+60
IL-12	0	0	0	0	0	0	0	0
TNF $\alpha$	9	20*	17*	18*	21*	17*	12	33
IL-10	14	27*	43*	37*	37*	42*	6	11
IL-6	432	431	498	494	506	477	232	502
IL-1b	51	95*	50	54	57	39	110	175
IL-8	610	583	529	591	600	577	408	636

# Overwinter Data: Plasma Cortisol





# Overwinter Data: Plasma EBV DNA







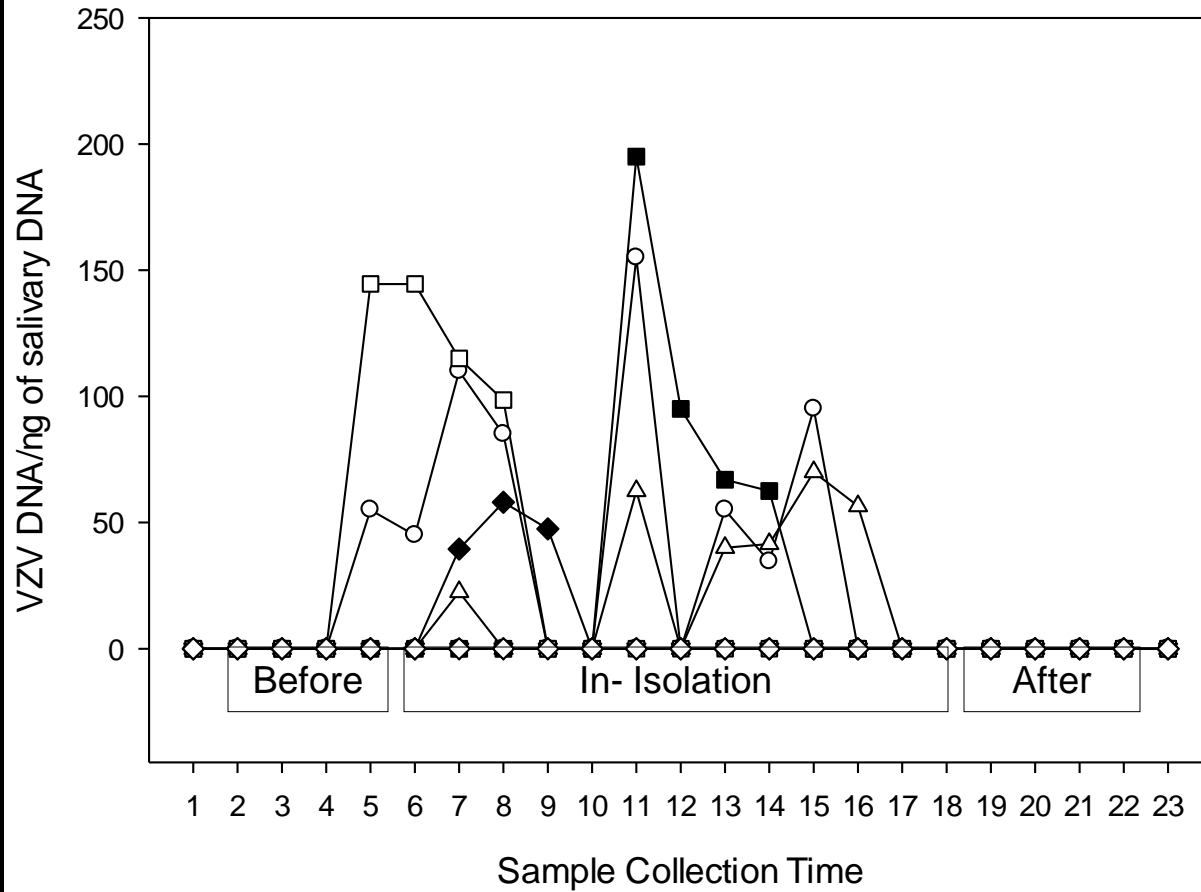
# Overwinter Data: VZV Reactivation

		Before		In Isolation							After
		Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	
G		-	-	-	-	-	-	-	-	-	-
H		-	NA	NA	NA	NA	NA	NA	NA	NA	NA
J		-	-	+	+	-	+	+	+	-	-
K		-	-	-	-	-	-	-	-	-	-
L		-	-	-	+	-	+	+	+	-	-
M		-	-	-	-	-	+	+	-	-	-
N		-	-	+	+	-	-	-	-	-	-
O		-	-	-	+	+	-	-	-	-	-
P		-	-	-	-	-	-	-	-	-	-
J		-	-	-	-	-	-	-	-	-	-
		-	-					-	-	-	-
		-	-					-	-	-	-

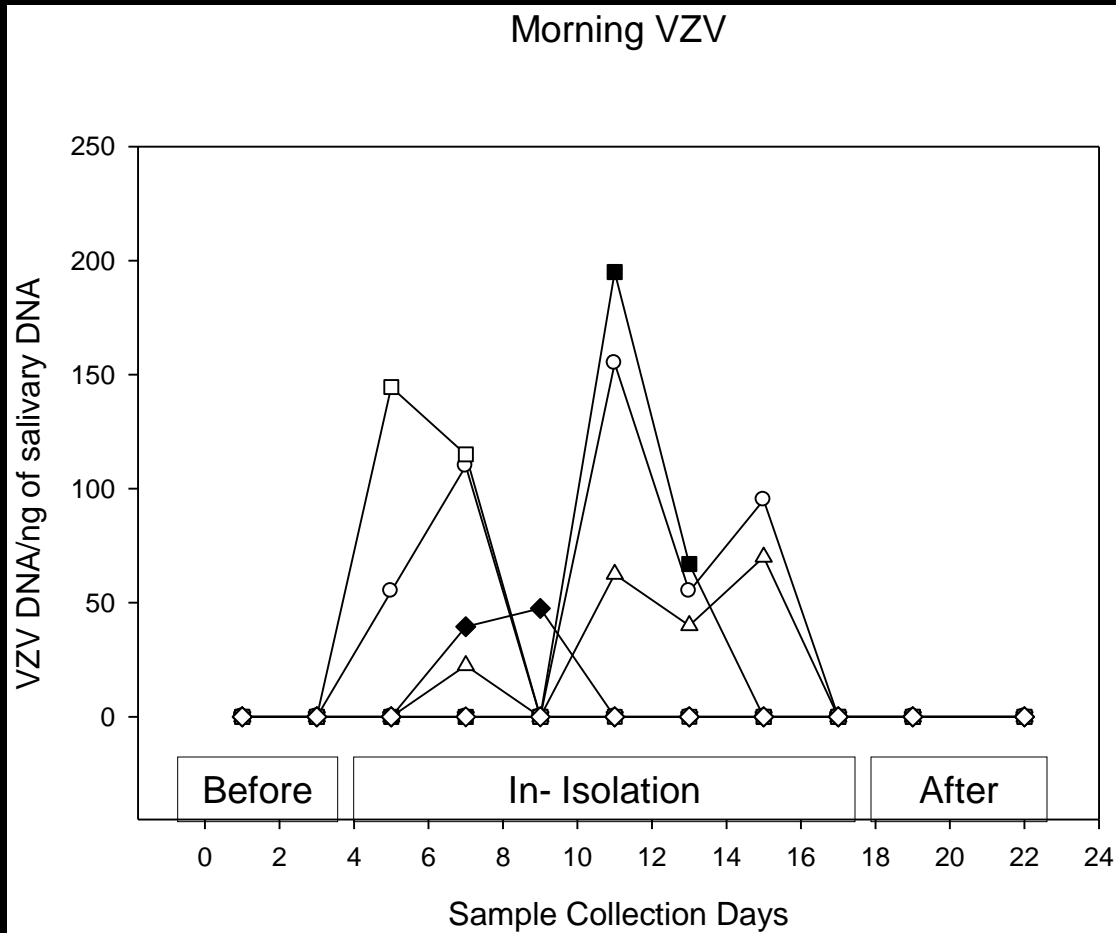


# Overwinter Data: VZV Reactivation

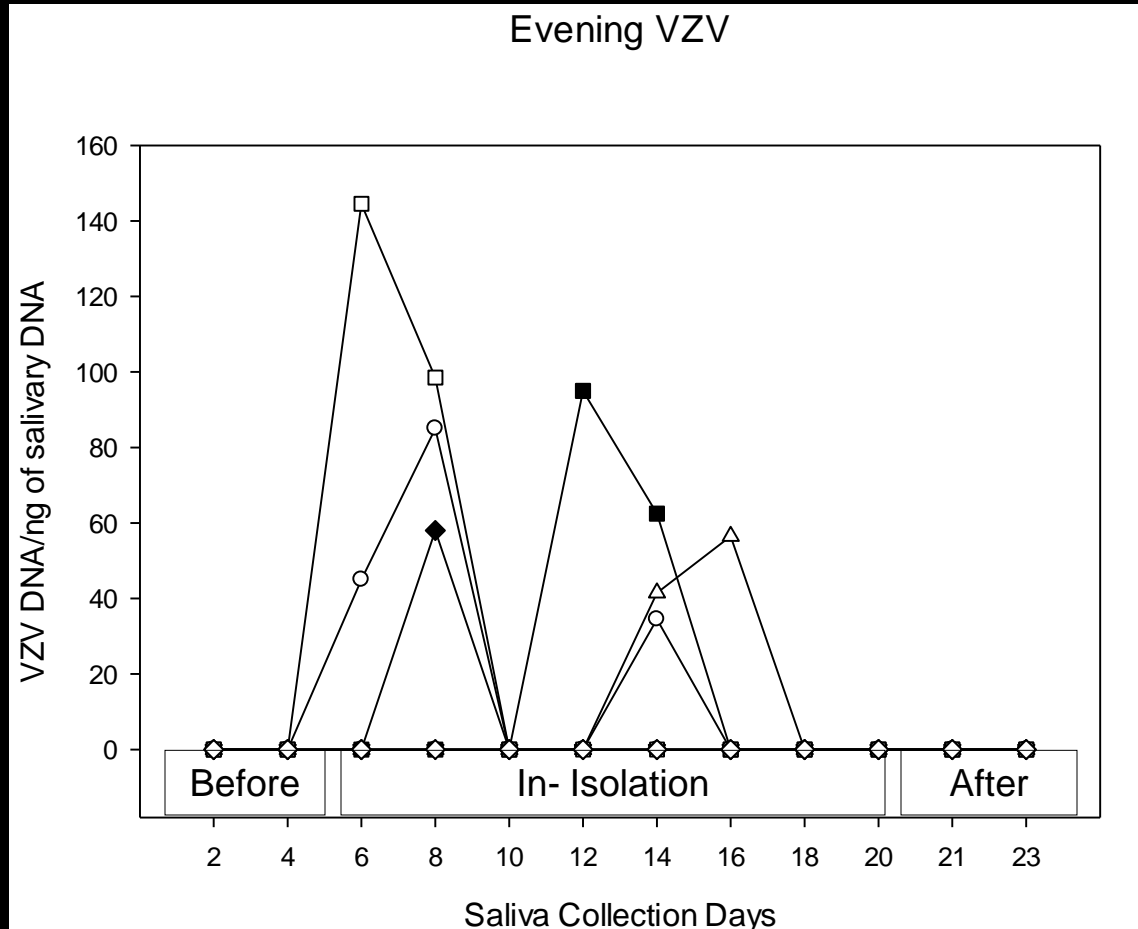
Varicella Zoster Virus in Saliva Concordia subjects before, during and after isolation.



# Overwinter Data: VZV Reactivation (AM)



# Overwinter Data: VZV Reactivation (PM)



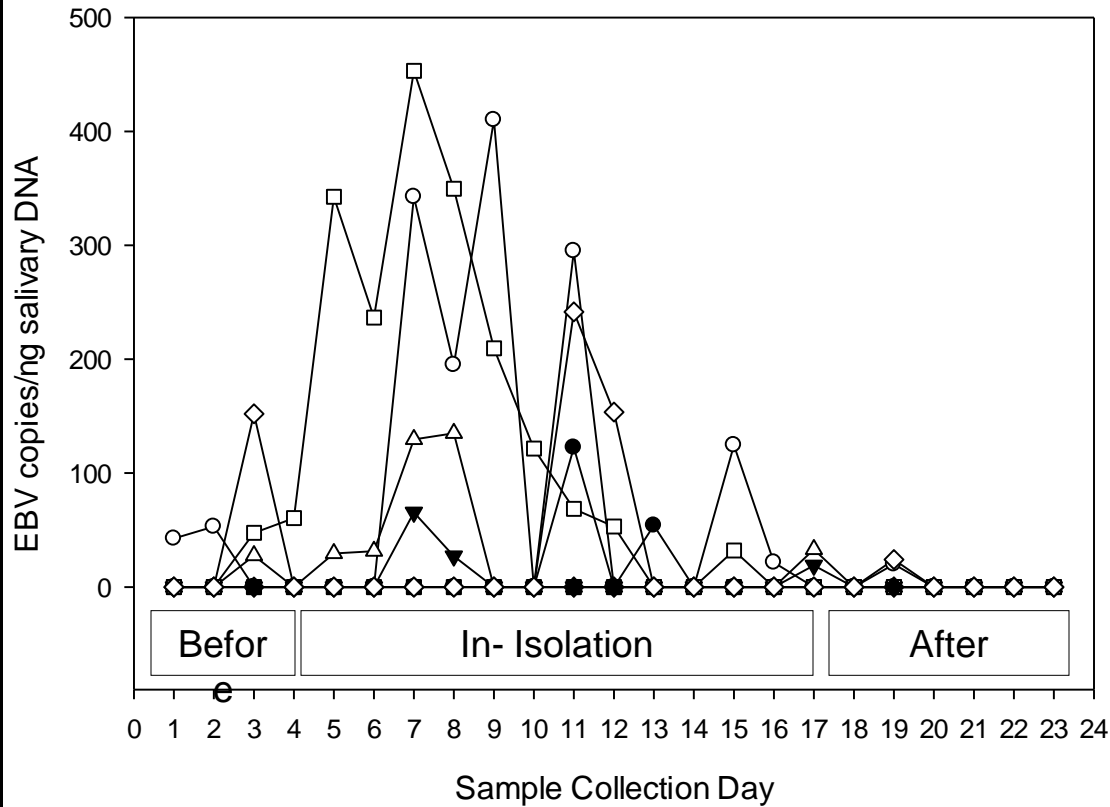
# Overwinter Data: EBV Reactivation

		Before		In Isolation							After
		Feb (M)	Mar (M)	Apr (M)	May (M)	June (M)	July (M)	Aug (M)	Sept (M)	Oct (M)	
G	JFV	-	-	-	-	-	+	+	-	-	-
H	DM	-	NA	NA	NA	NA	NA	NA	NA	NA	NA
J	JMM	+	-	-	+	+	+	-	+	-	+
K	CR	-	-	-	+	-	-	-	-	+	-
L	GD	-	+	+	+	-	-	-	-	-	-
M	AB	-	-	-	-	-	-	-	-	-	-
N	LM	-	+	+	+	+	+	-	+	-	-
O	KA	-	-	-	-	-	-	-	-	-	-
P	AR	-	+	-	-	-	+	-	-	-	0
J	AL*	-	-	-	-	-	-	-	-	-	-
	MF	-	-					-	-	-	-
	AC'	-	-					-	-	-	-



# Overwinter Data: EBV Reactivation

EBV in Saliva of Concordia subjects before, during and after isolation



Questions?

